ENCOURAGING INSTALLATIONS OF THIRD PARTY DISTRIBUTED SOLAR PHOTOVOLTAIC OWNERSHIP AS A STRATEGY FOR DECREASING WASHINGTON STATE'S GREENHOUSE GAS EMISSIONS

by

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ABSTRACT

Encouraging installations of third party distributed solar photovoltaic ownership as a strategy for decreasing Washington State's greenhouse gas emissions

Rudi Francisco Acevedo

Minimizing the effects of anthropogenic climate change has become a global priority. Encouraging installations of third party distributed solar photovoltaic ownership combines both technology and policy in order to create a more aggressive strategy to decrease Washington State's greenhouse gas emissions. Washington has approximately 220 gigawatts (GW) of solar electricity available per year. In 2013, the state generated 12.9 GW of electricity, of which 2.2 GW came from polluting sources. If at least 22 % of residential and 65 % of commercial buildings had average sized solar panels for their respective size, 11.4 GW of solar electricity could be produced in Washington. To more rapidly increase solar photovoltaic installations, third party solar photovoltaic ownership businesses should be given restricted access to the in-state production incentives. These solar photovoltaic leasing businesses should only be given access to the in-state production incentive if they utilize in-state labor and solar photovoltaic equipment produced within the state. This would reduce both the GHGs emitted and dependence upon fossil fuels within Washington.

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1.0 Introduction

In November of 2006, the Washington State voters passed citizen initiative I-937, otherwise known as the Energy Independence Act. This act showcased the people of Washington State's concerns over a clean and independent energy future for their state. When the act passed, section 19.285.020 of the Revised Code of Washington (RCW) stated:

> Increasing energy conservation and the use of appropriately sited renewable energy facilities builds on the strong foundation of low-cost renewable hydroelectric generation in Washington state [sic] and will promote energy independence in the state and the Pacific Northwest region. Making the most of our plentiful local resources will stabilize electricity prices for Washington residents, provide economic benefits for Washington counties and farmers, create high-quality jobs in Washington, provide opportunities for training apprentice workers in the renewable energy field, protect clean air and water, and position Washington state as a national leader in clean energy technologies.

To achieve the goals of this RCW, the Washington State legislature set conservation and renewable energy targets for Washington utilities. Utilities that served at least 25,000 customers, beginning in 2006, were required to use renewable energy and energy conservation methods in serving those customers (WADOC, 2012). As of 2012, the 17 utilities that met this criterion provided 81 % of the electricity sold to retail customers in Washington. State law mandated these utilities identify and pursue all cost-effective, reliable, and feasible conservation methods as defined by RCW 19.285.030. In addition, the utilities were required to meet an ever increasing percent of their electricity generation through renewables: three percent by 2012, nine percent by 2015, and 15 % by 2020 (WADOC, 2012). Utilities were allowed to mix and match the following electricity sources to meet their goals: water, wind, solar energy, geothermal energy, landfill gas, wave, ocean, tidal, gas from sewage treatment facilities, biodiesel fuel, and biomass energy (WADOC, 2012). Existing hydroelectric generation would not count, though some modifications might. Conservation methods were also counted as a means of reaching their goals (WADOC, 2012). The Washington State Utilities and Transportation Commission (UTC) enforces these renewable electricity and conservation goals.

The UTC is a three-member commission appointed by the governor, with the mission to protect consumers through ensuring fairly priced, available, reliable, and safe services (WAUTC, 2011). The UTC describes itself as an agency that protects Washington's essential services by preventing those private utilities or public services from unfairly controlling their markets (WAUTC, 2011). This commission continues to be proactive in their pursuit of business regulation. The businesses they regulate include those in the following categories: electric, telecommunication, natural gas, water, household movers, solid waste carriers, private ferries, inter-city busses, charter buses, railroads, limousines, and nonprofit senior / handicapped transportation services. In July of 2014, the UTC had concluded that Third Party Ownership (TPO) businesses of "Solar Photovoltaics" (Solar PV) met the criteria for an electrical company according to RCW 80.04.020. Thus the UTC had requested the Washington State legislature to clarify their jurisdiction in matters of TPO (Danner et al., 2014). The UTC's request for clarification coincided with Governor Jay Inslee's passing of Executive Order 14-04.

On April 29th 2014, Governor Jay Inslee signed Executive Order 14-04. This executive order described the current and projected negative effects of climate change in Washington and included a plan to mitigate them. Portions of the plan specifically emphasized reductions in carbon emissions and coal-fire electricity generation, followed by recommendations for the usage and development of clean technologies. Specifically, the Governor called upon the Washington State University Energy Program, Washington State Utilities and Transportation Commission, Washington State Department of Commerce, and other state agencies to work with utilities, solar manufacturers, solar installers and stakeholders to review Washington's current solar status in addition to expanding its use in state. The review was completed late 2014, its highlight being the continuation of solar incentives, with slight modifications, and the authorization of TPO.

Solar power has become a promising renewable energy technology that may be able to alleviate Washington's dependence upon fossil fuels. Nationwide, solar power expansion has been supported by a wide of policy initiatives including revised building codes, rebates on equipment purchased, loan programs, production tax credits, and agreements by utilities to purchase the output of installed solar systems (DSIRE, 2015). However, as of the beginning of 2015, TPO businesses had not been allowed to utilize Power Purchase Agreements (PPA) because TPOs are not yet considered electrical companies in Washington (see Figure 1, pg. 4). The orange states in Figure 1 represent those that have allowed TPO's to utilize PPAs while the red specifically limits or disallows this. The states in white have not made a legal decision towards or against TPO's utilizing PPAs. Additionally the legislature must determine who has regulatory authority over TPO businesses and whether they should be allowed access to in-state solar financial incentives. This thesis will address TPO businesses and whether supporting them financially and through policy initiatives could serve as an effective strategy for reducing Washington's greenhouse gas (GHG) emissions.

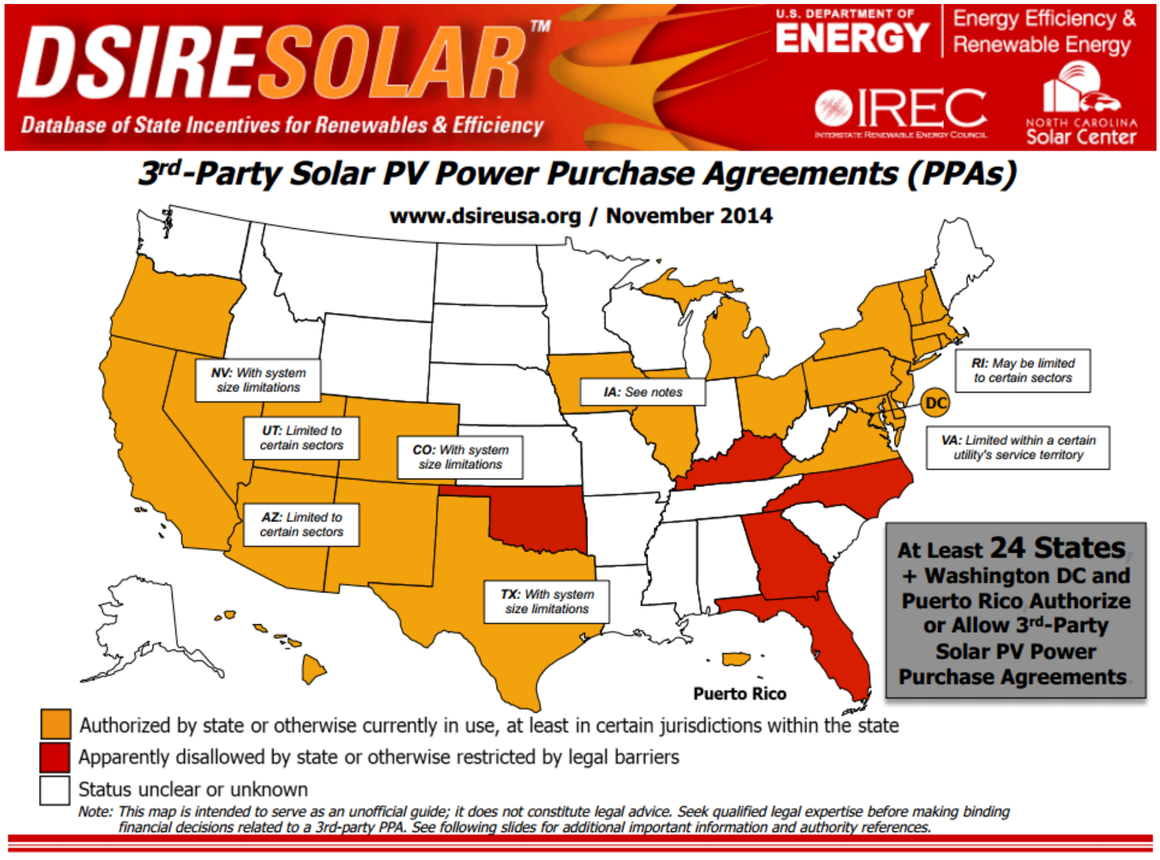

Figure 1. Third Party Solar PV Power Purchase Agreements (DSIRE, 2014)

1.1 Climate Change

The word "climate" refers to a region's weather patterns over a period of time. The term "climate change" has come to denote the changes in climate caused by an increase of GHG emissions into the atmosphere (IEA, 2014). Throughout the life of our planet, climate regions have shifted and changed due to natural processes. More recently, these changes in climate have occurred at an increased rate when compared to natural processes. Over the past century, the estimated difference in the earth's surface temperatures increased by 1.4ºF (EPA, 2014). The predicted change for the 21st century ranges from 2 to 11.5ºF (EPA, 2014). These temperature changes drive the shrinking of glaciers, thawing of permafrost, shifting of species ranges, and other effects (IPCC, 2014). Scientists have a "high confidence" that the increase in GHG emissions caused these temperature changes. The term "high confidence" translates to an 80 % likelihood that the change in temperature can be attributed to GHG emissions.

Are humans responsible for the GHG emissions causing climate change? According to the Intergovernmental Panel on Climate Change's (IPCC) report, "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century" (IPCC, 2014, pg. 3). The panel specifically estimates that human activity, specifically the burning of fossil fuels, has a 95 % chance of causing the majority of climate change (IPCC, 2014). When burned, fossil fuels release carbon which combines with oxygen in the atmosphere to create carbon dioxide or CO_2. This and other GHGs trap the sun's heat by either preventing or slowing its release back into space (EPA, 2014). Fossil fuel power plants burn said fuels to turn water into steam which will push a turbine in order to generate electricity. During the burning of those fuels greenhouse gasses are emitted.

According to Davis et al. (2010), if no new energy infrastructure were built, global GHG emissions generated from 2010 to 2060 would raise the global temperature by 33.3ºF compared to the pre-industrial era. Assuming the current rate of energy infrastructure expansion, Davis et al. calculate that the new energy infrastructure would increase current mean global temperature from 36.3 to 40.3ºF by 2100. If this estimate is accurate, the most damaging impacts to the climate will come from facilities not yet built. Thus, as more nations begin to create or expand their energy infrastructures, their desire for energy sources, renewable or fossil, will grow. In order to avert the damage, Davis predicts that nations will need to rely more upon renewable energies.

1.2 Renewable Energy

According to the IPCC, all societies require energy to serve basic human needs of lighting homes, cooking, and using communication devices. This reflects a drastic shift in thought from the view of of electricity being a luxury--the IPCC has deemed it a basic human necessity. In reality, humans can, and a significant number of cases do, live without access to electricity, but the push is on to increase electricity access across the globe. That will require an increase in electricity production. To meet this relatively new and growing electricity demand, some burgeoning energy infrastructures harvest fossil fuels (IPCC, 2011). However, alternatives to fossil fuels do exist.

Renewable energy derives from sources such as wind and solar, which replenish at a faster rate than they can be consumed, or are not consumed at all (IEA, 2014). Fossil fuels take millions of years to form and, as such, are finite within human lifetimes and are not considered renewable. Six major sources of renewable energy exist: biofuels, solar, geothermal, hydro, ocean and wind (IPCC, 2011).

The question then becomes, “Can renewable energy sources provide enough energy to offset the consumption of fossil fuels in electricity production?” In 2008, humanity generated approximately 2,416 gigawatts (GW) of electricity (EIA, 2011). Of the top six renewable energy sources, solar energy had the highest minimum and maximum potential, rated at 49,910 and 1,579,273 GW respectively (IPCC, 2011). Due to solar PV’s modular nature, solar can produce electricity in both centralized and decentralized installations, centralized being utility scale and decentralized commonly located on rooftops (IPCC, 2011). The minimum combined potential of all six renewable sources would be 59,733 GW of electricity in a year; the maximum combined potential would be 1,670,664 GW of electricity in a year (IPCC, 2011). Thus, when combined, these sources of energy can easily exceed the world's current energy demand many times over.

In comparison to fossil fuels, renewable energy technologies are still relatively new, even though the basis of the technologies that they comprise of may be ancient. Windmills and watermills have existed for centuries, but instead of creating electricity people harnessed wind and water to do work, grinding grain or pulling water from below the ground. With the invention of steam power, fossil fuels, especially coal, became the fuel of choice for the Industrial Age that started in Great Britain. Eventually, those same fossil fuels would be used to generate electricity. The last century has given rise to greater concern over the harmful effects of pollution, the dangers of climate change and the limited amounts of fossil fuels available worldwide. These concerns have led to a more aggressive investigation of renewable technologies potential. Of renewable technologies solar had the highest potential (IPCC, 2011). Thus, while other renewable energy technologies are being developed, solar can provide electricity and do so by utilizing existing human infrastructure for siting.

1.3 Powering Washington State with Solar Photovoltaics

Jacobson et al.'s data show that Washington will require approximately 15.2 GW of electricity delivered by 2050, compared to the 10.3 GW delivered in 2010 (Jacobson et al., 2014). This increase would be fueled by a 47 % increase in Washington's population by 2050, compared to the U.S. average of 29.5 % population increase, based on a 2013 report by the U.S. Census Bureau. The U.S. Census Bureau released a new expected population growth chart stating the average growth as 25.4 % instead of 29.5 % (Colby and Ortman, 2015). Using the newer figure, Washington's required electricity would be 14.4 GW instead of 15.2, approximately a five percent difference. Jacobson et al.'s solution to growth in population and in electricity demand would be an all renewable energy fueled Washington, which would receive 28 % of its electricity through solar photovoltaics (Jacobson et al., 2014). However, the researchers estimate that if any future need determinations include 100 % renewable Washington by 2050, energy delivered would only have to be to be 9.1 GW. Despite this population growth, per capita electricity usage would not increase in Jacobson et al.'s future scenario. Jacobson et al. predict that the savings from a 100 % renewable Washington will result in a 34.4 % reduction in energy delivered due to the efficiency of switching to electric heating and electric motors. Additionally, they predict a 5.4 % reduction due to conservation measures.

One alternative to utility scale solar is Distributed Solar Photovoltaics (DSPV). "Distributed" refers to electricity that is produced on or near the site where it is being used (SEIA, 2014). DSPV units can be mounted on top of building roofs, above parking lots or on open land near structures. The flexibility of DSPV permits it to be installed in a wide variety of locations. Unless the DSPV installation is independent from the grid, the electricity generated gets fed directly back into the grid. This flexibility makes DSPV a very promising renewable technology worth further investigation.

Jacobson et al. estimate that utility scale solar PV could generate 15 %, or 1.4 GW, of the state's electricity needed by 2050, whereas rooftop solar PV could provide 13 %, or 1.2 GW, of Washington future power load, using 5 kW residential systems and 100 kW commercial systems. The utility scale solar PV would be most effective at generating power on the eastern side of Washington, where more open land and greater solar irradiance exist (see Figure 2). The red areas on the image show the areas of highest solar irradiance (solar power per unit area), with dark blue being the lowest.

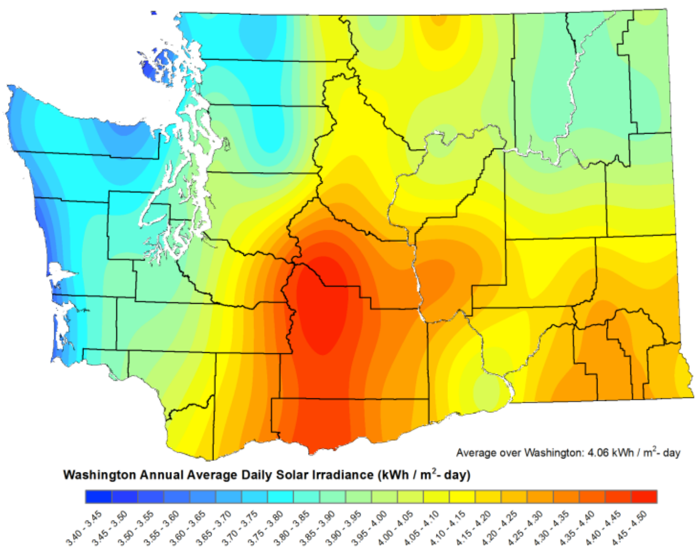

Figure 2. Representation of Washington State's Annual Average Daily Solar Irradiance (Jacobson et al., 2014)

1.4 Problems with Solar Photovoltaics

1.4.1 Production Window

One of the more common issues with solar PV is the "production window". Solar electricity production begins increasing in the morning and peaks at midday to the late afternoon, depending on a panel's position relative to the sun. Electricity production begins to decline in the evening and plateaus at night when the sun is not shining. In contrast, electricity consumption has a slightly different curve. Consumption increases in the morning, which leads to the first daily peak when people and businesses turn on electric appliances and equipment. In the afternoon consumption plateaus but reaches a second peak when individuals arrive home after work and turn on air conditioning or heat, stoves, televisions, computers, and other electronic devices. After this second daily peak, energy consumption falls to its lowest level until the following morning. Solar systems produce the majority of their electricity between the two daytime electricity use peaks.

Solar electricity generation could help Washington reduce its dependence upon fossil fuels. The excess, if any, produced during midday could be sold, or as storage technology develops, saved for later use. Most importantly, utilizing solar electricity for base load[1] electrical generation could reduce dependence on fossil fuel fired generation during the day, potentially reducing GHG emissions. Solar-based daytime generation could reduce dependence upon other energy sources, such as hydroelectric, allowing those other energy sources to be utilized more at night or during the day only to meet drastic increases in energy demand ("peak demand"). The technical issue of managing peak demand is separate but not independent from economic concerns regarding solar PV.

1.4.2 Economics

If solar PV has such potential, why is it not used? Up-front costs greatly limit the growth of DSPV (Glassmire et al., 2012). Depending on federal, state, local incentives

[1] Base load generation is the minimum amount of energy needed to meet demand.

and the maturity of the solar market, the cost of purchasing and installing DSPV systems can be prohibitive.

DSPV cannot effectively compete with other electricity generating sources because the costs are too high without some form of financial incentive. In 2009, prices ran 8.00 $/Watt (W) (Glassmire et al., 2012). In 2010, the price for DSPV energy fell between 6.20 and 5.20 $/W (Glassmire et al., 2012). If prices fall below 1.00 $/W, compared to 2012 market prices, DSPV could become a viable option for businesses and households (Glassmire et al., 2012).

At this time, increased demand for DSPV and government incentive programs are reducing costs in the U.S. In Washington, there are three levels of available incentive programs: federal, in-state production incentive, and utility-level net metering. Unfortunately, the in-state incentives are set to expire in 2020.

With utility-level net metering, the utilities must purchase or credit to an account the excess solar electricity produced by their customers. This complicates the task of meeting electrical demand because when solar peaks, during midday, utilities themselves may need to produce less electricity than in the morning or evening peaks. Utilities have to pay or credit the same amount for any excess solar electricity produced, making it potentially more expensive than their other energy sources. Thus, utilities may end up both losing demand as customers produce their own electricity and paying higher prices for electricity generation. This could lead utilities to raising their existing prices in order to compensate, passing on the cost to their existing customers.

Washington has an in-state production incentive in addition to the utility-level net metering program. If a customer purchases in-state equipment, their utility-level net metering payback can be increased from around $0.15 /kWh up to $0.54 /kWh (A&R Solar, 2012). The utility-level net metering applies to any customer of an offering utility, while the in-state production incentive provides its benefit to DSPV owners who have purchased equipment made in-state. However, only solar installations owned by the property owner may receive the in-state production incentive. This bars TPO businesses from receiving the in-state incentive since they do not own the properties they service.

1.4.3 Safety

Another issue with DSPV is safety. First, DSPV directly mounted on top of buildings, if improperly or poorly installed, could lead to roof damage. Second, DSPV produces electricity and requires proper wiring to prevent electrocution or fires. These two issues have led to a lengthy and expensive permitting process (SEIA, 2014).

1.5 Foreign Nation's Solutions for Promoting Solar Photovoltaics

Mitscher and Rüther (2012) analyzed the current competitiveness of distributed solar PV in Brazil. The researchers chose five state capitals that had two essential parameters: solar irradiation and electricity tariffs. They then analyzed three different interest rate scenarios for DSPV procurement: subsidies, mature market, and risk adjusted. They concluded that the lack of subsidies, which most effectively lower initial cost, had served as the greatest barrier to acquiring DSPV in Brazil. As of 2012, Brazil utilized less than 1 percent of its available solar energy (Mitscher and Rüther, 2012).

Many of the leading solar electricity producing nations utilize a government sponsored incentive program called feed-in tariffs (FIT). The FIT system creates different levels of payment to be applied to a variety of electricity generating technologies, giving priority to renewable energy sources connected to the grid (Tveten et al., 2013). In September 2014, a minimum of four of the top 10 solar electricity producing nations utilized FITs. Those nations were Germany, Italy, France, and Belgium (Wheeland, 2014). Of those, Germany had the greatest installed capacity, 35.5 GW, despite having significantly less solar energy than the United States, which was in fifth place with 12 GW installed (see Figure 3). The red regions in Figure 3 have the highest solar energy while the purple receive the least. The figure clearly demonstrates that the United States and even the Pacific Northwest have a greater solar resource than Germany. There is solar potential to be tapped in the U.S.

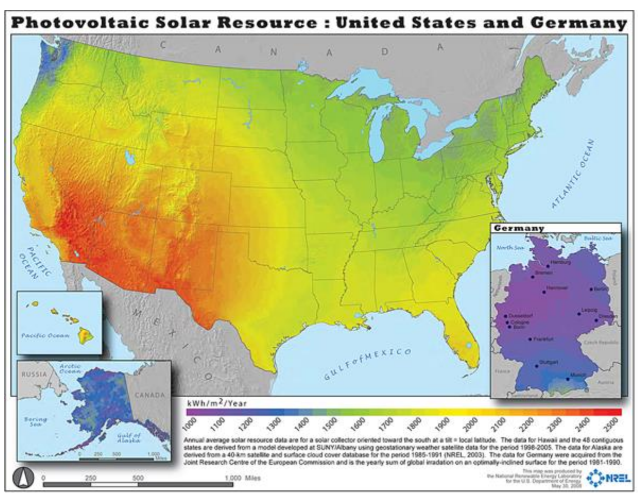

Figure 3. Photovoltaic Solar Resource: United States and Germany (NREL, 2008)

1.5.1 Germany

In 1990, Germany’s renewable energy installations provided three percent of that nation’s electricity (Tveten et al., 2013). By 2011, that contribution had been increased to

20 %. Germany's solar capacity had been increased from 0.1 GW in 2000 to 24.8 GW by 2011. And as of 2014, Germany is still the world leader at solar electricity production, rated at 35.5 GW of solar capacity (Wheeland, 2014). These changes began in 2000 when the German Renewable Energy Act provided a legal framework for fixed feed-in tariff contracts, guaranteed for 20 years (Tveten et al., 2013). As of 2013, the feed-in tariff set solar PV prices between 0.10 and 0.19 $/kWh whereas hydroelectric was rated between 0.04 and 0.14 $/kWh (Lang and Lang, 2013). According to Tveten et al., the high feed-in tariff rate for solar PV and decreased installation cost created this aggressive growth.

Despite the growth of solar in Germany, there has been considerable debate about whether or not the high feed-in tariff policy has achieved its goals effectively (Tveten et al., 2013). Frondel et al. have found that because it has the world's highest demand for solar PV, Germany's policy has actually raised the price of solar PV installations and lead to shortages in silicon (Tveten et al., 2013). The researchers also found that the increase in the use of solar power had not offset GHG emissions as well as the European Emission Trading Scheme. Frondel et al. concluded that a large investment in solar had drawn away government funding from investments into other alternative energy supplies and suggested that public funding may have been a better alternative to reducing solar PV's cost.

Frondel et al. emphasized the importance of the European Emission Trading Scheme in promoting solar. This system creates a cap on the total GHGs emitted by a nation's installations, such as power plants and factories (European Commission, 2015). The cap is lowered over time in order to reduce overall emissions. Companies can buy or sell their emission allowances. At the end of the year a company is fined heavily if it exceeds its emission limit. This approach can greatly reduce emissions by incentivizing measures to increase efficiency. However, a reduction in GHG emissions does not imply that a nation's base load generation is converting from fossil fuels to renewables. A nation could be using improved energy conservation methods, GHG reducing technologies or simply have a decrease in energy demand.

Since Frondel et al.'s research, Germany has continued its high feed-in tariff policies (Tveten et al., 2013). In both 2010 and 2011, as the country's solar markets established themselves, Tveten et al. calculated that average German consumer's electricity cost fell seven percent due to solar PV. The carbon offsetting potential of solar PV decreases the average price for electricity by 23 % instead of seven. Examples like this illustrate solar PV's true value, which is higher than its base production due to its other positive effects (Tveten et al., 2013).

1.6 U.S. Solutions for Promoting Solar Photovoltaics

In the U.S., the primary means of encouraging solar PV installation has been through programs such as net metering, renewable portfolio standards, tax incentives, subsidies, and feed-in tariff policies. Renewable portfolio standards (RPS) are regulations that require utilities and retailers of electricity to provide a certain percentage of their electricity generation through renewable energy sources. With net metering, utilities adjust a customer's electric bill by the amount of electricity they produce (Darghouth et al., 2011). If a customer uses more electricity than they generate, they have to pay the utility. If the customer uses less, they have no electric bill. Also, depending on the state using net metering, utilities can credit customers for the additional electricity they generate over what they consume. A new business model, third party ownership, has gained interest as a means of reducing DSPV costs.

1.7 Third Party Ownership

Up-front costs prove to be a great barrier to residential and commercial customers who want to buy DSPV. Traditional financing often carries high interest rates on loans for solar PV (U.S. DOE, 2014). Within the last decade, installers and developers introduced the concept of providing DSPV to customers without having them own the system, called third party ownership or TPO. Two forms of TPO have been developed: leasing and power purchase agreements or PPAs (U.S. DOE, 2014). With leasing, a contractor installs the system, the customer signs a contract and then pays a monthly fee to use the system without owning it, similar to a manufacturing equipment lease (SEIA, 2014). The customer pays either no up-front cost, or some of the system cost in exchange for a lower monthly rate. The customer may also have an option to purchase the system before the lease ends. With PPAs, contractors install the system on a customer's property at no cost. Instead of charging a monthly lease fee, the provider of the solar PV system charges the customer for the solar electricity they consume, typically at a rate lower than that of a local utility (SEIA, 2014).

In addition to avoiding the traditionally high up-front costs, TPO models can offer the customer installation, operation and maintenance guarantees, provided by the owner of the system (U.S. DOE, 2014). These guarantees allow a customer to enjoy the benefits of solar PV without having to deal with the difficulty or expenses of permitting or solar system upkeep. Because of these benefits, TPO has gained popularity in the U.S. (see Figure 4). Before 2010, PPA programs were still relatively new or did not exist in the states shown on the graph. In California, from 2009 – 2011, the percent of new TPO solar installations increased from 16 to 48 %, a level equal that of customer owned systems (Drury et al., 2012). The increase of TPO installations in the states shown could be in part attributed to the fact that each one allows PPA's. Furthermore, of the 24 states that allowed PPAs, California and Arizona where number one and two respectively in number of new solar PV installations in the second and third quarter of 2012 (SEIA, 2015). In that same list, Massachusetts had gone from sixth to fourth place and Colorado from 13th to 11th. This implies that of the 24 states, these four states have more aggressive state policies, business programs, or pricing structures that support the development of their solar PV industry.

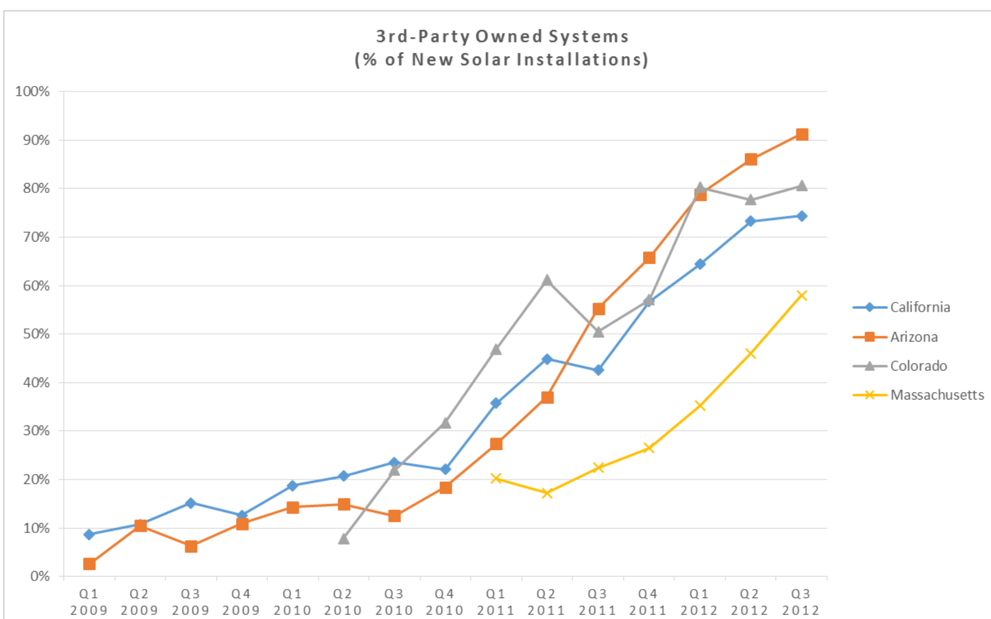

Figure 4. Percent increase of Third Party Owned solar installations based on date from the U.S. Department of Energy (U.S. DOE, 2014)

1.8 Concerns Regarding Third Party Ownership

Concerns about TPO are not inconsequential. The issues it faces include but are not limited to: contracts, industry regulation, access to government programs, and out of state ownership. These business issues also coincide with the technical problems that plague solar PV: the production window, economics and safety.

1.8.1 Contracts

TPO contracts are similar to but more complex than a manufacturing lease. When a customer signs a contract for manufacturing equipment, they sign a legal document promising proper usage and maintenance for the equipment. Broken lease rules lead to penalties. With TPO, the customer leases electricity generating equipment. Because of the hazards and difficultly permitting, a much more comprehensive contract needs to be created for leasing solar PV systems and PPAs. The UTC identified seven risks that consumers face with TPO Contracts: fraudulent / deceptive business practices, quality of installed systems, unfulfilled contract obligations, securitization of consumers' lease payments, possible limitation of consumers' legal remedies, inadequate communication / disclosure of contract terms, and impacts on the sale of a customer's home (Danner et al., 2014).

In terms of fraudulent and deceptive business practices, consumers have reported that certain companies used aggressive door-to-door sales agents who tricked them into signing a lease instead of just an agreement for the promised solar assessment (Danner et al., 2014). The agents also claimed the DSPV output was greater than the actual performance of those systems installed.

The second risk outlined by Danner et al. concerned the quality of the installed systems. Consumers alleged claims of poor workmanship and systems that did not meet electrical code or utility interconnection requirements (Danner et al., 2014). Faulty installations may void a homeowner's roof warranty.

According to the UTC, consumers bear the risk of unfulfilled contract obligations when going into a twenty-year contract with a company (Danner et al., 2014). TPO contracts generally state that the company will maintain, repair, monitor, and guarantee the output of the installed systems. Additionally, they will be responsible for returning the roof to its original condition at the end of the contract. If the company is immature there is greater risk of it being unable to fulfill the contract due to undercapitalization, bankruptcy, or cessation of operations (Danner et al., 2014).

The fourth risk concerns the new financial models that TPO companies are utilizing. The UTC's study found that two TPO companies respectively used web-based investment platforms and securitized bond offerings to finance their businesses' (Danner et al., 2014). These novel forms of financing contain unknown impacts for their customers.

Next, depending on the contract, consumer's ability to seek judicial review of disputes may be limited (Danner et al., 2014). The contracts may even limit a consumer's ability to join a class action lawsuit.

The sixth risk involves inadequate disclosure of contract terms. The TPO contracts reviewed by the UTC required consumers to keep solar panels clear of shading and clean (Danner et al., 2014). Customers alleged that without being informed they had to completely remove mature trees on their property. In addition, customers had great difficulty reaching customer service to receive further explanation of the lease.

The seventh risk identified by the UTC relates to impacts on the sale of a customer's home. The UTC found that all of the TPO contracts they reviewed limited a consumer's right to transfer the contract upon sale of home (Danner et al., 2014). If the home owner had a high enough credit score, they could transfer the equipment lease to the new home owner. However, if they did not meet the credit requirement, the original home owner would have to pay the full balance or add that cost to the sale of the home (Danner et al., 2014).

TPO contracts can be complex. The risks of leasing a solar PV system extend beyond just these seven risks. Poor quality solar PV installation can lead to roof damage while faulty wiring may lead to fires or electrocution. Thus, larger scale electricity generating equipment is generally regulated.

1.8.2 Regulation

TPO installations generate electricity but in Washington they are not considered an electrical company. Because of this, TPO businesses do not have to meet the same consumer protection and safety regulations that electricity producing companies fall under. The UTC has stated that TPO businesses meet the definition of an electric company as described by RCW 80.04.010 (12):

> "Electrical company" includes any corporation, company, association, joint stock association, partnership and person, their lessees, trustees or receivers appointed electricity solely for railroad or street railroad purposes or for the use of its tenants and not for sale to others), and every city or town owning, operating or managing any electric plant for hire within this state. "Electrical company" does not include a company or person employing a cogeneration facility solely for the generation of

> electricity for its own use or the use of its tenants or for sale to an electrical company, state or local public agency, municipal corporation, or quasi municipal corporation engaged in the sale or distribution of electrical energy, but not for sale to others, unless such company or person is otherwise an electrical company.

Specifically the UTC found that TPO solar systems met the definition because of the wording “for hire” (Danner et al., 2014). Furthermore, the UTC had declared that if the Washington State legislature does not act, it will consider acting in order to propose and adopt rules on how they would regulate TPO companies.

1.8.3 Financial Incentive Program Access

TPO companies have varied access to financial incentive programs. In Washington these companies have access to the federal tax credits and the net metering program (Danner et al., 2014). They do not have access to the in-state production incentive because of caveat 204 in Washington Administrative Code 458-20-273, which states that only customers of an electric utility that own a renewable energy system may utilize the incentive. A TPO company, by default, does not own the property on which they install their equipment. If TPOs were given access to it and it were passed on to the consumer in some manner, the incentive could further lower the cost of a TPO lease or PPA for the end user.

TPO companies may not be located in the state housing the customers they service. Local solar installers have voiced the concern that if TPOs were given access to the in-state production incentive, out of state TPO companies would potentially take a greater share of the incentive than in-state companies and would remove those economic gains from the Washington.

The many concerns regarding TPO are not insurmountable. They require careful consideration to resolve. Discovering those considerations drove my research.

2.0 Methods

This thesis utilized a mixed methods approach. Qualitative interviews provided background and policy information in regards to TPO. Quantitative analysis determined the potential effectiveness of TPO for increasing DSPV and its consequent potential for reducing GHG emission.

The individuals chosen for interviews specialized in their respective fields. The questions asked of them related to their fields of expertise. Because of the nature of the questions asked, there was no need to go through the full Human Subjects Review. Four individuals were contacted through phone and email. Meetings with two of the individuals were held at their offices, while the other was held at a public venue. For the interview, pen and paper were used to record notes, one individual allowed a recording device to be used. All interviewees were asked the same initial question, "What are your concerns about TPO as a strategy for reducing GHG emissions, from your professional standpoint?"

Quantitative calculations determined both solar potential and the amount of GHG emissions potentially offset by TPO installations.

3.0 Results

This chapter provides an overview of the key findings of the research conducted for this thesis, beginning with a review of the contents of the interviews, then moving into a discussion of the quantitative results.

Interviewee one was an energy researcher. Their expertise was in solar energy's potential / mechanics and had no opinion on problems with TPO. This individual's knowledge served as a means to solidify my understanding of solar technology.

Interviewee two was an energy installer who focused on the economics and incentives surrounding solar PV. This interviewee was interested in TPO companies' accessibility to the in-state production incentives for solar PV. Interviewee two stated that there are enough in state financial loan programs for consumers to acquire solar PV without needing to incentivize TPO businesses. This individual's opinion was based on current questionable TPO business practices by one particular company. The interviewee stated that this specific TPO business was quoting the value of their equipment at double its actual cost in order to unfairly garner additional financial support. Thus, interviewee two felt that TPO companies should not have access to the in-state production incentives unless strict safeguards were put in place to limit their access.

The final interviewee was an energy policy specialist with a concern about the regulation of TPO companies. The energy policy specialist had determined that these companies should be regulated like a utility in order to provide consumer protection against bad business practices in addition to insuring proper and safe installation. This individual believed that solar PV today still suffers from its traditional problems, as described earlier in section 1.4.

Understanding the issues surrounding TPO is just one part of the question. The following is a description of calculations used in this thesis, beginning with the solar potential in Washington. The annual solar potential in Washington is 3.64 kWh/meter^2/day (Itek Energy, 2015). Multiplying that number by the days per year and then dividing by hours per year yielded the average Kilowatts produced in a year per meter^2. That value, multiplied by the number of rooftops, then multiplied by the average size of a solar system yielded the Gigawatts produced in a year. Residential solar systems averaged 5 kW in size (Jacobson, 2014). Commercial solar systems averaged 100 kW in size (Jacobson, 2014). The panels consisted of one meter by 1.65 meter dimensions (Brightstar Solar, 2014). Researchers at Environment Washington, using NREL and the U.S. Census Bureau's methodology and data, calculated that approximately 22 % of residential rooftops (641,251) and 65 % of commercial rooftops (81,610) were available for solar PV (Burr et al., 2014).

<u>Meter^2 Calculation for Residential Rooftops</u>

1. 1.65 meter x 1 meter = 1.65 meter^2

2. $$\frac{1.65 \text{ meter}^2}{250 \text{ W}} = \frac{x}{5{,}000 \text{ W}}$$

3. 20 (1.65meter^2) = x

4. x = 33 meter^2

<u>Solar Potential Calculation for Residential Rooftops</u>

1. $$\frac{3.64 \text{ kWh/meter}^2/365}{8{,}765.81 \text{ hours/year}} = .152 \text{ kW/meter}^2\text{/year}$$

2. (.152 kW/meter^2/year) x (641,251 res. roofs) = 97,470.152 kW/meter^2/year

3. (97,470.152 kW/year) x (33 $meter^2$) = 3,216,515.016 kW/year ≈ 3.2 GW/year

<u>$Meter^2$ Calculation for Commercial Rooftops</u>

1. 1.65 meter x 1 meter = 1.65 $meter^2$

2. $$\frac{1.65\ meter^2}{250\ W} = \frac{x}{100{,}000\ W}$$

3. 400 (1.65$meter^2$) = x

4. x = 660 $meter^2$

<u>Solar Potential Calculation for Commercial Rooftops</u>

1. $$\frac{3.64\ kWh/meter^2/365}{8{,}765.81\ hours/year} = .152\ kW/meter^2/year$$

2. (.152 kW/$meter^2$/year) x (81,610 com. roofs) = 12,404.720 kW/$meter^2$/year

3. (12,404.720 kW/year) x (660 $meter^2$) = 8,187,115.200 kW/year ≈ 8.2 GW/year

The data utilized for the calculation of GHG emissions offset by TPO installations came from the U.S. Energy Information Administration; it listed how many megawatt hours were produced in Washington State for the past few decades. I choose the most recently published data, 2013, to estimate GHG emissions. Based on Washington's electricity production mix, to every megawatt hour generated in Washington by fossil fuels, 0.4 lbs. of Sulfur Dioxide, 0.2 lbs. of Nitrogen Oxide and 132 lbs. of Carbon Dioxide were released (EIA, 2012). The total emissions from all sources in Washington equaled approximately 3,592 metric tons of Sulfur Dioxide, 1,796 metric tons of Nitrogen Oxide and 1,185,360 metric tons of Carbon Dioxide. The emissions generated were from coal, natural gas, biomass, other gas, petroleum, pumped storage, wood and wood derived fuels. Coal and natural gas combined, produced 89 % of those emissions.

This demonstrates the importance of determining what percent of the state's energy came from those two sources. I took the megawatt hours produced in a year and converted them to gigawatts hours. I then divided that number by the hours in a year and generated a total number of gigawatts produced in a year. Performing the calculation with all polluting sources determined both how much energy had been produced by these sources and how it compared to the state's overall energy generation.

<u>Megawatt hours produced in Washington 2013 converted to gigawatts generated in 2013</u>

$$\frac{113{,}321{,}342 \text{ MWh}}{8{,}765.81 \text{ hours}} = 12{,}927 \text{ MW in 2013} \approx 12.9 \text{ GW in 2013}$$

4.0 Discussion

According to researchers at Environment Washington, a citizen-based environmental advocacy organization, and using data from the National Renewable Energy Laboratory and the Energy Information Administration, Washington generated 0.001 gigawatts of solar electricity in 2013 out of the approximate 220 gigawatts available in the state (Burr et al., 2014). This means that the state currently utilizes significantly less than one percent of the available solar electricity.

The DSPV potential in the Washington State could match the current levels of consumption. In 2010, Washington State consumed 10.3 gigawatts of electricity (Jacobson, 2014). In 2013, this amount increased to 12.9 gigawatts (EIA, 2015). According to the calculations described above, if 22 % of residential rooftops and 65 % of commercial rooftops were covered with solar PV, the state would generate 11.4 gigawatts of power in a year through solar electricity. This would be equivalent to harnessing five percent of the available solar electricity in Washington.

In 2013, Washington had, on average, 17 % of its electricity produced from GHG emitting sources. In 2013, hydro produced 8.9 gigawatts of the 12.9 consumed, or 69 %. When combined with other non-GHG emitting sources: nuclear, pumped storage, solar and wind, the total reaches 10.7 gigawatts or 83 % of the electricity consumed. Thus, of those 12.9 gigawatts consumed, 2.2 came from polluting sources. Of that, coal and natural gas produce two gigawatts of the polluting electricity. Approximately 89 % of the GHG producing emissions came from those two sources. If solar PV replaced coal and natural gas electricity generation in Washington, the state's GHG emissions would be reduced by 3,197 metric tons of Sulfur Dioxide, 1,598 metric tons of Nitrogen Oxide and 1,054,970 metric tons of Carbon Dioxide.

5.0 Conclusion

It is vital to know the potential of any renewable energy source in order to determine its usefulness. Washington State has significant solar energy available for capture. Knowing that Washington State has 220 gigawatts (GW) of solar electricity available will help decision makers to support and fund the development of solar as an energy source. To illustrate, it would take approximately 2/3 of existing commercial rooftops and 1/4 of residential rooftops, covered in solar PV, to harness 5.2 % of the available energy. That equates to 11.4 gigawatts of electricity in a year.

The value of Washington's solar resource is twofold. First, solar electricity can be generated near the point of consumption, thus reducing loss of electricity during transmission and distribution. This reduces the need for base load generators and transmission or distribution facilities. Second, solar power can make use of existing architecture without infringing upon protected or undeveloped land. However, in order to be utilized on a larger scale, distributed solar needs to be developed more aggressively.

Allowing the development of a Third Party Solar Ownership (TPO) businesses in Washington could stabilize or increase solar installations in the state. TPO could significantly increase the market growth rate of solar electricity production. Starting 2015, if the rate were to match California's 70 % solar market growth rate, which already incentivizes TPO, Washington would generate 0.51 gigawatts of energy per year by 2025 (Schneider et al., 2013).

Increased solar electricity production could replace greenhouse gas (GHG) emitting electricity generators. TransAlta has agreed to close the state's last coal powered electrical units in 2020 and 2025. That electricity source provided the state with 0.77 GW of electricity in 2013. It generated 34 % of the pollution emitted from electricity generators in the state that year. Instead of investing in further production through natural gas or other GHG emitting sources, the electricity deficit resulting from the closing of the coal-burning facility could be offset by distributed solar photovoltaics (DSPV). If it were replaced by 0.58 GW of solar, 943 metric tons (t) of Sulfur Dioxide, 471 t of Nitrogen Oxide and 404,425 t of Carbon Dioxide emissions would be eliminated.

The benefits of solar PV are not limited to offsetting pollution. Increased solar energy production would ease the burden on hydroelectric resources. Climate Change is altering the amount of snow pack in Washington. According to Casola et. al. (2008), the state has lost 8 to 16 % of its snow pack over the last 30 years and will lose an additional 11 to 21 % by 2050. Snow pack is a primary, time released, source of crucial water for agriculture and town water supplies. During Washington's colder wet winters, precipitation would normally freeze and create snow pack in the mountains. When summer arrives, this snow pack melts to provide needed water during the drier seasons. With changing temperatures, less rain is turned into snow during the winter and that snow pack that does exist melts earlier, creating a pattern of wetter winters and drier summers. This becomes a problem because Washington's dams are designed to retain only a certain amount of water. If they receive too much, the excess must be released. Thus more rain can then be expected to fall at one time and subsequently have to be released downstream bypassing hydroelectric turbines. This problem is becoming noticeably worse, on May 15th 2015, Governor Jay Inslee declared a state wide drought emergency because this year's snow pack was 15 % of the normal level, 10 % lower than the last drought in 2005 (WADOE, 2015).

I recommend that TPO businesses be given access to the in-state production incentive while being under the oversight of the UTC. In order to ensure that the in-state production incentive supports the local solar markets, it should only be distributed to TPO businesses with certain safeguards. Namely, any TPO business may gain access to the in-state production incentive if they utilize in-state produced solar equipment and in-state solar installers. This change could make Washington more appealing to TPO businesses while still encouraging those businesses to utilize the local equipment and installers. The UTC would then be responsible for ensuring the quality of TPO businesses' services and goods, in order to protect consumers from bad business practices and hazardous installations.

Significant work still remains to be done. Although TPO businesses should be allowed access to the in-state production incentive, my research did not extend into how that incentive should be allocated to each party or for how long. Nor does this paper address the issue of Washington's solar incentives expiring by 2020. As of May 28th 2015 the legislature has not adopted any of the proposed solar incentive bills. And although TPO businesses are increasing the amount of solar installations, could Feed-in-Tariffs be a better way of drastically increasing solar PV in the U.S.? Additionally, can solar installation permitting costs be decreased without diminishing the thoroughness that is intended to promote safety? And lastly, could utilities utilize DSPV as an effective means of base load electricity generation? One question down, many more to go.

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