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NET ENERGY METERING AND COMMUNITY SHARED SOLAR DEPLOYMENT IN THE
U.S.: POLICY PERSPECTIVES, BARRIERS, AND OPPORTUNITIES

A dissertation submitted in partial fulfillment of the requirement for the degree of Doctor of
Philosophy at Virginia Commonwealth University

by

Gilbert L. Michaud

Bachelor of Arts, Economics, University of Southern Maine

Master of Science, Community Economic Development, Southern New Hampshire University

Director: Damian Pitt, Ph.D., Assistant Professor
L. Douglas Wilder School of Government and Public Affairs

Virginia Commonwealth University
Richmond, Virginia
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LIST OF ABBREVIATIONS

AC – Alternating Current
ALEC – American Legislative Exchange Council
APCo – Appalachian Power Company
BEA – Bureau of Economic Analysis
CCSA – Coalition for Community Solar Access
CGP – Catalog of US Government Publications
CHP – Community Housing Partners
CICV – Council for Independent Colleges in Virginia
CO₂ – Carbon Dioxide
CPP – Clean Power Plan
DC – Direct Current
DCS – Dominion Community Solar Pilot Program
DEQ – Department of Environmental Quality (Virginia)
DMME – Department of Mines, Minerals and Energy (Virginia)
DPV – Distributed Photovoltaics
DSIRE – Database of State Incentives for Renewables & Efficiency
DV – Dependent Variable
EIA – Energy Information Administration
EPA – Environmental Protection Agency
FERC – Federal Energy Regulatory Commission
FTG – Freeing the Grid
GDP – Gross Domestic Product
GHG – Greenhouse Gases
GPO – Government Printing Office
GTM – Greentech Media
GW – Gigawatt
HB – House Bill
IOU – Investor-Owned Utility
IPP – Independent Power Producer
IRB – Institutional Review Board
IREC – Interstate Renewable Energy Council
IRP – Integrated Resource Plan
IRS – Internal Revenue Service
ITC – Investment Tax Credit
IV – Independent Variable
kW – Kilowatt
kWh – Kilowatt Hour
LEAP – Local Energy Alliance Program
MDV-SEIA – Maryland/DC/Virginia Solar Energy Industries Association

MW – Megawatt
MWh – Megawatt Hour
NEM – Net Energy Metering
NEPA – National Environmental Protection Act
NGO – Non-Governmental Organization
NREL – National Renewable Energy Laboratory
OLS – Ordinary Least Squares
OPEC – Organization of the Petroleum Exporting Countries
PET – Punctuated Equilibrium Theory
PPA – Power Purchase Agreement
PUC – Public Utility Commission
PURPA – Public Utilities Regulatory Policies Act
PV – Photovoltaics
RPS – Renewable Portfolio Standard
SB – Senate Bill
SCC – State Corporation Commission (Virginia)
SEIA – Solar Energy Industries Association
SEPA – Solar Electric Power Association
SREC – Solar Renewable Energy Credit
SRI – Solar Research Institute
SSG – Virginia Distributed Solar Generation and Net Metering Stakeholder Group
SSWG – Small Solar Working Group
U.S. – United States
VA SUN – Virginia Solar United Neighborhoods
VACSAC – Virginia Community Solar Advisory Council
VCU – Virginia Commonwealth University
VSEDA – Virginia Solar Energy Development Authority

ABSTRACT

NET ENERGY METERING AND COMMUNITY SHARED SOLAR DEPLOYMENT IN THE U.S.: POLICY PERSPECTIVES, BARRIERS, AND OPPORTUNITIES

By Gilbert L. Michaud, Ph.D.

A dissertation submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy at Virginia Commonwealth University.

Virginia Commonwealth University, 2016

Major Director: Damian Pitt, Ph.D., Assistant Professor
L. Douglas Wilder School of Government and Public Affairs

Solar photovoltaic (PV) energy has become a topic of intense policy debate at the state level in the United States (U.S.). Solar supporters have pointed to the economic development, environmental, and public health benefits this technology can provide. However, electric utilities and other interests have fought to scale back or cut favorable state PV policies as grid-connected solar PV installations have increased, due to decreased profits, grid complications, and customer fairness, among other reasons. This research first uses a hierarchical regression analysis with cross-sectional data from the years 2012–2013 to examine the suite of state-level policies used to encourage state non-utility PV installations. Comparing the impact of various policy approaches to other factors such as electricity costs, electricity market deregulation, per capita income, and the availability of solar energy resources, this research finds net energy metering to be the most important policy driver of non-utility PV installed capacity. Given this finding, the research shifts its focus to community net energy metering or shared solar, which is

an innovative policy approach that allows multiple consumers to share the costs and benefits of ownership in an off-site solar PV facility, opening market access to a wide variety of individuals. Using the punctuated equilibrium framework and semi-structured telephone interviews with policy experts across the U.S. from the solar industry, environmental groups, government, and electric utilities, this research discovers that electric utility lobbying and an overall lack of attention have hindered community solar enabling legislation. However, opportunities exist for future development via increased participation, collaboration, and key events that may alter the policy equilibrium. Finally, this method is utilized in Virginia to more narrowly study why the state has dismissed community solar legislation multiple times. Such an approach is useful in understanding how other historically laggard states may adopt community net energy metering or shared solar legislation in the future.

1. INTRODUCTION

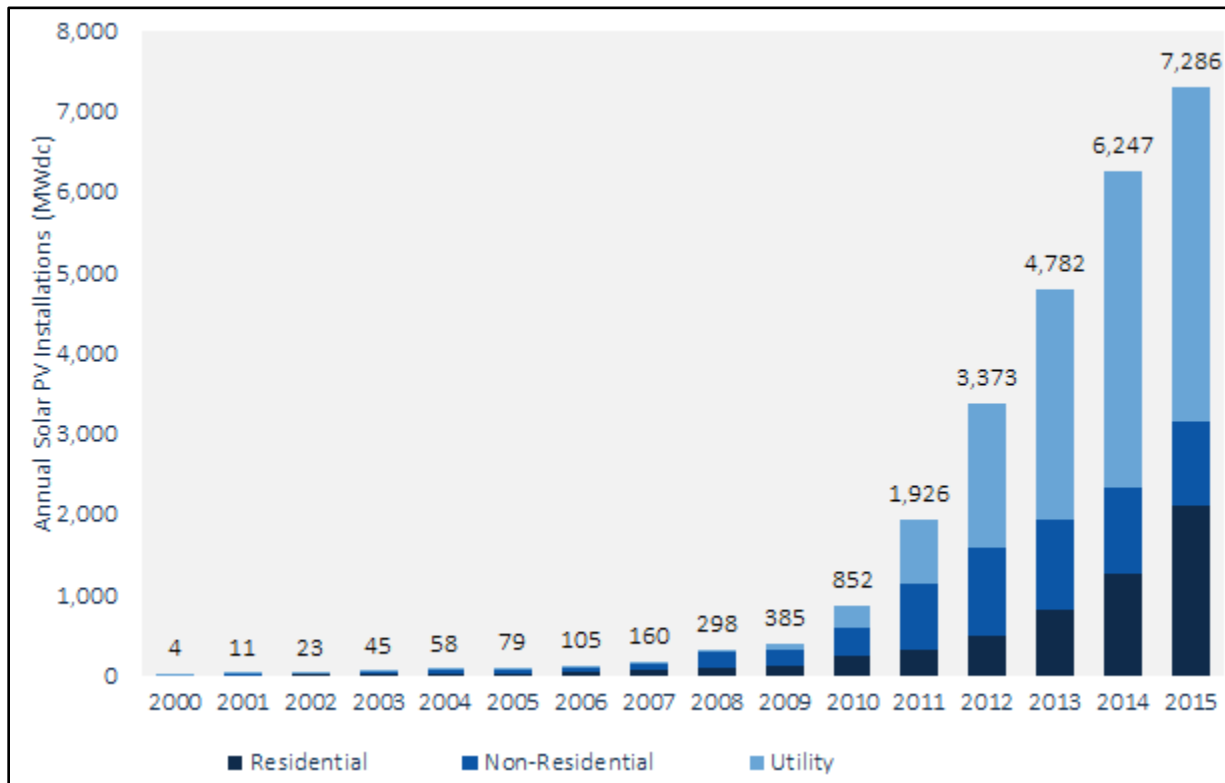
1.1. Background of the Study

Solar photovoltaic (PV) systems offer both a renewable and clean source of energy that can be an important element toward decarbonizing the United States' (U.S.) electricity generation portfolio. Electricity generation via solar PV can help reduce greenhouse gas (GHG) emissions to help mitigate future global warming and climate change impacts. Solar PV can also deliver crucial public health benefits and help avoid new generation capacity investments by electric utilities. Nevertheless, solar PV technology still represents less than 1% of the overall electricity generation in the U.S. (U.S. Energy Information Administration, 2015).

Despite this small percentage, reports indicate that solar PV deployment in the U.S. has been increasing significantly in recent years. In fact, to illustrate, solar PV made up roughly 40% of all new installed electric capacity in 2014, outpacing all other generation sources (e.g., coal, natural gas, wind, etc.) (Solar Energy Industries Association, 2015a). Solar PV deployment has been particularly growing for commercial and residential (i.e., non-utility) PV systems, also known as 'distributed PV' (DPV). The DPV phrase is used to distinguish these smaller-scale PV systems from larger, utility-scale PV systems. Since 2010, installed U.S. solar PV capacity has increased 755%, with roughly half of this increase from DPV alone (GTM Research, 2016). In 2015, grid-connected (net-metered) DPV totaled over 3,000 megawatts (MW) of total installed solar PV capacity (GTM Research, 2016), as shown in Figure 1, and this number continues to grow each year.

Figure 1.

United States Installed Solar Capacity in MW, 2000–2015

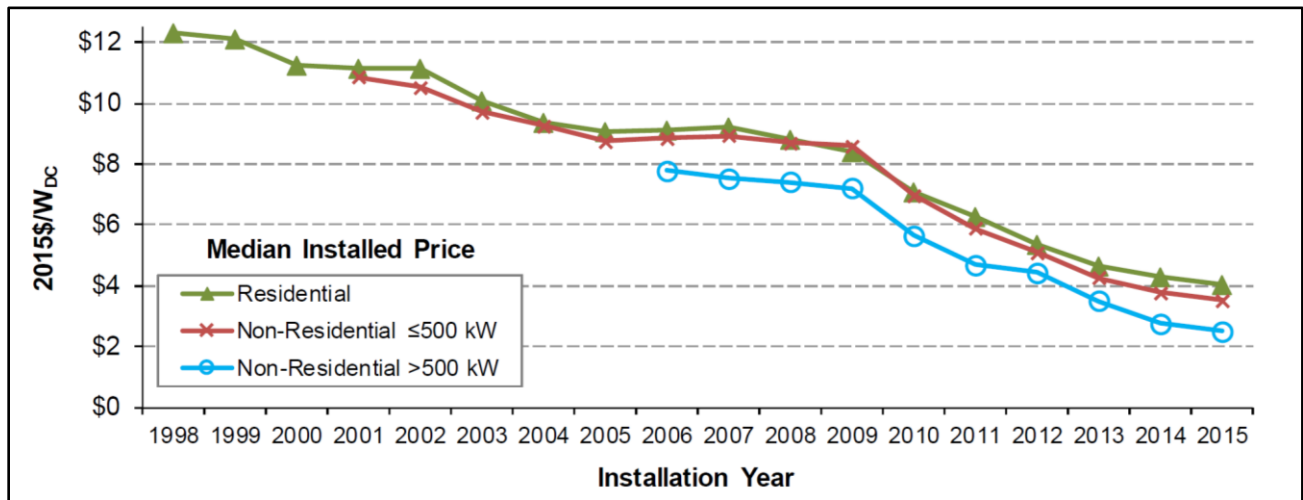


Note. Figure from GTM Research (2016).

In addition, the cost of solar PV materials and installation has decreased dramatically in recent years. As illustrated in Figure 2, the median installed price of residential solar PV systems has particularly diminished over the past decade, including a 50% drop (from an average of over \$8 per watt to about \$4 per watt) from 2009 to 2015 (Barbose & Darghouth, 2016). A Lawrence Berkeley National Laboratory report indicated that DPV installation prices are “falling year-over-year by 12 to 15% depending on system size” (Barbose, Weaver, & Darghouth, 2014, p. 1). Solar PV material costs (i.e., module costs) have also fallen 75% since 2007, from \$4 per watt to roughly \$1 per watt (Barbose & Darghouth, 2015). These cost reductions, in part, have stimulated the growth of PV markets in the U.S.

Figure 2.

Price Trends for DPV System Installations, 1998–2015



Note. Figure from Barbose and Darghouth (2016).

Public policies and other incentive programs have also contributed to increasing solar PV deployment figures. Particularly, state policymakers in the U.S. have been increasingly interested in developing solar PV energy marketplaces, yet it remains unclear what policy tool(s) to implement. States have adopted a variety of policies and incentives to promote the deployment of DPV systems, such as 1) personal or corporate tax credits, 2) property or sales tax exemptions, 3) low-interest loan programs, 4) grant programs, 5) renewable portfolio standards (RPS), 6) solar renewable energy credits (SRECs), 7) streamlined interconnection procedures, or 8) net energy metering (NEM) laws, among others. These policy tools are discussed in greater detail in section 1.2.2. Moreover, innovative models in several U.S. states such as lease programs, power purchase agreements (PPAs), and community shared solar arrangements have extended the prospects for solar PV investment and development.

However, in recent years, solar PV policy has become a subject of fervent policy debate at the state level for a number of reasons, largely stimulated by these increasing deployment

figures. As grid-connected solar PV installations have increased and NEM capacities have been reached, electric utility providers and other interests have fought to scale back or cut favorable state PV policies. Particularly concerning NEM laws, which are the most widespread policy tool used in the U.S. today (Database of State Incentives for Renewables and Efficiency, 2016), utilities have cited decreased revenues and net costs to ratepayers. Thus, there have been several pushes throughout the U.S. to establish fees for owners of DPV systems, limit system capacities, and/or restrict the types of eligible technologies eligible for NEM. Questions have also been raised about the valuation of benefits under NEM, and as of December 2015, 27 states were considering changes to their NEM laws (Pyper, 2015b). Other reports have indicated that 2016 and 2017 will be a telling year for NEM, especially as Public Utility Commissions (PUCs) in states such as Hawaii and Nevada have already decided to phase out their NEM programs (Bernhardt, 2016).

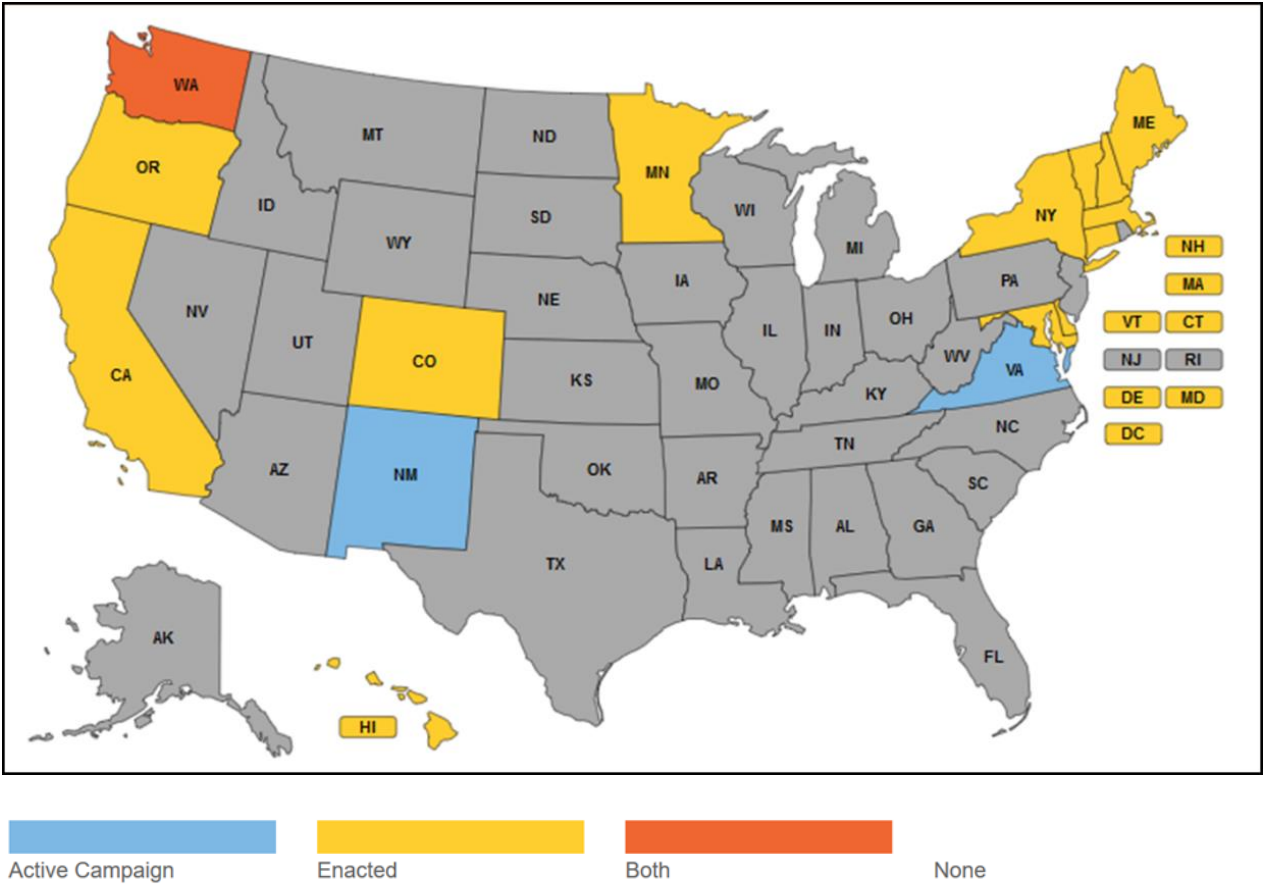
Some states have already expanded NEM and passed community NEM legislation, which is a common and effective way to permit community shared solar projects. Community NEM allows multiple electric utility customers to share the costs and benefits of ownership in a local solar PV facility. This is a particularly compelling approach since it allows renters, condominium owners, business owners, low-income individuals, and homeowners with obstructed roofs, among others, to purchase shares in an off-site facility and reap the benefits from a solar PV project. This is also important considering only about 25% of U.S. households have the structural ability to install solar panels on their roofs (Denholm & Margolis, 2008).

As revealed in Figure 3, 14 states, plus the District of Columbia, have enabled some form of community NEM or shared solar policy, while a number of others are considering (or have previously considered) adopting such policy (Shared Renewables HQ, 2016). However,

community shared solar policies have also faced considerable scrutiny, such as concerns about electricity price increases due to infrastructure improvements that increased PV penetration via community solar projects would cause (Jossi, 2015). Nonetheless, community shared solar policies continue to be implemented throughout the country, with five states (Connecticut, Hawaii, Maryland, New York, and Oregon) adopting such policy in the year 2015 alone (Shared Renewables HQ, 2016).

Figure 3.

U.S. Community Shared Solar Policy, 2016



Note. Figure from Shared Renewables HQ (2016).

1.1.1. Relevant Prior Research

Various academic studies have investigated the effectiveness of the range of state-level policy mechanisms to encourage DPV investment. Krasko and Doris (2013) used a cross-sectional regression to show that states with superior interconnection, NEM, and RPS installed more solar PV in the year 2010. Burns and Kang (2012) found that NEM, SRECs, and RPS solar carve-outs (i.e., the specific amount of the RPS that must be met by solar), are the best approach for successful PV markets. Sarzynski, Larrieu, and Shrimali (2012) showed that strong state RPS' and financial incentives are the most influential policies to encourage DPV. In essence, there is much discrepancy among this literature. Additionally, previous studies have merely looked at cumulative installed PV capacity figures (i.e., residential, commercial, *and* utility-scale), and not just non-utility, which is problematic in the discussion of community shared solar since the latter are the key subscribers in such arrangements. Additional research is needed to better understand NEM's effectiveness among the suite of state-level policies that exist to incent DPV.

Further, several have explained how community shared solar can provide financial benefits and mitigate concerns about climate change and rising energy costs (Bomberg & McEwan, 2012), while adding limited, if any, costs to ratepayers (Jossi, 2015). Community shared solar also achieves economies of scale, ideal project locations (Coughlin et al., 2012), collaborative emissions reductions goals, and enhances community cohesion (Hoffman & High-Pippert, 2010). Community NEM is often the key policy initiative toward enabling shared solar (Asmus, 2008), and prior research has addressed the various community shared solar models that exist (e.g., Coughlin et al., 2012). However, since no prior literature has addressed community shared solar policymaking processes in different state contexts, particularly considering the

debates that exist, further research is needed into the discourse, policy perspectives, obstacles, and opportunities for community NEM and shared solar throughout the U.S.

1.1.2. Purpose of the Study

Therefore, this study was developed to assess the impact of state NEM policy, while also examining the controversies surrounding community NEM and shared solar policy adoption. Among the various state policy incentives that exist to encourage DPV, in addition to possible non-policy elements such as income, deregulation, electricity costs, and solar energy resources, this study first seeks to analyze the effectiveness of state NEM policies. This research then uses that data and findings to supplement the analysis with an examination of the various perspectives concerning community NEM and shared solar deployment throughout the U.S. Better understanding the perspectives for and against community NEM and shared solar, as well as the political processes and forces that shape such policies, can shed light on how change can occur in intricate social and political systems (i.e., state legislatures). To accomplish this task, this research uses Baumgartner and Jones' (1993) Punctuated Equilibrium Theory (PET) to investigate the policy adoption of state NEM and community shared solar policy, as this framework illuminates the determinants of policy change and stability.

1.1.3. Research Questions

This study analyzed NEM's relationship with installed DPV capacity, as well as the various policy perspectives that exist concerning the community shared solar issue. It also examined the perspectives that exist within the Commonwealth of Virginia as a case study proxy for other laggard states (i.e., states that make slow progress or are reluctant to adopt new policies) without community NEM or shared solar policy. Such an approach was useful in

understanding how other historically laggard states may adopt community NEM and shared solar legislation. Thus, this study aimed to provide insight to the following research questions:

1. Compared with other state-level policies and non-policy determinants, what impact does NEM have at increasing non-utility solar PV installed capacity throughout the U.S.?

2. What are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar throughout the U.S.?

3. What are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar in Virginia?

4. What are the key barriers and opportunities for community NEM and shared solar legislation to be adopted by other U.S. states?

1.1.4. Design and Methods

To answer these research questions, this study utilized a multi-method approach. First, this research used an ordinary least squares (OLS) multiple linear regression with cross-sectional data from 2012–2013 to understand the impact of NEM at increasing non-utility solar PV installed capacity, which is the dependent variable. In addition to NEM, other policy-related independent variables included state interconnection grades, availability of an SREC market, low-interest loans, tax credits, and property/sales tax exemptions. The model also controlled for deregulation, year, state per capita income, average retail electricity prices, and availability of sun energy resources via solar insolation, to depict correlations between the variables and newly installed DPV capacity. This quantitative analysis organized data by each U.S. state within the time frame, plus the District of Columbia, thus yielding 102 total observations. It is worth noting that community NEM is incorporated into the grading methodology for NEM (Freeing the Grid, 2013).

The second methodological approach comprised of semi-structured telephone interviews with policymakers and key stakeholders from a selection of U.S. states. These individuals came from a variety of interests, including exactly one from the solar energy industry, an environmental group, a government entity, and an electric utility within each selected state. This methodology focused on the adoption or non-adoption of community NEM or shared solar legislation, helping understand the forces and perspectives that have either helped or hindered the passing of such policy. Included states were selected using the data compiled from the first methodology to develop a matrix which organized each state based on whether they have community shared solar legislation or not, whether their electricity markets are regulated or deregulated, and whether they are in a state that is ‘solar favorable’ or not. A more detailed discussion of the sampling plan can be found in section 3.3.1. Transcript coding helped identify main concepts and themes that arose in the interviews (e.g., favorable perspectives for community shared solar exist, but contributions and lobbying by large, investor-owned utilities (IOUs) have hindered the passing of legislation).

Lastly, this research concluded with semi-structured telephone interviews with key solar energy stakeholders in Virginia, serving as a proxy for other laggard states without community NEM or shared solar policy. Interview participants were derived from the Virginia Distributed Solar Generation and Net Metering Stakeholder Group (SSG), which contains key policymaking, lobbying, and other individuals knowledgeable on solar energy issues. Similar to the second methodology, these SSG members were selected considering their affiliation with the solar industry, an environmental group, a government entity, and an electric utility. This qualitative, grounded theory approach helped organize the perspectives for and against community NEM and shared solar, and how these have impacted Virginia’s legislative history on the issue. Again,

interview transcript coding and analysis helped identify main themes that ascended in this set of interviews.

1.1.5. Definition of Terms

This research utilizes the definition of community shared solar brought forth in a National Renewable Energy Laboratory (NREL) report by Coughlin et al. (2012), who defined it as “a solar-electric system that provides power and/or financial benefit to multiple community members” (p. 3). Further, the focus of this research is on *off-site shared solar*, often called ‘solar gardens,’ which allow “customers [to] enjoy advantages of solar energy without having to install a system on their own residential or commercial property” (National Renewable Energy Laboratory, 2015, para. 1). This focus is to specifically differentiate from other shared solar approaches such as community group purchasing, on-site shared solar (e.g., DPV on a multi-unit building), or community-driven financial models (e.g., ‘Solarize’ programs). Concentrating on off-site shared solar also allowed this study to more narrowly focus on community NEM as part of the key legislation to enable this type of shared solar (since customers need to remotely net meter into the PV system), which coincides the overarching focus on NEM as the policy mechanism in question.

This study’s emphasis on off-site shared solar also leads to other key defining characteristics, adopted from a University of Delaware - Center for Energy and Environmental Policy (2012) report. These characteristics include: 1) solar PV projects with two or more subscribers; 2) solar PV projects that are typically larger than those financed by an individual; 3) solar PV projects that include community members and impact local economies; and 4) solar PV projects that aid in the transition toward community energy independence (University of Delaware - Center for Energy and Environmental Policy, 2012). In essence, off-site community

shared solar offers distributed solar PV access to a number of people, as well as impacts a local economy.

Next, community NEM is defined as an NEM arrangement that allows customers to “purchase shares in a single net metered system” (National Conference of State Legislatures, 2015, para. 19) located at an off-site location. Sometimes termed as ‘neighborhood NEM,’ community NEM is notably different from the related phrases of aggregate NEM (i.e., NEM via one customer with multiple meters their property), or virtual NEM (i.e., NEM via one customer with multiple meters that distributes credits to different accounts, such as renters in a multi-unit building) (National Conference of State Legislatures, 2015). Through this definition, some form of community NEM must exist, independent of utility programs, to allow multiple customers to receive bill credits and offset their electricity loads from a solar PV system located elsewhere.

Defining community NEM and community shared solar in these ways allowed this study to emphasize the importance and appeal of off-site shared solar gardens, especially for the variety of interested customers who cannot house their own DPV for a number of reasons. Other key terms, such as state-level policy incentives to encourage DPV (e.g., RPS, SRECs, etc.) are defined in section 1.2.

For the purposes of the qualitative interview research associated with this study, ‘policy perspectives’ are defined through Baumgartner and Jones’ (1993) PET, and their discussion of ‘policy images.’ Through this framework, Baumgartner and Jones (1993) defined policy images as how policies are discussed and understood by the public and policy elites/experts (i.e., key politicians, lobbyists, business owners, and other stakeholders). Such an ‘image’ is generally affiliated with a fundamental social or political belief system, and can be easily communicated to the public (Baumgartner & Jones, 1993). These ideas or perspectives “are a mixture of empirical

information and emotive appeals” (True, Jones, & Baumgartner, 2006, p. 11), and are often connected with policy monopolies, which are “institutional structure[s] responsible for policymaking in an issue area” (True, Jones, & Baumgartner, 2006, p. 7)

1.1.6. Summary

In sum, this research utilized a multi-method approach to answer the four outlined research questions. Each methodology parallels the corresponding research question number (e.g., methodology 1 will answer research question 1), while the synthesis of all results worked to answer research question 4. The PET framework provided a theoretical underpinning for the interviews under methodologies 2 and 3, and Table 1 also shows the linkages between each methodology, research questions, and methodology.

Table 1.

Summary of Methods, Research Questions, and Theory

Methodology	Research Question	Hypotheses / Theory	Relationship to Other Methods / Questions
1. State-level regression on PV deployment	1. Compared with other state-level policies and non-policy determinants, what impact does NEM have at increasing non-utility solar PV installed capacity throughout the U.S.?	NEM is a major influencer of state DPV deployment	Identifies potential factors (both policy and non-policy) influencing community shared solar
2. Interviews of U.S. state policy experts / stakeholders	2. What are policy experts’ arguments on the factors that influence the adoption of community NEM and shared solar throughout the U.S.?	PET: Potential for community NEM / shared solar adoption influenced by policy perspectives, focusing events, other factors	State sample based on characteristics identified in Method 1
3. Interviews of Virginia SSG members	3. What are policy experts’ arguments on the factors that influence the adoption of community NEM and shared solar in Virginia?	PET: Potential for community NEM / shared solar adoption influenced by policy perspectives,	Virginia selected as a proxy for other laggard states without community NEM or shared solar policy

		focusing events, other factors	
Synthesis of all results	4. What are the key barriers and opportunities for community NEM and shared solar legislation to be adopted by other U.S. states?	PET: Potential for community NEM / shared solar influenced by policy perspectives, focusing events, other factors	Conclusions drawn from observations about community NEM / shared solar obstacles and challenges identified in Methods 2 and 3, with Virginia used as proxy for other laggard states

Note. Compiled by author.

The following sections of this introductory chapter provide an in-depth background on the policy context for solar PV systems in the U.S., particularly at the federal, state, and local levels. State NEM and community shared solar policies are comprehensively discussed to provide further context concerning the debates surrounding these issues. These policies, along with other solar PV incentives, issues, and debates, are then deliberated within Virginia as an exemplary case study of a laggard state in this context. The chapter concludes with a legislative history on Virginia’s community NEM and shared solar bill proposals.

1.2. Policy Context

There are multiple levels of policy tactics to encourage solar PV investments in the U.S. Surprisingly, perhaps the smallest number of government incentives come from the national, or federal, level. U.S. states have considerable power to develop policies to encourage DPV deployment, and local governments may also offer useful incentives, budget permitting. Finally, electric utility providers, such as Dominion Virginia Power in Virginia (henceforth referred to as ‘Dominion’), have developed an assortment of programs to facilitate solar PV, yet the results from these types of programs are mixed since most are developed as short-term pilot programs.

1.2.1. Federal Policy

At the federal level, one of the most powerful incentives is the Investment Tax Credit (ITC), which allows solar PV energy owners to deduct 30% of total system costs from their federal income taxes (Baca, 2014). The ITC has been a major factor in the growth of the solar energy industry. The ITC was created as part of the Energy Policy Act of 2005 (P.L. 109-58), and was extended through 2008 under the Tax Relief and Health Care Act of 2006 (P.L. 109-432) (Solar Energy Industries Association, 2016b). The Emergency Economic Stabilization Act of 2008 (P.L. 110-343) extended the credit for another eight years, through the end of 2016 (Solar Energy Industries Association, 2016). The American Recovery and Reinvestment Act (P.L. 111-5), implemented in 2009, eliminated the \$2,000 cap that had been previously applied to the ITC (Solar Energy Industries Association, 2016b), and expanded funding for renewable energy and energy efficiency investments (Eber, 2009). Examples of programs from this act include Residential Energy Property Credits (for energy efficiency), Plug-In Electric Vehicle Credits, and Clean Renewable Energy Bonds (Eber, 2009; IRS, 2015).

Via the Emergency Economic Stabilization Act of 2008, the ITC was slated to step down to 10% of expenditures for commercial applications starting January 1, 2017, with residential credits expiring on that same date (Baca, 2014). However, in December of 2015, President Barack Obama signed the Consolidated Appropriations Act of 2016, which extended the ITC for solar PV projects beyond 2022 (Parnell, 2015). The Act extended the 30% ITC figure from January 1, 2017 to January 1, 2020, after which it steps down gradually until 2022 (i.e., 26% in 2020, 22% in 2021, and 10% in 2022 and beyond) (Williard, 2015). This most recent ITC extension aims to continue to help stimulate growth in solar PV installations and jobs. Greentech Media (GTM), a leading energy research firm, estimated that the ITC extension will create an

additional 25 gigawatts (GW) of installed PV capacity, compared to the scenario without the extension (Tweed, 2016).

The federal government has also recently announced a National Community Solar Partnership, which aims to expand “solar access, on- or off-site shared solar, [and allow] for multiple households or businesses to benefit from the output of a single shared solar array” (U.S. Department of Energy, 2015, para. 3). The White House announced this initiative in July 2015, and it will use federal resources to develop financial models and share best practices for community shared solar deployment (e.g., NREL’s Guide to Community Shared Solar report) (U.S. Department of Energy, 2015). The official program announcement claims that community “shared solar could represent 32%–49% of the distributed PV market in 2020, thereby leading to growing cumulative PV deployment growth in by 2020 of 5.5–11.0 GW, and representing \$8.2–\$16.3 billion of cumulative investment” (U.S. Department of Energy, 2015, para. 3). The partnership contains members from federal and state government organization, academia, utility providers, nonprofits, and the solar industry (U.S. Department of Energy, 2015).

The federal government has yet to adopt other significant policies or programs to encourage solar PV energy use nationwide (e.g., a federal RPS). However, of note, the U.S. Environmental Protection Agency’s (EPA) recently announced Clean Power Plan (CPP) regulations are requiring states to reduce GHG emissions by an average of 30% (Federal Register, 2014). Individual states each have the ability to determine their own strategies for achieving these GHG targets, so their ultimate impact on DPV deployment remains unclear. At the time of this writing, the CPP was under review by the Circuit Court of Appeals, with an ultimate decision only to be rendered in 2017 via the Supreme Court. Nevertheless, in the U.S., most policies and programs to encourage DPV deployment lie at the state level.

1.2.2. State Policy

U.S. states play a key role in DPV policy by filling voids or complementing federal mandates. At the state level, policies such as NEM, RPS, tax incentives, and other grant, rebate, and loan programs have significantly aided DPV deployment. Since a majority of policies to encourage DPV are enacted at the state level (Vachon & Menz, 2006), policy and incentive programs vary widely. For example, U.S. states frequently implement ‘market-opening’ policies to remove obstacles to solar PV investments (Krasko & Doris, 2013) and homogenize market access for interested parties (Stoutenborough & Beverlin, 2008). Such policies are often low cost to government (Krasko & Doris, 2013) and include interconnection standards, RPS, and NEM laws. States also often enact financial incentive policies to invigorate state solar PV markets by providing financial support or fee exemptions (Sarzynski, Larrieu, & Shrimali, 2012). Policies in this sense may include property or sales tax exemptions, tax credits, low or zero interest loans, or the ability to sell credits from DPV systems within an SREC market.

Interconnection standards outline the state-level legalities and processes for connecting a DPV system to the grid (Randolph & Masters, 2008). These standards can institute fees for interconnection, place limits on system capacity, and outline certification procedures (U.S. Department of Energy, 2011). These standards contain terms that DPV owners and electric utilities must follow, and this process can sometimes be complex and pricey, often serving as a barrier to market entry (Solar Energy Industries Association, 2016a).

Next, NEM policies create a repayment system for selling energy back to the grid once a system is interconnected (Darghouth, Barbose & Wiser, 2011; Interstate Renewable Energy Council, 2009). Typically, such arrangements are a direct kilowatt hour (kWh)-for-kWh offset on a residential or commercial utility bill for all energy produced, credited over a 12-month

period (Cai, Adlakha, Low, De Martini, & Chandy 2013). These NEM programs can also place a limit on system capacity, establish fees, and define which energy systems are eligible for the program (Menz, 2005). These standards are vital for non-utility solar PV installations since they allow consumers to collect payments for excess energy generation (Hughes & Bell, 2006).

State RPS programs are a broader state-level market creation policy, as they mandate an electric utility's minimum amount of energy that must come from renewable sources by an identified date (e.g., 15% by year 2025) (Menz, 2005). A handful of states call this policy 'Alternative Energy Portfolio Standards' (Center for Climate and Energy Solutions, 2016). Sometimes, RPS' have precise carve-outs that establish a specific amount of the RPS that must be met by a certain technology, such as solar PV (Rabe, 2006). Currently, 16 states have RPS solar carve-outs (National Renewable Energy Laboratory, 2014d). According to the Center for Climate and Energy Solutions (2016), these RPS "standards range from modest to ambitious, and qualifying energy sources vary" (para. 1).

A byproduct of state RPS policies, SRECs are credits that owners of DPV systems can sell for every megawatt hour (MWh) of solar electricity created, helping to recoup installation costs and aiding in financing. Markets for SRECs are most often present in states with a mandatory RPS, as electric utilities purchase SRECs from local consumers to meet RPS goals (Burns & Kang, 2012). However, owners of PV systems in states without an RPS can sometimes sell their SRECs to an out of state market, which, for example, is common in the Mid-Atlantic region of the U.S. (Bird, Heeter, & Kreycik, 2011). These tradeable commodities are a smaller, yet still important, incentive for DPV investors.

States may also offer loan programs for solar PV investments, often with zero or very low interest rates (Zhao, Bell, Horner, Sulik, & Zhang, 2012). Similarly, property tax exemptions

may exist to exempt solar PV equipment from state property taxes, while sales tax exemptions work to exempt solar PV equipment from state sales taxes (Sinclair, 2008). Typically, states enact these policies, with a local option to allow an exemption within a particular jurisdiction. States with favorable solar policy may also offer personal and/or corporate tax deductions for solar PV investments (e.g., Vermont), which are comparable to the federal ITC. Often termed personal tax credits, such deductions can occasionally be coupled with the ITC to further encourage solar PV (Burns & Kang, 2012). Such financial incentives adopted by states often indicates the level of commitment toward promoting renewables (Ciocirlan, 2008), despite the fact that they are costlier to the governing authority (Krasko & Doris, 2013).

Of course, certain policy incentives have different implications for state budgets, which is an influencing factor in why states adopt certain policies over others. For instance, some states may have shifted toward SRECs or utility-facilitated public benefit funds models to specifically ease state budgetary impacts. The cost of the policy to the state is frequently a key determination in whether a policy is passed (Krasko & Doris, 2013), meaning states are more apt to implement NEM and RPS policies than tax credits.

1.2.2.1. Electricity Restructuring

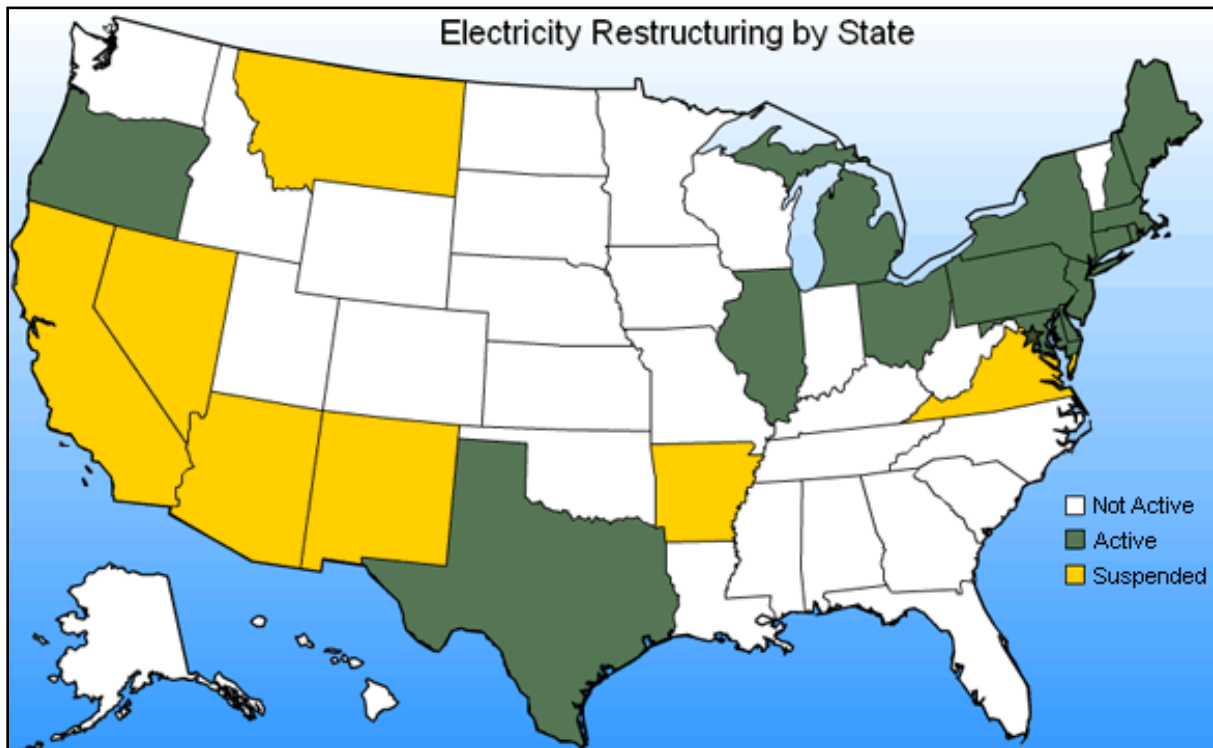
Another consideration in the discussion of state PV policy is the structure of a state's electricity market. The restructuring, or deregulation, of state electricity markets began with the 1978 passage of the Public Utilities Regulatory Policies Act (PURPA), which allowed Independent Power Producers (IPPs) to generate and market electricity (Randolph & Masters, 2008). The passage of the Energy Policy Act of 1992 further eliminated restrictions on wholesale electricity prices (Randolph & Masters, 2008). Therefore, electric utilities in deregulated markets are only responsible for distribution, operation, maintenance, and ratepayer

billing – not generation and transmission (Borenstein & Bushnell, 2015). Such deregulation aimed to expand consumer choice, keep electricity prices low, and increase private sector control and flexibility (Borenstein & Bushnell, 2015).

However, these various electric utility components under deregulation has proven to be more complex, with several competing interests (Slocum, 2007). Questions have also been raised about electricity grid reliability, as state power supplies are more vulnerable due to increased competition, causing various blackouts (e.g., California in 2000–2001) (Nadler, 2013). Therefore, some deregulation efforts have been suspended (e.g., Virginia), and some states have re-regulated their electricity markets (e.g., California (partially re-regulated)) (Ferrey, 2007). States with regulated electricity markets (e.g., Colorado, Florida, Kentucky, etc.) contain utilities that are vertically integrated, meaning they control the generation, transmission, and distribution of electricity to their ratepayers (Michaels, 2004). However, as shown in Figure 4, there still exist a number of deregulated electricity markets, mostly in the Northeast, Mid-Atlantic, Mid-West, as well as in Texas (U.S. Energy Information Administration, 2010).

Figure 4.

Electricity Deregulation by U.S. State, 2010



Note. Figure from the U.S. Energy Information Administration (2010).

Currently, approximately 15 states have deregulated electricity markets, while at least seven others (including California, which has the most installed PV capacity in the nation) have attempted and subsequently abandoned deregulation (U.S. Energy Information Administration, 2010). Most states continue to adhere to the 1930s-era regulated monopoly system. Electricity deregulation has also faced its fair share of scrutiny, as some have counterintuitively cited higher electricity rates, as consumers have had to help utilities pay for stranded costs (i.e., unnecessary infrastructure in the more competitive, deregulated market) (Bensinger, 2015). Conversely, utilities in regulated states (which are often large, profit oriented IOUs) are often regarded as ‘regulated monopolies,’ meaning these utilities are the single firm which produces and sells electricity in their area. In turn, these IOUs exert much influence on state PUCs, often through

money power (Sforza, 2015; Warrick, 2015). These IOUs also utilize their overarching trade and lobbying group, the Edison Electric Institute, to influence PUCs and other policymakers in their own interest (The Regulatory Assistance Project, 2011). These IOUs have also pursued mergers and acquisitions to make themselves more competitive when their service territory overlaps with deregulated markets (PBS, 2014). Overall, favorable state PV policies, such as NEM, are more difficult to implement and keep in regulated states, perhaps leading to lower installed capacity levels (Rothwell, 2010).

1.2.2.2. NEM

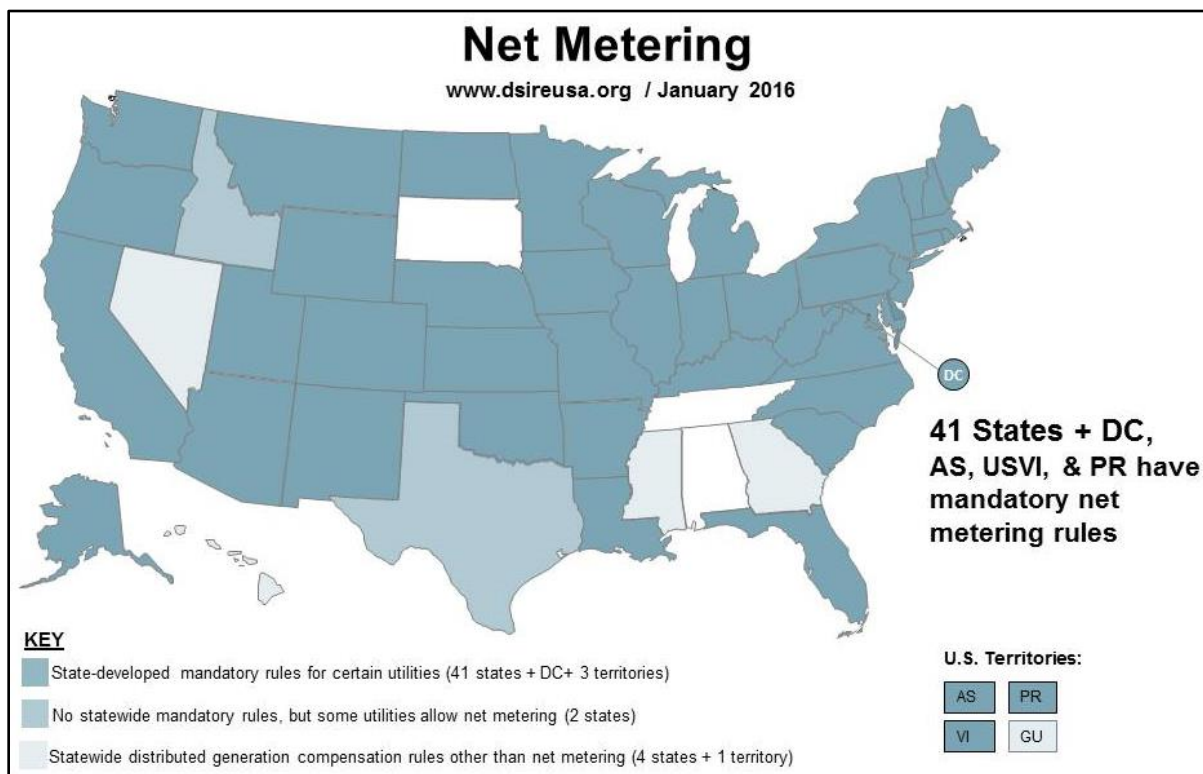
The overall policy of focus of this study is state NEM policies, which allow electric utility customers with DPV systems to receive credits for the energy delivered back to the electricity grid (Doris, Busche, & Hockett, 2009). Customers use such credits to offset their electric bill, significantly enhancing a PV system's economic viability, particularly if it collects the full retail rate through state law. Under NEM, the energy produced by a DPV system is used directly by the building on which it is installed (e.g., a home or business), but excess energy produced beyond the building's needs is returned to the greater electricity grid. When the building's needs surpass the production of the PV system – such as at night – the building draws the power it needs from the grid (Caballero, Sauma, & Yanine, 2013). Ultimately, the consumer pays the retail electricity rate for the net amount of energy consumed from the electricity grid per month.

As shown in Figure 5, a majority of U.S. states have adopted some form of NEM legislation over the past three decades, as it is now mandated in 41 of the 50 states (Inskip, Kennerly, & Proudlove, 2015). Only two states (Idaho and Texas) have voluntary NEM programs through one or more electric utility providers, while only three states (Alabama, South

Dakota, and Tennessee) have no NEM programs whatsoever (Database of State Incentives for Renewables and Efficiency, 2016). The state of Mississippi passed NEM legislation in December 2015 after five years of deliberation, as a commissioned study found a net benefit from the program to utility ratepayers (Pyper, 2015a). However, to date, this program has not been fully implemented. Georgia, Hawaii, and Nevada have recently decided to phase out their NEM programs and provide alternative statewide DPV compensation rules (Database of State Incentives for Renewables and Efficiency, 2016).

Figure 5.

U.S. NEM Policies, January 2016



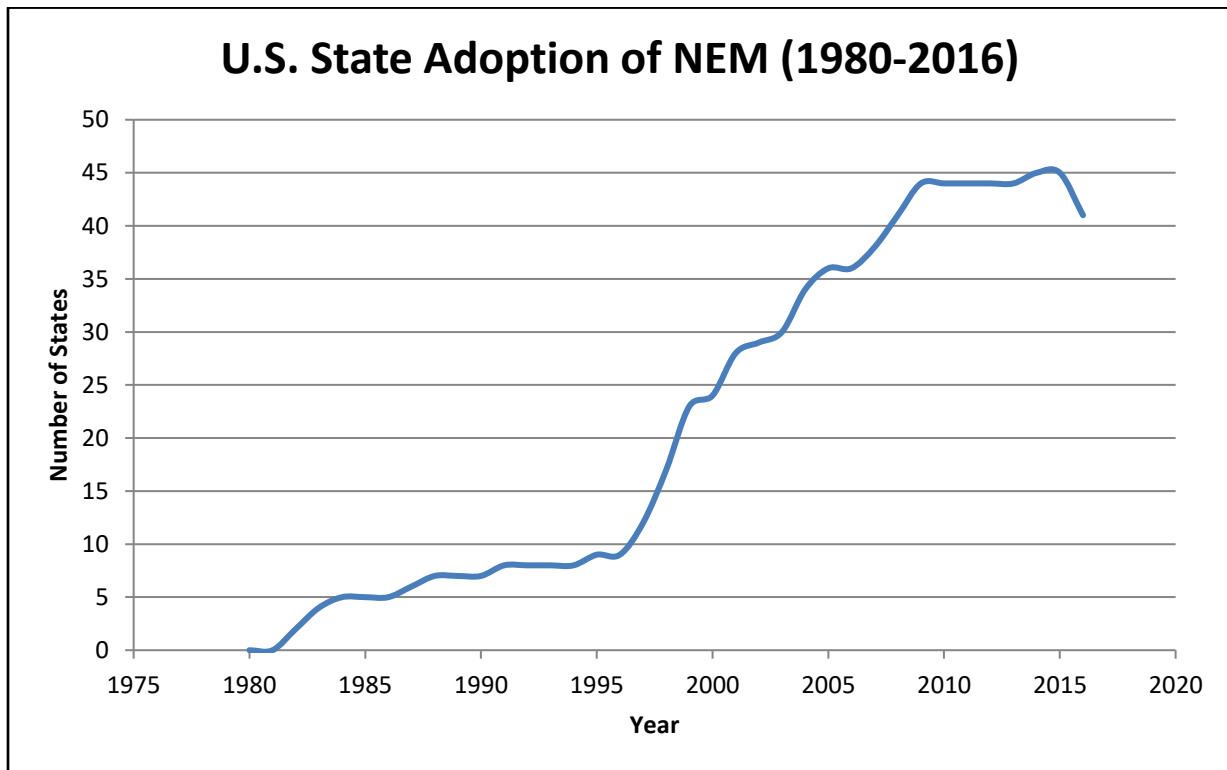
Note. Figure from Database of State Incentives for Renewables and Efficiency (2016).

Georgia, Hawaii, and Nevada’s recent decisions to eliminate their programs represents a new and fascinating trend in state NEM policies. Until these decisions, state NEM laws had only expanded and grown since their first implementation in 1982. However, as concerns and debates

of increasing penetration levels of DPV have intensified, the country is starting to see the first downward trend in the number of states with NEM. Figure 6 illustrates the historic trends of U.S. state adoption of NEM since 1980, showing the massive policy adoption from 1995–2010. However, this has leveled off in the past 5–10 years.

Figure 6.

U.S. State Adoption of NEM, 1980–2016



Note. Data compiled by author from Carley (2011) and Database of State Incentives for Renewables and Efficiency (2016).

State NEM policies were originally enacted to enhance a pricey DPV market in its infancy. However, as module costs of DPV systems continue to plummet due to technological advancements and economies of scale (Stanfield, Schroeder, & Culley, 2012), electric utilities and other interests have been pushing back on the NEM issue. In fact, more than half of all states with NEM programs in place saw efforts to weaken or eliminate these programs in 2015.

Though municipal electric utilities and electric cooperatives (co-ops) have cited issues with NEM, IOUs particularly assert that NEM places a financial burden on other utility customers, as both owners and non-owners require the same amount of generation, transmission, and distribution infrastructure to meet their needs. Regardless, it remains certain that NEM has greatly facilitated the expansion of DPV (Poullikkas, 2013).

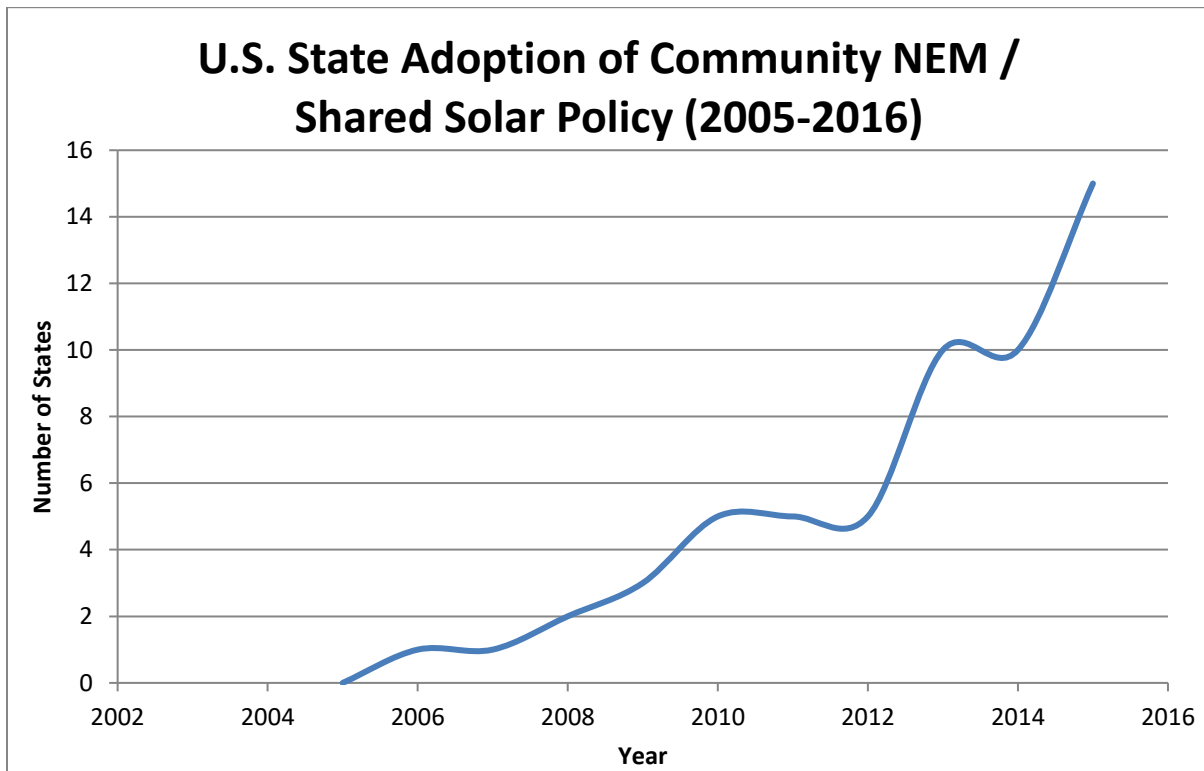
1.2.2.3. Community NEM / Shared Solar Policy

Shared solar gardens have been an emerging development throughout the U.S. in recent years, stimulated by an increasing number of states passing community NEM or shared solar policies. This is important considering the lack of feasibility of certain grid-connected customers to physically own a generating system due to reasons such as site shading, roof orientation, zoning laws, roof/system size, and lack of property ownership, among others (McCabe & Bertolino, 2007). Beyond the high up-front costs to finance a solar PV system, such barriers are the central impediments to more widespread deployment.

Currently, over a quarter of U.S. states allow community NEM, which has helped stimulate additional distributed electric generation beyond levels that would normally prevail. Since 2013, 10 states have adopted community shared solar enabling legislation, half of which were passed in 2015 alone. This suggests a very recent and growing trend of states adopting such policy, considering only five states had community NEM as recently as 2012 (Vermont was the first to pass such legislation in 2006). Figure 7 illuminates these trends.

Figure 7.

U.S. State Adoption of Community NEM / Shared Solar Policy, 2005–2016



Note. Compiled by author from National Conference of State Legislatures (2015) and Shared Renewables HQ (2016).

Like NEM, community NEM and shared solar have been at the forefront of numerous arguments, such as how for-profit electric utilities claim it undercuts company revenues. Utility providers have also cited the difficulty for the electricity grid to accommodate such non-dispatchable resources since community shared solar is usually deployed on the distribution grid rather than as a central power source (i.e., grid operators cannot reliably control its quantity and timing) (Masters, 2013). Yet with a range of models, and increased accessibility and affordability, supporters argue that community NEM and shared solar are much more economically efficient than traditional rooftop solar PV. They claim that aggregating consumers on larger projects to achieve economies of scale should also appeal to utilities, as community

shared solar can be sited near substations or distribution feeders and reduce interconnection issues (Kraemer, 2015).

1.2.3. Local Policy

Localities can also implement financial incentives and other DPV deployment strategies, which vary even more widely from jurisdiction to jurisdiction. For example, localities may offer property tax exemptions or abatements for residents or businesses who invest in solar PV energy (Zahran, Brody, Vedlitz, Lacy, & Schelly, 2008). Low or zero interest loans, grants, and rebates for DPV projects may also exist, but are relatively uncommon due to jurisdictional budgetary restraints in recent times. Localities can also encourage solar PV via the removal of building code or zoning barriers (Pitt, 2008), streamlining permitting procedures and reducing permitting and inspection fees (Ardani, Barbose, Margolis, Wisner, Feldman, & Ong, 2012), or by offering valuable technical assistance toward project planning and financing (de Jager & Rathmann, 2008). Despite these approaches, local policies to encourage DPV deployment are not as prevalent, established, or powerful as state policy approaches. In addition, local policies' variability presents key evaluation challenges for researchers.

1.2.4. Virginia Solar PV Trends, Programs, and State Policies

As of December 2014, Virginia had 13.57 total MW of installed net-metered DPV capacity (State Corporation Commission, 2014b), which is enough to power over 1,000 homes. According to December 2015 data, this figure has increased to 21.86 total MW, ranking the state 39th in the country for solar PV capacity per capita (Ramsey, 2016). In September of 2016, this figure had risen to 27.30 total MW (Virginia Solar Energy Development Authority, 2016). Nevertheless, this amount could increase significantly in the coming years, particularly as Dominion has recently sought approval from the Virginia State Corporation Commission (SCC)

to own three utility-scale solar projects totaling 56 MW and is negotiating another 47 MW of solar Power Purchase Agreements. Further, recent legislation requires Dominion to invest roughly \$700 million in solar in exchange for a rate freeze and suspension of annual financial reviews by the state government (Geiger, 2015). Other organizations, such as the Old Dominion Electric Cooperative, Appalachian Power Company, and Council for Independent Colleges in Virginia (CICV) have also recently announced planned solar energy projects.

Nevertheless, Virginia's solar capacity remains far less than the smaller, adjoining state of Maryland, which has 92 MW of net-metered DPV capacity (Maryland Energy Administration, 2014), ranking it 14th in the U.S. in installed capacity (Ramsey, 2016). Differences in state-level solar policy to encourage DPV may explain this dissimilarity in installed capacity. For instance, unlike Virginia, Maryland has a mandatory RPS that requires electric utility providers to deliver a certain proportion of its power from renewable sources such as solar. Compared to Virginia, Maryland also has a superior NEM policy, as well as offers state tax credits for DPV investment.

Despite this, a 2012 report from the U.S. EPA's Green Power Partnership Program found the potential for up to 35 MW of solar on just 49 municipal government facilities within the Metropolitan Washington Council of Governments territory in Virginia (Metropolitan Washington Council of Governments, 2013). The 2007 and 2010 versions of the Virginia Energy Plan both estimated the state's solar energy potential to be between 11,000–13,000 MW (Schlissel, Loiter, & Sommer, 2013). The U.S. Department of Energy's SunShot Vision Study projects solar PV installed capacity for Virginia to be 8,700 MW by 2030 and 21,200 MW by 2050 (U.S. Department of Energy, 2012). Lastly, an NREL report from 2012 estimated that Virginia has the technical potential to develop approximately 1.9 million GW hours of solar,

which is roughly 17 times the current total annual electricity consumption in the state (Lopez, Roberts, Heimiller, Blair, & Porro, 2012).

Moreover, numerous local policies and programs have successfully expanded DPV deployment and demonstrated strong market demand for solar energy among Virginia residents and businesses. For example, in 2014 alone, seven different ‘Solarize’ programs were initiated in the state, by organizations such as Virginia Solar United Neighborhoods (VA SUN), Community Housing Partners (CHP), and the Local Energy Alliance Program (LEAP). VA SUN continued to establish 11 additional solar cooperatives in 2015, all of which offered a 10–20% discount on materials and installation costs through group purchasing (Komp, 2016). These programs have helped accelerate solar PV growth in Virginia, particularly by overcoming market barriers such as high up-front costs and overall intricacy of solar purchasing decisions. Overall, to date, at least 25 Virginia communities have developed Solarize or cooperative programs, which has helped increase residential PV installations in the state by 122% since 2012 (over \$8 million in sales and 2.9 MW installed) (Daigneau, 2015; Hubbard, 2016).

In addition, Virginia has seen large commercial PV projects initiated under Dominion’s Community Solar Partners Program, including at Capital One and Virginia Union University in the Richmond region, and at the Prologis Concorde Distribution Center in Loudon County (Dominion Virginia Power, 2014). Further, a variety of financial incentives to support the development of such projects are available at the state level. In addition to those noted below, a bill passed in 2014, Senate Bill (SB) 18, prevents localities from applying machinery and tools taxes to solar energy equipment (Database of State Incentives for Renewables and Efficiency, 2015e).

Virginia does mandate that their electric utilities provide NEM programs for owners of DPV systems, which is discussed in greater detail in section 1.2.5. One state mandate that Virginia does not currently possess is an RPS, as its program is merely voluntary (Database of State Incentives for Renewables and Efficiency, 2015b). While there have been proposals for a mandatory RPS in the state, most recently in 2016's session (i.e., SB 761) (Virginia's Legislative Information System, 2016d), none have been passed. The lack of a mandatory RPS in Virginia means that owners of DPV systems cannot sell SRECs to Virginia utilities (i.e., Virginia utilities do not need renewables to formally meet RPS goals). However, SRECs generated in Virginia can, in fact, be sold to utilities in other states (currently, only in Pennsylvania) (SRECTrade, 2015b). The value of SRECs in the Pennsylvania market varies greatly, making them an unreliable, but possibly valuable, way to help offset the costs of PV systems for Virginians.

Virginia also has a state Clean Energy Manufacturing Incentive Grant Program that was created in 2011. This grant program is available to commercial clean energy manufacturers for up to six years if they: 1) begin or expand its operations in Virginia on or after July 1, 2011; 2) make a capital investment of more than \$50 million in Virginia on or after July 1, 2011; 3) create 200 or more new full-time jobs on or after July 1, 2011; 4) enter a memorandum of understanding setting forth the requirements for capital investment and the creation of new full-time jobs (Database of State Incentives for Renewables and Efficiency, 2015b). However, this program currently does little to increase DPV deployment figures in the state.

Finally, Virginia is also taking steps to comply with the EPA's recently-announced CPP. The carbon dioxide (CO₂) emissions goal for Virginia is 37% below 2005 levels by 2030 based on: 1) coal plant efficiency; 2) natural gas dispatch; and 3) renewable & nuclear generation, and the Virginia Department of Environmental Quality (DEQ) has already hosted listening sessions,

and hired staff to write the state's plan. Further, Virginia Governor Terry McAuliffe was one of the 17 Governors to recently sign a bipartisan pledge to expand energy efficiency, increase solar and wind power production, modernize the electricity grid, and cut emissions (Milman, 2016). However, it remains to be seen how or whether these efforts will impact DPV deployment figures in the state.

1.2.4.1. Dominion Virginia Power Programs

Dominion, Virginia's largest IOU, has a number of incentives available to residential and commercial customers. For instance, the Dominion Solar Purchase Program is a buy-all, sell-all deal for up to 3 MW of customer-owned solar, available to eligible commercial and residential customers for an initial five-year period. This pilot program started on June 20, 2013 and allows owners of DPV systems on homes and businesses to sell the power and the associated SRECs to Dominion at 15 cents/kWh, while buying regular grid power at retail prices for their own use (Database of State Incentives for Renewables and Efficiency, 2015c). Participating customers purchase all of the electricity for their home or business from the company on their current rate schedule (Database of State Incentives for Renewables and Efficiency, 2015c). As of June 30, 2016, 123 customer installations had been completed totaling 1.544 MW (Commonwealth of Virginia State Corporation Commission, 2016).

Dominion's Renewable Generation Tariff is another pilot program that allows commercial customers to buy larger amounts of renewable power from providers, with the utility acting as a go-between and collecting a monthly administrative fee. Customers specify a type of green electricity and then negotiate a contract with Dominion, which signs a PPA with the operator of the renewables project. The customer's purchase is self-funding; any costs associated

with delivering the renewable energy would be passed on to them. That includes a monthly administrative fee of \$500 per participating electricity buyer (Davidson, 2013).

Dominion also initiated a Third Party PPA Program on July 1, 2013, allowing commercial Dominion customers to install projects as large as 1 MW using PPAs financed by private companies (State Corporation Commission, 2013). Projects must have a minimum size of 50 kilowatts (kW), so the program can be used by commercial customers but excludes homeowners, whose solar PV systems most often range from 4–8 kW (State Corporation Commission, 2013). According to the Commonwealth of Virginia State Corporation Commission (2016, p. 12), “to date, Secure Futures, LLC (“SFLLC”) has been the only participant in the Third-Party PPA Pilot Program with eight proposed facilities at high school and university sites, totaling 999.24 kW of solar generation under notification to be installed.” All are expected online by the end of 2016.

Dominion also has a Solar Partnership Program which is a multi-year pilot program aims to expand community-based solar energy, with Dominion installing, owning, and operating “up to 30 megawatts of company-owned solar facilities on leased rooftops or on the grounds of commercial businesses and public properties throughout [their] Virginia service area” (Dominion Virginia Power, 2014, para. 8). It should be noted that the term community is defined here as a societal increase in solar PV investment, not to be confused with the traditional community shared solar definitions previously mentioned. According to the Commonwealth of Virginia State Corporation Commission (2016), this program will have 10 operational facilities by the end of 2016 amounting to 8.418 MW installed capacity and capital costs of \$20.9 million.

Lastly, in January of 2015, Dominion filed an application for a Community Solar (DCS) Pilot Program, and on August 7 of that same year, the Virginia SCC granted the application

(Virginia’s Legislative Information System, 2015a). The DCS pilot program allows customers to voluntarily purchase energy from a 2 MW PV facility owned and operated by Dominion in a remote location within their service territory. In essence, this pilot program provides an option for consumers to purchase solar PV energy – particularly, by paying an extra \$.04/kWh (in \$4 blocks) on top of Dominion’s retail rate (State Corporation Commission, 2015) – that cannot install systems on their homes or businesses. Dominion has limited DCS participation to five blocks per month for residential customers, and 10 blocks per month for commercial customers (State Corporation Commission, 2015). Nevertheless, the SCC filing language indicates that Dominion will not actually sell PV energy to participants, but rather use their payments to help fund the aforementioned Solar Partners program, enabling the utility to build an extra 2 MW of solar and sell the associated SRECs to boost profits (State Corporation Commission, 2015). Essentially, this program, despite its name, is quite different than the recently emerging community shared solar models across the U.S. due to its allocation of financial benefits (or lack thereof). As of this writing, no facilities have been constructed. A summary of these programs and incentives is provided in Table 2.

Table 2.

Summary of State and Dominion Solar PV Financial Incentives in Virginia

Administrator	Incentive	Applicable Sectors
State	NEM	Commercial and Residential
State	SRECs	Commercial and Residential
State	Clean Energy Manufacturing Incentive Grant Program	Commercial Only
Dominion	Renewable Generation Tariff	Commercial Only
Dominion	Third Party PPA Program	Commercial Only
Dominion	Community Solar Partners Program	Commercial Only
Dominion	Solar Purchase Program	Commercial and Residential
Dominion	Community Solar (DCS) Pilot Program	Commercial and Residential

Note. Expresses non-utility incentives for solar PV investment through Dominion, which serves roughly one third of the population of Virginia, including nine of the 10 largest cities (PR Newswire, 2016; State Corporation Commission, 2010). Policies and incentive programs gathered from the Database of State Incentives for Renewables and Efficiency (2015b; 2015c; 2015d; 2015e), the State Corporation Commission (2013; 2015), and Dominion Virginia Power (2014) websites.

Near the end of 2015, Dominion also announced an objective to install 110 MW of solar PV capacity in Virginia, by building 75% themselves and working with third party developers to build the remaining 25% (Roselund, 2015). This announcement will help Virginia meet its recently-announced target for the state government to obtain 8% of its electricity from renewables (Virginia Office of the Governor, 2015). As part of this process, Dominion will spend roughly \$700 million on new solar PV energy infrastructure (Clover, 2016). For example, Dominion has already announced a “21 MW solar PV plant at Naval Air Station Oceana in Virginia Beach” (Kenning, 2016, para. 1) to be completed by the end of 2017, as well as a 19 MW project in Isle of Wight County and a 20 MW project in in Fauquier County (reNEWS, 2016). Though not a formal program or policy, these recent announcements indicate Dominion’s desire to augment utility-owned solar PV in the state. Falling PV costs, coupled with customer demand for more solar, has paved the way for additional MW to be installed by Dominion.

Appalachian Power Company (APCo), Virginia’s second largest electric utility provider after Dominion, does not offer any formal incentives or programs for DPV, yet it does participate in Virginia’s NEM program (Optony, 2016). Serving Southwest Virginia, APCo has also recently proposed an RGP Rider partnership to assist the CICV Solar Market Pathways Program (more detailed information is found in Section 1.2.4.5). Serving residents of the Shenandoah

Valley and Potomac Highlands, the Shenandoah Valley Electric Cooperative also has an NEM program, along with a Renewable Power Purchase Program (Optony, 2016). Several Virginia utilities, including Dominion and APCo, have noted in their integrated resource plans (IRPs) that they will increasingly invest in utility solar PV, particularly in compliance with the EPA's CPP (Chittum, 2015).

Moreover, the BARC Electric Cooperative, which serves a small, rural Appalachian region, was awarded a U.S. Department of Energy and Appalachian Regional Commission grant to fund a utility-sponsored community shared solar program (Ralston, 2014). The utility has developed a learning center along with its recently-built 550 kW community solar garden which allows investments by roughly "180 residential and 25 small commercial members" (BARC Electric Cooperative, 2016, para. 10) for a 20-year period. This represents the first utility-owned community shared solar project in Virginia, and the program was already fully subscribed by May 2016 with power being provided by August 2016 (BARC Electric Cooperative, 2016; Stewart, 2016).

Lastly, Karen Schaufeld, a resident of Loudoun County in Northern Virginia, is building Virginia's largest privately-financed solar array on personal property on her five-acre farm in Leesburg. According to Peskin (2015, para. 2), "she aims to establish a community model for the acquisition and distribution of solar power as a less expensive, more efficient and enlightened alternative to Dominion's authority over energy in the state." Schaufeld is urging the passing of state community NEM policy to distribute the benefits of her array, as well as to encourage the installation of other solar gardens on agricultural land throughout Virginia. Though just one example, this case indicates the appetite for community shared solar from the citizen's perspective.

Virginia also has several recent programs and initiatives developed to study and support the development of solar PV energy, including the Virginia Energy Plan, the Virginia Solar Energy Development Authority, the Virginia Solar Stakeholder Group, and the Council of Independent Colleges in Virginia Solar Market Pathways Partnership.

1.2.4.2. Virginia Energy Plan

Published in October 2014 by the Virginia Department of Mines, Minerals and Energy (DMME), the Virginia Energy Plan laid the framework and vision for future state energy policy. The plan established particular goals to transition Virginia to a new energy economy, focused on developing the state's energy industry, investing in reliable energy infrastructure, lowering energy consumption and GHGs, and preparing Virginia's workforce for jobs in the energy sector. The plan called for 15% of the state's energy to come from renewable sources by 2025, with specific goals for solar PV deployment (Virginia Department of Mines, Minerals and Energy, 2014). Other key recommendations included increasing the cap on customer-owned solar from the current 1% of a utility's peak load to 3%, increasing size limits for net-metered residential and commercial projects, increasing the stand-by charge (i.e., charges levied by utilities for DPV system owners) capacity from 10 kW capacity to 20 kW, and allowing PPAs and community shared solar projects (Virginia Department of Mines, Minerals and Energy, 2014). Despite these ambitious suggestions, there is no mention of a mandatory RPS for Virginia within the plan, nor is there specificity concerning community shared solar projects or policies.

1.2.4.3. Virginia Solar Energy Development Authority

As part of the Energy Plan, Governor Terry McAuliffe and his administration also implemented a Virginia Solar Energy Development Authority (VSEDA) to facilitate public-

private partnerships in solar energy use. It has been estimated that Virginia can potentially generate between 11,000 MW to 13,000 MW of power via solar (Bacque, 2014). The authority's goal is to install 15 MW of solar generation at state and local government facilities by June 30, 2017 (Virginia Department of Mines, Minerals and Energy, 2014). Additionally, the authority hopes to install an additional 15 MW of solar energy generation at commercial, industrial, and residential facilities by the same target date (Virginia Department of Mines, Minerals and Energy, 2014). These bold goals would roughly triple Virginia's installed PV capacity, yet, at the time of this writing, it remains to be seen what strategies or specific projects will take form.

1.2.4.4. Virginia Solar Stakeholder Group

In 2014, the DEQ and DMME convened a stakeholder group to study the costs and benefits of DPV and NEM in Virginia (Virginia Department of Mines, Minerals and Energy, 2015). At the time, DEQ and DMME were already facilitating a Small Solar Working Group (SSWG), whose goal was to meet and collaboratively to seek common ground in encouraging solar PV deployment in Virginia. These state agencies formed the larger, 49-member SSG to conduct a study, consisting of representatives of multiple relevant interest groups such as electric utilities, the solar industry, local governments, environmental advocacy groups, academic institutions, and state residents. The final SSG report discussed the costs and benefits of DPV in Virginia, recommended data sources, and identified points of consensus and debate, for placing a value on solar PV. Specifically, the report evaluated 13 different variables along which the costs and benefits of solar energy can be measured, and identified three different approaches that future value of solar studies in Virginia may adopt. However, due to data limitations and time constraints, it stopped short of calculating an actual 'value of solar' figure for the state. At the

time of this writing, it remains unclear whether the SSWG or the SSG will continue to meet and discuss solar PV development and policies in the state.

1.2.4.5. Council of Independent Colleges in Virginia Solar Market Pathways Partnership

In 2015, the CICV won an \$807,000 grant from the U.S. Department of Energy SunShot Initiative's 'Solar Market Pathways program (Shenandoah University, 2015). The three-year program will help the 15 CICV member schools develop a plan to increase solar deployment on their campuses, using "group purchasing power to achieve price reductions for hardware and installation services" (Shenandoah University, 2015, para. 6). The program has an overall goal of installing 30 MW of DPV on CICV campuses by 2020 by collaboratively traversing the intricate regulatory and legal considerations associated with such installations (Optony, 2016). The program will engage stakeholders, prepare financing options, and create a network to share best DPV deployment practices (Optony, 2016).

1.2.5. NEM and Community Shared Solar in Virginia

The state of Virginia passed NEM legislation in 2000 (Database of State Incentives for Renewables and Efficiency, 2015d). However, while Virginia allows NEM, it has a relatively modest capacity limit of 1 MW for commercial and 20 kW for residential systems, with a limit on overall enrollment cap of 1% of a utility's peak capacity (Database of State Incentives for Renewables and Efficiency, 2015d). Other states have much higher NEM capacity limits (e.g., Oregon has 2 MW for commercial and 25 kW for residential), while some states have no limits whatsoever (e.g., New Jersey). Freeing the Grid, an annual report published by the Interstate Renewable Energy Council (IREC) and The Vote Solar Initiative which investigates each U.S. state's interconnection and NEM policies, grades Virginia's most recent NEM policy as a C on

an A–F scale (up from a D the prior year), ranking it among the bottom third of U.S. states (Freeing the Grid, 2016).

Though Virginia has passed an NEM law, it has not been successful at implementing community NEM or shared solar legislation, making it unmanageable for investors to purchase shares in a solar PV generation project without installing it at their own site. However, bills that would have permitted this have, in fact, been brought to the state’s General Assembly (i.e., legislative making body) before. In 2012, Virginia Delegates Scott Surovell and Kaye Kory, both of Fairfax County, proposed House Bill (HB) 672 entitled *Distributed Electric Generation; Community Solar Gardens*. This bill would have authorized the establishment of community shared solar gardens in Virginia, for projects with at least 10 subscribers (any retail customer of a utility) and for those smaller than 2 MW (Legiscan, 2012).

Under this proposal, a special purpose entity or nonprofit organization would have controlled the subscribers, being responsible for owning and operating the community shared solar garden. The individual subscribers would have received credits on their respective utility bills from the energy generated at the shared solar garden based on their ownership percentage. Such credits would have to be purchased by the utility provider via NEM, and if these NEM credits exceeded the owner’s bill in a given period, they could be rolled over to future bills. It is also crucial to note that the bill stated “if the electricity output of the community solar garden is not fully subscribed, the utility is required to purchase the unsubscribed renewable energy at a rate equal to the utility's average hourly incremental cost of electricity supply over the immediately preceding calendar year” (Legiscan, 2012, para. 1).

In January 2012, HB 672 was referred to the Committee on Commerce and Labor, and then relegated to a special Subcommittee on Energy (Legiscan, 2012). After minimal debate, the

House unanimously voted to table the bill (13 votes yes, 0 votes no / no vote) and it was left in the Commerce and Labor Committee of the Virginia State Senate on February 14, 2012 (Legiscan, 2012), meaning that the bill could emerge again, if necessary.

In January of 2014, the bill did reemerge, this time as HB 1158. The bill had the same title as the previous, and most likely rematerialized due to the shift in political winds as a result of the 2013 gubernatorial election result in Virginia, with Democrat Terry McAuliffe now in office (Gabriel, 2013). Delegates Surovell and Kory again presented HB 1158, which had identical text to the 2012 version (HB 672). However, HB 1158 was also referred to a special Subcommittee on Energy within Commerce and Labor, ultimately being tabled and left in this committee on February 12, 2014 (Legiscan, 2014).

2015's legislative session saw yet another community shared solar bill materialize, this time by Delegate Richard C. Sullivan, Jr. Yet, this bill went through the same exact process again and was tabled on February 5, 2015 (Legiscan, 2015). Another bill, HB 1636, titled *Net energy metering; program for community subscriber organizations*, was proposed by Delegate J. Randall Minchew during the 2015 legislative session. The bill was more explicit about community NEM, and would have allowed "community subscribers and community subscriber organizations" (Virginia's Legislative Information System, 2015b, para. 1) to participate in NEM. Like similar bills, HB 1636 was referred to the Committee on Commerce and Labor and its special Subcommittee on Energy, and was tabled on February 5, 2015 (Virginia's Legislative Information System, 2015b).

The 2016 legislative session in Virginia saw still another relevant bill proposed, indicating a dedicated commitment to get a community shared solar bill passed in the state, as no other state has proposed as many related bills. 2016's version, HB 618, *Community Solar*

Gardens, proposed by Delegates Paul Krizek and Vivian Watts, also included language to enable community solar gardens (Virginia's Legislative Information System, 2016c). However, this bill included language that would have allowed utilities to levy a 'reasonable charge' to cover associated costs with administering the program. Regardless, once again, the bill was referred to the Committee on Commerce and Labor, and then to the special Subcommittee on Energy. On February 9, 2016, the Subcommittee on Energy recommended to continue this bill to 2017 by voice vote (Virginia's Legislative Information System, 2016c).

Lastly, two other bills proposed during Virginia's 2016 legislative session would have helped the state expand community energy programs. More specifically, HB 1286's language enclosed a provision to authorize community energy programs (under the 'net energy metering' aspect of the bill), whereas HB 1285 would have authorized, yet not mandate, Virginia's IOUs and electric cooperatives to establish community energy programs (Main, 2016b). However, like all of the other community energy/solar bills in Virginia, neither bill passed after being sent to the Subcommittee on Energy. On February 11, 2016, both bills, similar to HB 618, were recommended to continue to 2017 by voice vote (Virginia's Legislative Information System, 2016a; Virginia's Legislative Information System, 2016b).

Instead of completely voting down these 2016 solar energy related bills, the 'carry over' to 2017 technically leaves the proposed legislation alive yet comatose (Main, 2016a). As of this writing, the Senate formed a small energy subcommittee that met in the summer of 2016, reviewed these solar energy bills, and made recommendations for the following year's legislative session. Regardless, this decision effectively killed these bills for 2016. The Subcommittee on Energy is often regarded as utility-friendly (Main, 2015), and the frequent tabling and

postponing of bills related to community NEM and shared solar suggests that future bills will have great difficulty gaining enough support to become law.

1.2.6. NEM Policy Debates in Virginia

Various parties interject themselves into the solar PV policy and regulatory process in an attempt to achieve certain outcomes that benefit them, and groups and individuals in Virginia are no different. With regard to NEM, electric utilities generally hold the overall view that environmentalists and solar equipment vendors have joined forces to increase solar PV penetration beyond the level that would otherwise prevail. This increase in solar PV penetration is also attractive to environmentalists as they favor renewable energy sources that do not emit CO₂ or other harmful air pollutants. Further, the increase in solar PV penetration is desirable to solar installation firms and manufacturers since it increases their profits. Utilities have historically been against DPV, yet are now increasingly building their own (utility owned and operated) generation plants. Regardless, Tweed (2016) noted that the recent ITC extension will only make these arguments, perspectives, and state NEM battles more intense.

1.2.6.1. NEM Opposition

Utilities have historically been at the forefront of NEM opposition in Virginia. As noted, utilities claim that NEM places a financial burden on other utility customers, as well as grid control problems and decreased revenues (Sulaiman, 2013). Consequently, one recent approach initiated by IOUs has been the pursuit of monthly ‘stand-by charges’ for solar PV owners using NEM, as a way to help pay for the existing generation infrastructure they need to upkeep. For instance, in 2011, the Virginia General Assembly adopted House Bill (HB) 1983, which enabled Virginia utilities to pursue stand-by charges, and the SCC subsequently approved Dominion’s request for a \$4.19/kW monthly stand-by charge for owners of net-metered systems larger than

10 kW (Shapiro, 2011). APCo has also received SCC approval for a similar stand-by charge (State Corporation Commission, 2014a). Similar policies have been passed or considered in Arizona, Georgia, Idaho, Maine, Oklahoma, Vermont, and Wisconsin (North Carolina Clean Energy Technology Center, 2014), among other states.

Addressing some of these concerns, the Virginia SCC prepared reports on the impacts of NEM and DPV to utilities in 2011 and 2012. The 2011 SCC NEM study found that at existing levels of market penetration, “customer generators impose a very small net cost on Virginia's utilities in total, and such cost results in an ‘immaterial’ average annual bill impact on non-net metering customers” (State Corporation Commission, 2012, p. 8). The study also found that under a fully subscribed program, (i.e., if installed capacity reached 1% of peak demand within each utility’s service area), the average residential electric bill would only increase by \$6.73 per year (State Corporation Commission, 2012). Further, reaching this capacity would require about a 50-fold increase over 2011 DPV levels, indicating the multitude of installations that would need to occur to even reach that level.

1.2.6.2. NEM Support

Despite this, solar advocates, installation firms, and others still claim that the utilities’ arguments and the SCC’s conclusions are speculative, and that states, such as Virginia, should continue to allow and push for favorable NEM laws. Solar supporters have pointed to the public health, environmental, and economic development benefits that DPV provides, as it reduces air pollution from conventional power plants and creates job opportunities for the solar industry (Perez, Norris, & Hoff, 2012). They also argue that strong NEM laws and increased DPV may actually provide value for utilities by reducing the need for traditional generation fuels (e.g.,

coal), avoiding new generation capacity, and reducing the anxiety on existing transmission and distribution infrastructure (Beach & McGuire, 2013).

These solar energy activists have repeatedly attempted to repeal the stand-by charge legislation in Virginia (e.g., SB 582, 2012; and SB 1025, 2013), arguing that the state's electric rate structure currently causes all customers to pay for distribution in an amount proportional to their electricity consumption. Therefore, they affirm that it is unwarranted to isolate the owners of DPV systems, when any customer who consumes electricity at a below-average rate places the same distribution burden on utility providers. They also claim that stand-by charges create a substantial financial burden for owners of DPV systems, yet do not generate adequate revenue to justify the expense of administering the program.

1.3. Conclusion

On the whole, this study aimed to shed light on the NEM and community shared solar debates, both throughout the U.S. and in Virginia. First, this study analyzed the effectiveness of NEM policy at encouraging non-utility solar PV investments throughout the U.S., juxtaposed with other state policies such as tax exemptions and loan programs, as well as possible non-policy factors. Non-utility scale solar, or DPV, is the focus for the analysis since residential and commercial utility customers are the ones who are eligible to invest in community shared solar gardens. This analysis augmented the NEM debate by providing statistical evidence on NEM's impact on DPV deployment in the U.S. amidst the alternative policy forms, standards, and mandates that exist at the state-level.

Community NEM and shared solar has been widely cited as an approach to increase DPV deployment, particularly for those who cannot house a solar PV system. However, these arrangements have also faced much scrutiny, and there are significant debates surrounding such

policy implementation throughout the U.S. In this sense, it is of interest to examine the political processes and forces that shape state-level solar policy, as well as the various perspectives for and against community NEM and shared solar. Additional research is needed to study where community NEM and shared solar works and where it does not work in the U.S. considering respective political ideologies and regulatory structures, especially to understand the future of such legislation.

Lastly, this study attempted to discern the variety of perspectives that prevail around the community shared solar issue in Virginia, which, as noted, currently lacks any provision that allows community NEM. Understanding the perspectives and policymaking culture in the state helped comprehend why Virginia has not been successful at passing such legislation despite multiple attempts. It was also useful to understand these processes as a proxy for other historically laggard states when it comes to energy policy, helping to decipher the future of community NEM and shared solar policy throughout the U.S.

Baumgartner and Jones' (1993) PET, which argues that key actors attempt to tactically control policy directions through rhetoric and actions that favor their political goals, bound this study's actions. Under PET, decision makers only adopt radical change once the pressure for change has become overwhelming. Extended periods of stasis often endure until such events occur. Several authors have utilized PET to better illuminate the determinants of policy change and stability (e.g., Breunig & Koski, 2006; Givel, 2006; Mortensen, 2005; Walgrave & Varone, 2008). PET is a worthy framework for the NEM and community shared solar issue in the way it uses developments, shifts, institutional strategies, and political environments to determine policy directions and potential changes.

2. LITERATURE REVIEW

This section first contains a detailed description of the methods used to obtain the literature for this review. The underlying theoretical framework, Baumgartner and Jones' (1993) PET, is then reviewed as a means to comprehend changes in public policy adoption. A comprehensive solar policy and historical background is then provided, including a description of the key institutional players in this realm and how they interact in the political process. The literature review moves on to discuss results from previous research on state solar PV policies in the U.S. Lastly, the section provides a thorough narration of community NEM and shared solar, including projections, best practices, models, current legislation, and results from prior research.

2.1. Method of Review of the Literature

This dissertation examined the role of state-level policy at encouraging non-utility solar PV installations, as well as the perspectives on community shared solar deployment. In December of 2015, the researcher used the Virginia Commonwealth University (VCU) Libraries search website using the phrases “net energy metering,” “community shared solar,” “energy policy in the U.S.,” “state solar policy incentives,” and “punctuated equilibrium theory.” 2,984 studies were initially identified, yet after duplication removal, and title and abstract screening, roughly 80 applicable reports were selected to be included in the literature review. The VCU Libraries search website includes several relevant databases to public policy research such as the Catalog of US Government Publications (CGP), CQ Library, Government Printing Office (GPO) Monthly Catalog, and ProQuest Congressional, as well as more general research databases such

as the Academic Search Complete, Directory of Open Access Journals, WorldCat, EBSCOhost, and JSTOR (VCU Libraries, 2015).

All reference lists of the relevant articles were also reviewed. Abstracts published in conferences and Congress were also considered. Other forms of relevant scholarship that were considered included theoretical or conceptual essays, meta-analyses, and professional or technical reports (i.e., white papers publishing best practices) conducted by credible national energy organizations such as NREL and IREC. This research only looked at studies in the years 1990–2015 since this is when most of the state-level policies to encourage solar PV began to develop. The researcher also used the Google Scholar platform to supplement the peer-reviewed articles, books, and white papers found on the VCU Libraries' webpage. Several non-applicable studies, as well as non-peer reviewed works (e.g., position pieces, master's theses, etc.) were disregarded for the purposes of this research.

2.2. Theoretical Framework

Creswell (2009, p. 51) defined a theory as “an interrelated set of constructs (or variables) formed into propositions, or hypotheses, that specify the relationship among variables (typically in terms of magnitude or direction).” Such theories can provide a structure to develop research questions and methods to study related variables. There are a number of public policy related theoretical frameworks that discuss policy change and adoption, including Kingdon's (1995) Multiple Streams Theory, Rogers' (1962) Diffusion of Innovation Theory, Baumgartner and Jones' (1993) PET, and Lindblom's (1959) Incrementalism. Downs' (1972) Issue-Attention Cycle concept may also be relevant as a means to understand the public's attention to an issue and how that stimulates change. Generations of prior scholars have utilized these theories in both quantitative and qualitative research.

Rogers' (1962) Diffusion of Innovation Theory, later termed by scholars as 'policy diffusion,' is a relevant approach at framing solar PV energy policy change and adoption throughout the U.S. (e.g., Stoutenborough & Beverlin, 2008). This theory centers on how policies are replicated and spread (i.e., best practices) over geographic areas (i.e., U.S. states). Rogers (1962) categorized different levels of innovation adopters as innovators, early adopters, early majority, later majority, and laggards. Such diffusion of innovation occurs over time, meaning that there are a number of aspects (e.g., the media) that can speed or slow diffusion.

Similarly, peer diffusion and the issue-attention cycle in agenda setting can explain how social interactions and public perceptions affect governmental decision making processes. Kingdon's (1995) Multiple Streams approach explains agenda change through three 'streams' of separate, simultaneous activity surge: problems, policies, and politics. Kingdon's (1995) explanation of policy change accommodated some elements of rationalism and incrementalism, which relates to Lindblom's (1959) incrementalism, which discussed policy change as evolutionary rather than revolutionary (i.e., small incremental changes rather than a few substantial changes).

Despite the potential value of fragments of these prior theories, and after considering alternatives such as Advocacy Coalitions (Sabatier & Jenkins-Smith, 1993) and Choice Awareness Theory (Lund, 2010), this study elected to use Baumgartner and Jones' (1993) PET. History is important in understanding energy policy formulation (e.g., certain events have triggered policy change or adoption), and PET offers the strongest resource for such a historical narrative. It also provided the most robust set of predefined phrases (e.g., bounded rationality, disproportionate attention, framing, policy monopolies, etc.) that help describe how change transpires in the complex realm of energy policy. Overall, PET was the most appropriate theory

due to the historically radical shifts in policy adoption (e.g., NEM), and the fact that the U.S. may be at the beginning of another radical shift in policy adoption for community NEM and shared solar. The theory also highlights political power and how institutions (and actors, such as the solar industry, electric utilities, etc.) pursue the energy policy status quo (i.e., policy punctuation/adoption can happen, but only via the right set of circumstances). This highly-vetted theory is both unique and valuable to the study of state-level PV policies.

The phrase ‘punctuated equilibrium’ in public policy was inspired from its original use in the natural sciences to describe dramatic shifts as opposed to incremental progress in evolution (Baumgartner & Jones, 1993). In the discipline of public policy, equilibrium (i.e., balance or stability) is the result of dominance within governmental structures in maintaining the status quo. Punctuation, therefore, refers to an actual public policy change or shift using data or viewpoints to alter the decisions of policymakers.

As part of their text, *Agendas and Instability in American Politics*, scholars Frank Baumgartner and Bryan Jones developed the punctuated equilibrium theory (PET) as a framework to comprehend public policy change and stability. Baumgartner and Jones (1993) argued that long periods of policy stability, supplemented by short periods of intense change, can be explained by the important interaction of what are termed ‘policy images’ with ‘policy venues.’ The concept of ‘policy images’ refers to how policies are discussed and understood by the public and policy elites/experts (i.e., they refer to the various perspectives one may have on a public policy issue). In contrast, ‘policy venues’ refers to the establishments that literally make public policy determinations.

Since public policies affect individuals in dissimilar ways, the public holds diverse images, both positive and negative, of the same policy. That is to say, there are various ways in

which a policy is understood and discussed (Baumgartner & Jones, 1993). As part of this process, the concept of framing helps explain the way such policy images can be arranged to make them appear technical and relevant only to experts, or linked to wider social values to heighten participation (Rochefort & Cobb, 1994). For instance, to draw interest in the U.S., persons often link ideas to the widely accepted values of independence, patriotism, and economic growth (Baumgartner & Jones, 1993). As part of the policy image development, framing is “a mixture of empirical information and emotive appeals” (Sabatier, 2007, p. 161).

Most public policy issues are multifaceted and, therefore, can command a wide range of policy images. For instance, smoking could be framed in terms of health, public nuisances, employment, taxation, the role of corporations, civil liberties, and human rights. Nevertheless, while there exist various ways to frame the same problem, there is also limited time and energy to devote to issues. Consequently, highly complex issues are typically simplified, with very few issues focused on at any one time at the expense of all the rest.

On the other hand, policy venues are sets of governmental institutions where authoritative decisions over policy are made (Baumgartner & Jones, 1993). Relevant examples of policy venues include the federal executive branch, Congress, courts, and lower levels of government such as state and local jurisdictions. Baumgartner and Jones (1993) argued that changes in a policy image can produce changes in policy venue and, conversely, venue changes can facilitate image changes. The interaction between venues and images may result in long periods of stability or, in some cases, short periods of intense change.

An illustration of such an interaction is the case of the National Environmental Protection Act (NEPA) which was enacted in 1969. Environmental groups, which were particularly concerned about nuclear power, were unhappy about regulatory decisions made by the federal

government and appealed to previously uninvolved members of Congress (Anderson, 2013). Congress became more sympathetic to this new image of environmental policy and passed new legislation to regulate business and help develop the federal Environmental Protection Agency (EPA), which was more consistent with the new policy image (Baumgartner & Jones, 1993). This image was advanced in public opinion by the nuclear power plant accident at the Three Mile Island, as several lost confidence in the nuclear industry (Culley & Angelique, 2010). In sum, persistent opposition by the environmental groups shifted the policy image of nuclear power from a highly positive one to an overwhelmingly negative one.

Often, crises such as environmental disasters serve as a triggering event, focusing media, government, and public attention to an issue previously lower on the policy agenda (Thompson & Wallner, 2012). Such triggering or focusing events may also act as “dramatic symbols of problems that are already rising to national attention” (Baumgartner & Jones, 1993, p. 130). This propensity to give disproportionate attention to disasters over more routine events allows an opportunity for activists to push forth their demands. Sometimes, these parties label problems as a crisis “to elevate a concern when facing an environment overloaded with competing claims” (Rochefort & Cobb, 1994, p. 21).

Venue shopping is the strategy used to describe this situation of policy images and the seeking of sympathetic policy venues. According to Baumgartner and Jones (1993), this tactic involves the manipulation of policy images in order to push policy debates toward favorable venues. In other words, those who have not succeeded in policy debates will seek supporters in alternative venues such as congressional committees, courts, or even state government agencies (Holyoke, Brown, & Henig, 2012). In this quest, the manipulation of policy images explains why an issue is discussed in a particular venue and attracts the interest of the members of such

venue (Wood & Doan, 2003). There are commonplace techniques of venue shopping. For example, venue shopping typically works to appeal to a broader audience so that more supportive participants get involved in the debate. Further, attacks to current policies from decision makers occur in other venues aiming to extend their own policy jurisdictions.

The study of group-to-government relations has fashioned numerous approaches and an abundance of terms to describe this relationship such as competitive pluralism, state corporatism, sub-government, policy whirlpools, and iron triangles (Jordan & Schubert, 1992). One intriguing approach is the discussion of policy communities and policy networks as deliberated in PET. Baumgartner and Jones (1993) describe policy communities as systems of limited participation containing interest groups and persons knowledgeable of a particular policy arena. This suggests a steady, close, and typically concurring relationship between a small number of groups and government (Princen, 2010). In contrast, policy networks represent a more comprehensive set of associations between interest groups and governments, which contains less stability and agreement. These concepts are illustrated in Table 3.

Table 3.

Policy Communities and Networks

	Policy Community	Policy Networks
Number of Participants	Small	Large
Nature of Consultation	Frequent, high quality	Inconsistent frequency and lower quality
Nature of Interaction	Stable and close	Less stable; fluctuates
Levels of Consensus	Participants share understanding of the policy problem and how to solve it. Members accept and support the outcomes.	A measure of agreement may be reached but conflict and opposition is more likely.

Note. Adapted from Rhodes and Marsh (1992).

As Table 3 outlines, policy communities are typically protected from the wider political process. This happens since public policies are dissected and analyzed at a level that a limited number of actors have the time or resources to become involved. These policy communities comprise of stable relationships between public officials and influential interest groups. These relationships are sustained since the participants share a general agreement about a policy issue, and therefore try to restrict others interested in the issue (Jordan & Maloney, 1997). Moreover, individuals involved in policy communities understand that while not all may agree with every decision made, it remains preferable to act in this manner as opposed to seeking larger networks which may diminish their power.

In fact, Baumgartner and Jones (1993) have explicitly discussed the monopolistic nature of policy communities. Such policy monopolies are delineated as institutional structures that develop policy decisions while limiting the entrance of other participants (Givel & Glantz, 2001). In turn, monopolistic control over policy venues makes changes in policy images difficult, which weakens the possibilities for policy change (Givel & Glantz, 2001).

Baumgartner and Jones (1993, p. 7) explain that policy monopolies have a “definable institutional structure is responsible for policy making, and that structure limits its access to the policy process” and that a “powerful supporting idea is associated with the institution.”

The preservation of the policy monopoly requires an agreement to the same policy image as well as an ability to exclude groups who disagree. A policy issue is often rendered as dull, to minimize external interest, or as technical, requiring a certain level of expertise, specifically to leave out other persons. Accordingly, policymaking is often incremental and based on prior agreements between a small number of individuals (Repetto, 2006).

The monopolistic structure of a policy community can only be altered when new participants with opposing interests make their way into the community (Breunig & Koski, 2006). Those excluded from the policy monopolies will attempt to shift the debate by questioning the existing approach and appealing to public officials. New understandings of public policy issues attract new participants to the policy process, which can sometimes weaken the power of policy monopolies. Once more, an example of this occurred when the negative images surrounding nuclear power helped diminish the powerful policy monopoly of the time. Environmental advocates raised the issue in several arenas, and an increased number of individuals were immersed in nuclear policymaking, causing the previous policy monopoly to collapse.

Baumgartner and Jones (1993) acknowledged that shifting institutional and political environments can influence public policy change, as well as stimulate change in policy via Congress. Congress can be either a source of policy stability or a promoter of change; it can work to maintain or destroy policy communities. For instance, when Congress pays more attention to a particular policy issue in response to requests, interest groups, or executive agencies can force change in congressional behavior toward those issues (de Figueiredo, 2013). Members of Congress can link their interests with those of persons outside of Congress to move the issue to a different policy venue. This framework is also applicable in state legislatures.

The notions of agenda setting and bounded rationality are also a fundamental component of PET. Since key decision-makers such as Congress or state legislatures cannot consider all issues at all times, they disregard most and consider only a few at the top of their particular agenda. Moreover, some public policy issues are much more pressing than others, whereas some entail quick actions. For example, economic issues (e.g., unemployment) often remain high on

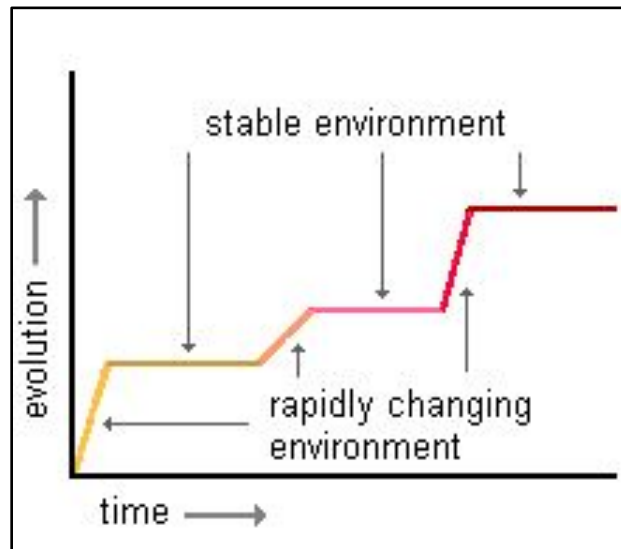
the political agenda, while catastrophic events (e.g., natural disasters) demand an immediate response. However, since the attention of audiences is limited, and the number of policy issues is limitless, the importance of each issue is open to various analyses and deliberations.

More specifically, agenda setting refers to the aptitude of policymakers to focus on one policy issue while disregarding others. Dearing and Rogers (1996) describe this process as “an ongoing competition among issue proponents to gain the attention of media professionals, the public, and policy elites” (p. 1). The absence of attention to majority of policy issues explains why numerous public policies do not change, whereas concentrated periods of attention to other policy issues may stimulate alternative ways to frame and resolve such problems. The concept of bounded rationality suggests that policymakers’ ability to implement decisions is inseparable from their objectives (i.e., true rationality does not exist). Therefore, even individuals who intend to make rational choices are bound to make satisficing choices in these complex policymaking environments.

These political environments of public policy change all point to the key PET concept that political systems can be characterized as both stable and dynamic. Most public policies stay the same for long periods, whereas others change very quickly and dramatically. Alternatively, public policy change in a certain arena may be incremental for several years, yet followed by overwhelming changes which set an entirely new direction for the issue(s) in the future. The aim of PET is to explain these long periods of policy stability punctuated by short but intense periods of change, as illustrated in Figure 8.

Figure 8.

Punctuated Equilibrium Framework



Note. Long periods of stability and short episodes of change. Figure from O'Neil (2012).

The PET approach considers that powerful political actors attempt to strategically control policy images through rhetoric, policy analyses, and symbols in a way that favors their own political goals. Policies remain the same within certain policy communities since there is limited external interest, or perhaps limited capacity of outside parties to participate. Policies change when adequate external interest, often triggered via key focusing events, initiates the collapse of the policy communities. In this scenario, external attention rises and the issues are considered in a broader environment, where power is more evenly spread and new actors can influence the agenda. If the levels of external pressure gain enough momentum, they may cause major policy punctuations, as opposed to the more common minor policy changes. The increased attention and communication can cause novel approaches to be considered, which may rouse new conflicts between political actors.

Overall, in PET, changes in public policy can be explained by a successful challenge to policy monopolies. Naturally, the majority of public policies remain unchanged for long periods since policymakers are incapable or reluctant to pay enough attention to them. However, those excluded from monopolies have an interest in challenging or reshaping the dominant way of defining policy problems, which are often triggered or brought to the agenda by focusing events. The successful re-definition of a policy problem prompts an influx of new actors. Previously excluded interest groups can work to attract the attention of decision-makers in other venues through the definition of new policy images. Consequently, public policy change in PET often follows a progression of increased attention, venue shopping, and shifting policy images. As individuals come to understand the nature of a policy problem in a different way, more and more become attentive and involved. This growth in outside involvement offers an increased likelihood of an additional shift to a policy image, as new participants discuss new ideas and propose policy solutions. Although most public policy issues display stability, and there are numerous policy communities, they are continually being created and destroyed.

2.3. History, Institutions, and Policymaking Processes

Public policy is often construed as governmental activities to mitigate societal problems. Mainstream policy texts habitually describe an agenda-setting process (Gandy Jr., 1982) that is clouded by value conflicts and power struggles (Birkland, 2011; Moran, Rein, & Goodin, 2006). Policymakers must consider what resources are available to achieve a solution (Fischer, 1995) and determine which agency or organization is accountable for policy enactment (Peters, 1999). Evaluation measures help conclude if a policy was justified considering its expenses and remunerations (Nagel, 2002).

2.3.1. Historical Analysis

In the U.S., energy has historically been used via oil, coal, and natural gas, which are all non-renewable forms of energy. However, the first solar power system was actually developed in France in the mid-1800s to produce steam to drive machinery. In the late 1800s, the development of the first hydroelectric plant, windmill, and geothermal heating system occurred (Solomon & Krishna, 2011). Moving forward, powerful industrial forces began to grow as a key actor in the early third of the 1900s. At this time, vehicles began to go into mass production, and the birth of the modern oil industry occurred with a discovery in Texas' Spindletop oil field (Mody, Gerrard, & Goodson, 2013). During this same period, the development of large IOUs occurred to provide a new commodity – electricity – to Americans. In 1935, President Franklin D. Roosevelt's Rural Electrification Act (REA) further expanded infrastructure and electric services throughout the country (Emmons, 1993), setting the stage for the electricity providers and markets seen today.

However, non-governmental organizations (NGOs) began to grow as a key player over the next few decades. For instance, in the 1940s, there was a growing concern for nuclear energy technologies by the greater citizenry as a byproduct of World War II (Morrone, Basta, & Somerville, 2012). Moving into the 1950, 1960s, and 1970s, nuclear anxieties continued, as did those concerning fossil fuel usage, as fossil fuel smog was blamed for the illness and death of numerous Americans (Berkowitz, 2006). The theory of peak oil also arose during this time frame (Brecha, 2012). Several new organizations formed to combat environmental concerns and advocate for a greener earth. For example, Greenpeace was founded in the late 1960s (Berkowitz, 2006).

The federal government began to take a more prominent role in energy matters in the 1970s as a result of various crises. The 1969 Santa Barbara Oil Spill, coupled with growing environmental concerns, spurred federal governmental institutions to intervene. The Clean Air Act passed in 1969 (Foster, 2012). Subsequently, in 1970, the U.S. EPA was established to focus on damage to natural areas as a result of energy harvesting (Suter, 2008). To make matters more complex, the 1970s were the decade of oil shortages, demonstrated by the 1973 and 1979 oil crises, respectively. To mitigate such crises, the federal government established various commissions to regulate energy and develop alternative sources (Berkowitz, 2006). Interestingly, in 1976, Congress authorized a committee to examine the potential for the development of electric vehicles (Masood & Bouwmans, 2015), and also became involved in wind energy. The formation of the Solar Energy Research Institute occurred in 1977 (Ciment, 2015), which later became known as the NREL.

Yet, as demand for foreign oil fell, the Organization of the Petroleum Exporting Countries (OPEC) cut oil prices, and diplomacy with Middle Eastern nations helped to reestablish the supply of imported oil for the U.S. and Europe (Barsky & Kilian, 2004). The U.S. Department of Energy formed in 1977 as a government agency to concern itself with energy policies and safety in handling nuclear materials (Fehner & Holl, 1994). President Jimmy Carter felt the need to consolidate national energy policy. Consolidated institutions included the Federal Energy Administration, the Energy Research and Development Administration, and the Federal Power Commission (Elliot & Ali, 1984). In 1979, another key focusing event occurred at Three Mile Island in Harrisburg, Pennsylvania. A nuclear radiation leak from a nuclear power plant forced it to shut down (Walker, 2004). A related event in 1986 in the Soviet Union at

Chernobyl also led to the relative decline of the nuclear power industry at the time (Berkowitz, 2006).

The 1980s and 1990s saw an increased focus on sources of renewable energy such as wind, hydrogen, and solar PV. The Exxon Valdez oil spill in 1989 added to the increasing pressures away from oil and gas technologies; while they were still a viable resource, increasing amounts of people were becoming attuned to the exploration of alternative energy resources (Laird & Stefes, 2009). Conservative President Ronald Reagan's deregulatory policies of the 1980s gave way to the rise of New Federalism, signifying a comprehensive return of powers to state governmental institutions (Tobin, 1986). Reagan's policies set the stage for the growth of solar deployment in the 1990s, and ultimately, the growing power of state governments in the solar energy policy discussion. Over the past few decades, U.S. states have explicitly taken initiative to address issues of energy production and consumption via legislation, taxation, energy conservation standards, subsidies, and other forms of incentives (Byrne, Huhges, Rickerson, & Kurdgelashvili, 2007; Carley, 2011).

Specialists on the matter claim that federal attempts to create national solar PV standards have proven much too partisan and, thus, unsuccessful. Additionally, federal solar would require many square miles of panels and would create line loss (Teng, Yat-Sen, Luan, Lee, & Huang, 2012). This means that electricity would literally be lost by traveling through the intricate and expansive set of power lines this situation would require. This, among other reasons, pushed solar PV policy to state legislatures, indicating a huge shift in how energy policy was enacted in the U.S. By the 2000's, NEM and RPS laws had emerged in several U.S. states. Other key focusing events during this same timeframe, such as the coal-ash spill in Kingston, Tennessee in

2008, and the BP oil spill in 2010, added to the growing cultural and political push for solar PV and other renewable energy technologies (Valentine, 2011).

Clearly, history and key focusing events have played a key function in the comprehension of the development of institutional players in the solar PV policy domain. Fundamental actors such as state legislatures, industrial players, and NGOs have all gained steam over the past century or so, and are now the most crucial actors with regard to state DPV policy. Analyzing these historical events provides necessary context for outlining of the current institutional framework and environment in Virginia.

2.3.2. Key Institutional Players

Two focal categories of institutions are present within this state solar PV policy environment: governmental and voluntary. Governmental institutions are public institutions or policy venues which enact policy on behalf of the citizenry. Within this category exists the legislature and the executive. Together, these groups have the ability to steer governing actions in terms of solar energy policy by way of enacting, amending, and repealing laws. The next category within the set of governmental institutions is the legal system, consisting of courts and judges, whose role is to explain, interpret, and apply energy laws. Governmental agencies also play a key part in this process as an institutional player, via the literal oversight and administration of solar policy. In Virginia, agencies such as the SCC, which regulates electric utilities, the DMME, and the DEQ, come to mind.

The other category present when looking at state solar PV policy is of the voluntary variety. These organizations are established for a specific purpose, such as profit or advocacy. For instance, the media plays a role in transmitting state solar policy information to the citizenry. Following, IOUs, as well as solar firms, serve as prominent actors in this realm by influencing

public policymaking via lobbying. NGOs also play a role by facilitating awareness and organizing the citizenry. Groups such as think tanks, advocacy groups, charitable organizations, and political parties work to influence solar policy enacted by the governmental institutions. In Virginia, groups such as Appalachian Voices, the Chesapeake Climate Action Network, and the Virginia Chapter of the Sierra Club appear as relevant organizations.

2.3.3. The Political Process

State governmental institutions, with this new liberation from the federal government, have taken on many new responsibilities in the policymaking arena since the 1980s. This profound shift is unequivocally central toward the examination of current solar policies that are implemented by state legislatures. In U.S. states, this system allows the legislature to have immense amounts of power with regard to DPV policy.

Quite literally, policies to encourage solar PV are created by passing state-level bills into law. In this sense, a bill is typically introduced by a member of the House or Senate, and a committee forms to consider the bill (and possibly amend it). The purpose of going through such a committee process is to better discuss and determine the bill's legality and practicality before coming to a vote. If the bill does pass via vote, it is then either signed into law or vetoed by the governor. If it is vetoed, the legislature does have the ability to override the veto and the bill can become law without the governor's approval (Kousser & Phillips, 2012). This governmental system allows state legislatures to have immense amounts of power with regard to solar PV policies. In fact, in nearly any realm of state-level public policymaking, state legislatures have much authority, control, and command of the direction of policy.

State legislative bodies are the key institutional players at shaping the nature of PV policies. This group is empowered to enact, amend, and repeal laws, and fundamentally have a

strong force as a political unit, especially in the renewable energy policy arena. All U.S. states except Nebraska have a bicameral legislature (Schneider, 2012), meaning that two separate legislative chambers exist – the smaller typically being the Senate. This assembly of legislators has a unique role in the policymaking process in the U.S., especially considering the aforementioned fact that they have the ability to override a bill that may have been vetoed by the governor.

Nevertheless, solar firms, solar advocacy groups, and electric utilities all work their way into this elaborate arena, pursuing their respective interests. While solar advocacy groups have robust powers in numbers and organizing ability, they often lack the financial capital to make an impact. Solar firms do have the financial capital to influence state legislatures, but since these firms are principally small (in revenue and geographic reach), they have tremendous difficulty competing with the large IOUs who have considerably larger profit streams and typically employ lobbyists to influence the policy direction of state officials (Agrawal & Knoeber, 2001).

Political power serves as a key factor in influencing and/or controlling the making of state-level solar PV policy. Politicians, individuals who make a career out of practicing administrative governance (Fleisig, 1987), seek and possess political power in the way they can control political behaviors. Firms, interest groups, political action committees (PACs), and many others also pursue ways to influence and shape political activities in their best interest. The acquisition and exercise of political power in the scope of public policy allows for a variety of groups or individuals to manipulate and guide the direction of public policy, largely by influencing political officials.

It is likely that the most effective and powerful way this political power is garnered is through the use of money. The influence of money power and corporate dominance serves as

one of the most prominent ways that politics and public policy are manipulated (Nichols & McChesney, 2012). Hence, money influence in elections, government functions, and politics as a whole plays a large role in the comprehension of public policy. Through the combination of political and money powers, governmental outlanders immensely affect political spending priorities and public policy execution. Though public officeholders have the literal political authority to make and carry out public policy decisions, they are frequently and habitually coerced by those with financial assets who have self-interested motivation to get involved in the policy process. In this discourse of state-level policies to encourage solar PV investments, those with the largest financial assets are the IOUs.

Think tanks also have a distinctive influence in the discussion of how political power influences policy. By design, think tanks are research organizations run by policy and political professionals with the purpose of pushing the policy conversation along. Ultimately, the goal is to assist political officials and promote useful policy alternatives that can grow into legislation. However, even think tanks are politically motivated, influenced by money power, and tend to work toward their own agendas.

The respective motivations, manipulations, and overall infiltration of those seeking political power incomparably shapes policy formulation. State legislators have developed sizeable PV marketplaces in the U.S. over the past couple decades, and now with more economical materials and installation, as well as simplified permitting processes, electric utilities are fighting back with lobbying and big money. In essence, state legislatures have the ability to make policy with the help and recommendations of state agencies, academic researchers, etc., but other institutional players such as industry and NGOs are increasingly working to maneuver

and navigate the direction of PV policy. Today, states with the largest utility providers face the most lobbying and backlash in terms of passing PV incentive legislation.

2.4. Renewable Energy and the Role of Public Policy

As a sweeping description, energy policy refers to governmental measures attending to the generation, transmission, distribution, and overall use of energy commodities. Renewable energy policies may include licensure, monitoring the performance of regulated firms, determining tariff structure, and addressing how renewable energy technologies can be connected to the grid (Beck & Martinot, 2004). Therefore, legislators and regulators make a wide range of decisions when it comes to policy, which in turn affects the financial outcome of firms, the well-being of the environment, and the social utility of a citizenry.

Governments around the globe have played a continuously increasing role in implementing energy policy since the oil crises and spike in energy rates in the 1970s (Kowsari & Zerriffi, 2011), often to meet objectives such as reliability, economic growth, environmental protection, and resource diversification (Couture & Cory, 2009; Hurlbut, 2008). More recently, governments have realized the importance of taking action on climate change and the need to diversify sources of energy (Rabe, 2006). Relevant public policies include incentives to encourage energy efficiency, policies to boost renewable energy generation, and carbon sequestration programs. There exist a multiplicity of questions and issues to address in this sense, such as how future energy will be consumed, what environmental externalities are tolerable, what is the degree of energy self-sufficiency, and from where future energy sources will derive (West, Bailey & Winter, 2010).

Due to rapid development, the demands of comfort, and a growing world population, energy consumption is rising tremendously year by year. Currently, fossil fuels such as coal, oil

and gas, are playing the lead role to meet that energy demand (Crabtree & Lewis, 2007).

However, environmental pollution has become a noteworthy problem due to the widespread use of fossil fuels today. Reports have shown that human activities, such as the burning of fossil fuels, are increasing the concentration of CO₂ and several other GHGs, resulting in concerns about warming of the earth over the next century (Wuebbles & Jain, 2001). Wuebbles and Jain's (2001) models suggest, "without major policy or technology changes, future concentrations of CO₂ will continue to increase largely as a result of fossil fuel burning," (p. 99) which can have several detrimental effects.

In fact, fossil fuels are the largest GHG emitters in the world, contributing three-fourths of all carbon, methane and other GHG emissions. While coal, petroleum, and fossil fuels offer relatively inexpensive and reliable means to produce electricity today, they also lead to heavy concentrations of pollutants in the air and water. In turn, the earth's atmosphere naturally absorbs much of these GHGs, and is trapping up to 25% more of the sun's radiation due to annual increases in GHG emissions (U.S. Environmental Protection Agency, 2015). This situation of global warming is leading to an increase in the average worldwide temperature due to the higher concentrations of GHGs in the atmosphere.

Though oil and gas energy resources continue to dominate today's industrialized world, their standing is already declining (Burkett, 2011). Numerous scholars have noted the pervasiveness of energy efficiency and renewable energy integration and subsequent reductions in air pollutants and environmental impacts (e.g., Panwar, Kaushik, & Kothari, 2011). In fact, Prasad and Munch (2012) found that state-level policy in the U.S. can specifically help lower carbon emissions. Such policy and renewable energy integration is significant considering fossil fuels' influence on CO₂ and other GHG emissions being trapped in the Earth's atmosphere

(Lehmann, 2007), which poses a major threat to global development, human health, and the environment via global warming (Mann, 2009). Policymakers' recent focus on rising energy prices, energy security, and environmental protection (Pizer, Sanchirico, & Batz, 2010) has led to a greater emphasis on energy conservation and the pursuit of alternative sources such as biomass, wind, and solar PV. In fact, solar PV systems are one of the most practical ways for homeowners and businesses to capture energy from the sun's rays to provide electricity to a building, allowing them to participate in the transition to cleaner and more sustainable forms of energy.

Among renewable energy options, solar PV systems are a promising and reliable energy source that can help meet energy demand, and governments have been providing various incentives to develop solar energy marketplaces. Specifically, solar PV systems include modules or panels made up of silicon crystals that create a solar array, when combined. Each solar panel contains cells that capture sunlight and convert it to direct current (DC) power (Natural Resources Defense Council, 2015). An inverter is subsequently required to convert the DC power to alternating current (AC), allowing the use of AC-powered equipment that are commonly found in homes and businesses today (Natural Resources Defense Council, 2015). Other components of solar PV systems include batteries, wiring, and mounting hardware.

Solar PV systems present a number of advantages, particularly since they are a technology, not a fuel. As such, solar PV systems offer reduced emissions when compared to their alternate energy sources, and there is also a general lack of water needed to operate such systems. Since the resource is renewable, there is an infinite amount of power that can be generated throughout the life of panels. Current industry data shows that, if well-maintained, PV systems are expected to last for 30 years before any replacement is required (Xiarchos & Vick,

2011). PV systems also operate autonomously, have widespread availability, and do not generate any noise or disturbances. Reductions in PV materials costs, coupled with continual rises in global energy prices, make PV systems an attractive investment and savings option for interested parties.

However, current PV installation figures are still quite small, and today, solar PV provides only about 0.1% of world total electricity generation (Tyagi, Rahim, Rahim, & Selvaraj, 2013). Nonetheless, some market reports indicate that PV installations are growing at a 40% average annual rate (International Energy Agency, 2010), largely due to decreases in module costs and municipalities and installers becoming more familiar with the technology. With continual advances in technology and storage, solar PV systems are making more and more economic sense for interested investors. It is predicted that solar PV will deliver roughly 345 GW by 2020 and 1,081 GW by 2030 (Greenpeace, European Photovoltaic Industry Association, 2011) of power to the world.

In the U.S., in 2015, it was reported that PV installations reached 6,201 MW, up 30% over 2013 and more than 12 times the amount installed five years earlier (Solar Energy Industries Association, 2015b). Over 600,000 homes and businesses now have on-site solar (nearly 200,000 of these installations were completed in 2014), and six states are home to more than 500 MW each of operating solar capacity (Solar Energy Industries Association, 2015b). In addition, according to The Solar Foundation (2014), there are now nearly 174,000 solar workers in the U.S., a more than 20% increase over employment totals in 2014. The increasing number of projects has injected life into the U.S. economy as well. In 2013, solar installations were valued at \$13.7 billion, compared to \$11.5 billion in 2012 and \$8.6 billion in 2011 (Solar Energy Industries Association, 2015b). The Energy Information Administration (2015) expects solar

capacity to continue to grow in coming years due to continual advances in technology and installation procedures.

2.5. Prior Research on State Solar PV Policies

A small number of prior studies have evaluated the effectiveness of solar PV policy mechanisms through comprehensive statistical analysis of the factors driving solar PV capacity at the state level. These studies have primarily employed multiple regression analyses to weigh the effects of various state policies against other non-policy factors such as solar insolation, electricity prices, and various demographic conditions. Examined as a whole, this prior research has produced mixed results about the relative importance of market opening policies, financial incentives, and other non-policy factors in support of the growth of solar PV capacity.

One of the most comprehensive findings from the related literature was discussed in the seminal piece by Carley (2009b). The author investigated state renewable energy deployment and the efficacy of state RPS, subsidy (i.e., grants, loans, and rebates) and tax incentive policies, electricity prices, solar potential, and a number of other political and environmental factors. Although she did not consider the role of interconnection and NEM policies, Carley (2009b) discovered RPS, loan programs, solar potential, and demographic factors (e.g., per capita gross domestic product (GDP)) to be the most statistically significant and positive drivers in renewable energy generation figures.

In a related study, Steward and Doris (2014) controlled for each state's demographic and economic conditions, and evaluate the effectiveness of interconnection, NEM, RPS carve-outs, and third-party ownership policies at increasing solar PV installations. The authors found that the implementations of interconnection and NEM policies were fundamental for PV market growth, yet demographic and economic contextual variables (i.e., income, solar rooftop

potential, electricity prices, and environmental awareness) also impacted policy effectiveness (especially third-party ownership policies) and, ultimately, increased PV capacity figures.

A similar analysis by Krasko and Doris (2013) highlighted the importance of the order by which policies are implemented (i.e., ‘policy stacking’), and the authors found that while market opening policies prepared the market for PV growth, states with high populations and superior RPS installed more solar in the year 2010. Building off of this study, Steward, Doris, Krasko, and Hillman (2014) used a more complex range of non-policy factors such as solar resources, income, electricity prices, and sustainability awareness to group states into broad categories, also discovering that interconnection, NEM, RPS, RPS carve-outs, and the allowance of third-party ownership all tend to result in enhanced solar PV deployment.

Sarzynski, Larrieu, and Shrimali, 2012 (2012) similarly evaluate the impact of state-level solar PV incentives, finding that states with advanced RPS, RPS carve-outs, and cash incentives fare better in terms of grid-tied PV deployment, whereas tax incentives (e.g., property and sales) did not exhibit positive effects. Further, states with high competing electricity prices were more likely to invest in PV, while states with high GDPs were less likely to invest. Shrimali and Kniefel (2011) also factor in economic variables such as electricity prices and GDP, but find them to be insignificant drivers of state solar PV investments, while mandatory RPS bring forth the most favorable results. The findings from Doris and Gelman (2011) are much more varied, showing that RPS, personal tax incentives, rebates, and population are the key drivers of PV investments.

Table 4 offers a graphic portrayal of the variables included in the seven key studies most similar to this research. Demographic factors refer to any variable meant to assess economic strength, income, population, or environmental preferences.

Table 4.

Key Drivers of Solar PV Identified in Prior Studies

Authors (Year)	NEM	Interconnection	RPS	Loans	P/C Tax Credit	Property Tax	Sales Tax	Insolation / PV Potential	Electricity Prices	Demographic Factors
Carley, 2009b			√	√	X	X	X	√	X	√ ^a
Doris and Gelman, 2011 ^b		X	√		√ ^c		X			√
Krasko and Doris, 2013	√	√	√							√
Sarzynski et al., 2012 ^d	X		√			X	X		√	X
Shrimali and Kniefel, 2011			√						X	X
Steward and Doris, 2014	√	√	√					C	C	C
Steward et al., 2014	√	√	√					C	C	C

Note. A check (√) signifies a study finding a policy incentive to be sufficient at spurring PV market growth, while an (X) indicates policy insufficiency. Some studies use these variables as controls (C), but do not individually analyze their unique effect, significance, or direction. Cells remain blank if authors did not address the variable.

^a While state GDP brings forth a positive result, income and educational attainment were dropped from the model due to insignificance.

^b NEM and electricity price variables dropped from model due to multicollinearity issues.

^c Personal tax incentives are positively associated with PV capacity, yet corporate tax incentives show a negative relationship.

^d Cash incentives resulted in greater PV market deployment, but not property and sales tax incentives.

Other, more tangentially relevant studies have supported certain state-level policy approaches despite not assessing as comprehensive a range of policies. For instance, Carley (2009a) illustrates how favorable interconnection standards, NEM policies, and RPS have a strong positive relationship with expanded distributed solar. Such market opening policies are

widely noted as being foundational for increased PV market growth (Krasko & Doris, 2013; Steward & Doris, 2014). Others have noted the strong positive impact of state RPS and their carve-outs on solar PV deployment (e.g., Li & Yi, 2014; Wisner, Barbose, & Holt, 2011; Yin & Powers, 2010). However, some findings indicate that the implementation of advanced interconnection and NEM policies are often insufficient to spur market growth on their own. For example, while Shrimali and Jenner (2013) found that interconnection standards play a key role in promoting residential PV investments, they also found that financial incentives such as property tax exemptions most strongly encourage PV investments, particularly at the commercial level. Others indicate that financial incentives most strongly encourage PV investments (e.g., Bush, Doris, & Getman, 2014; Crago & Chernyakhovskiy, 2014; Gouchoe, Everette, & Haynes, 2002). While these studies investigate the impact of key state-level policy determinants, they often neglect other important variables (e.g., insolation and electricity price) that have been shown by others to drive PV investments.

Though several studies have concluded that state policies are the key determinant in PV deployment, much literature exists that cites alternative factors as most central to market growth. For instance, supporting the findings of Steward et al. (2014), Zhao et al. (2012) conduct a resident survey in Florida and find that lower income families are less likely to invest in PV systems. Income becomes a meaningful variable in this realm due to the high initial costs associated with PV investments (Shrimali & Jenner, 2013; Yang, 2010). Others allude to factors such as educational attainment (Hasnain, Alawaji, & Elani, 1998) and awareness for environmental concerns (Bamberg, 2003) as significant non-policy elements in renewable energy investment. Still others cite economic factors such as electricity prices as most central to PV deployment (Doris, Busche, & Hockett, 2009; Sarzynski, Larrieu, & Shrimali, 2012), signifying

that solar PV installations are comparably more cost effective in locations with higher electricity prices. Matisoff and Edwards (2014) found state political culture to be the key driver of renewable energy policy adoption. Doris, Busche, and Hockett (2009) also note a number of contextual factors affecting renewable energy use, including resource availability, technology availability and cost, energy costs, economic factors, financing options, institutional structures, and social acceptance.

In examining the prior literature, it has become apparent that inconsistencies exist in terms of explaining the relationship between solar PV investment and its multiplicity of potential determinants. The effectiveness of the various state-level policies brings forth mixed results, perhaps due to quantification issues and discrepancies from study to study. While a common conclusion exists that exceptional state-level policy drives solar PV investments, others have stressed the influence of policy ordering, electricity prices, deregulation, incomes, availability of sun energy resources, and variations in environmental sensitivity, among others.

2.6. Community Shared Solar

Community shared solar is a distinct branch of community-scale renewable energy generation focused on solar PV deployment. It is generally delineated as projects with two or more subscribers (Morrigan, 2010), who typically live “in geographic proximity to the solar project, and [share] the costs and benefits of ownership of the solar project” (Farrell, 2010, p. 1). Community shared solar projects have been a developing trend in the U.S. in recent years as a means to overcome various barriers to entry with regard to DPV. As the economic and social benefits of the community solar model have become clearer, and as implementation methodologies diffuse, more community projects are breaking ground across the U.S. at a groundbreaking pace.

2.6.1. Background and Projections

A key technical report by the IREC, *Model Rules for Shared Renewable Energy Programs*, claims that the shared renewables market “is currently underserved but potentially quite large. For example, if just five percent of U.S. households were to invest in a five kW interest in a shared solar system – the size of a typical residential rooftop solar installation – it would result in over 28 GW of additional solar capacity, equivalent to the output of over 50 coal-burning power plants” (Interstate Renewable Energy Council, 2012, p. 3). The report notes how community shared solar projects are the most predominant form of community/group renewables projects, taking advantage of site characteristics not readily available to individual on-site generation.

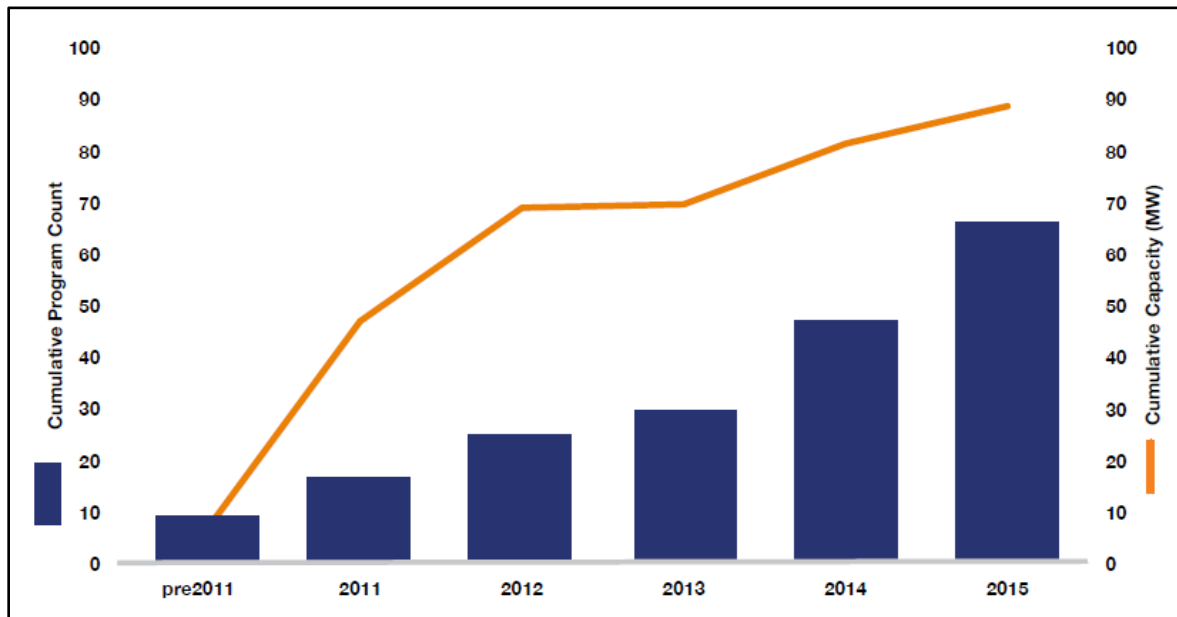
While a strong NEM law is often a key qualification for community shared solar, standard NEM is inadequate to solely facilitate the development of shared solar (Steward & Doris, 2014), and several policy approaches have been developed to expand NEM. The most common approach is community NEM. This arrangement allows multiple customers to acquire shares in a single net-metered solar PV system, located at any nearby site (Interstate Renewable Energy Council, 2012). This policy strategy helps lower installation costs, optimizes array placement, and permits PV system owners to physically disassociate generation meters from consumption meters, maintaining only an administrative and financial relationship with the solar array (Coughlin et al., 2012). A report by the Sun Farm Network (2008) further claimed that community NEM “removes market barriers and expands the addressable market...and attracts key market development resources (like capital) that eventually reduce the need for [other] state incentives” (p. 3).

Community shared solar projects can be an attractive option for consumers in how they diversify participation in the solar energy market. Many electricity customers are unable to own or host a solar PV installation. This may include renters and residents of condominium buildings (Coughlin & Cory, 2009), as well as customers who lack the financial resources to fund an entire DPV system on their home or business (Yang, 2010) but could fund a portion of an installation. Some property owners may have inadequate space on their rooftop or land. Rooftops may suffer from shading or obstacles, or they may face directions other than the South, which is the ideal direction for PV installations (Mingfang, 2002). Rooftops may also be aging, or customers may be contemplating a move (Asmus, 2008). In addition, some companies may lease and not own their commercial property (Asmus, 2008). Zoning issues or homeowner's association restrictions may be an additional hindrance toward installing solar (Caffrey, 2010). The recognition of these barriers has led to the development of local and community-owned shared solar PV projects.

While off-site, community shared solar gardens are a rapidly-expanding and compelling approach to solar PV deployment, they make up less than 1% of installed solar capacity in the U.S. (Trabish, 2016). A recent Solar Electric Power Association (SEPA) report notes 68 deployed or planned community shared solar projects in the U.S. as of August 2015, equating to almost 70 MW of installed solar capacity (see Figure 9) (Chwastyk & Sterling, 2015). By the beginning of 2017, Chwastyk and Sterling (2015) estimated this community shared solar total installed capacity figure to grow to roughly 300 MW. However, of the 68 projects being tracked by the SEPA, Chwastyk and Sterling (2015) found that currently only one third of the projects are fully subscribed, while one-quarter were less than 50% subscribed.

Figure 9.

Community Shared Solar Projects and Installed Capacity, pre-2011–2015

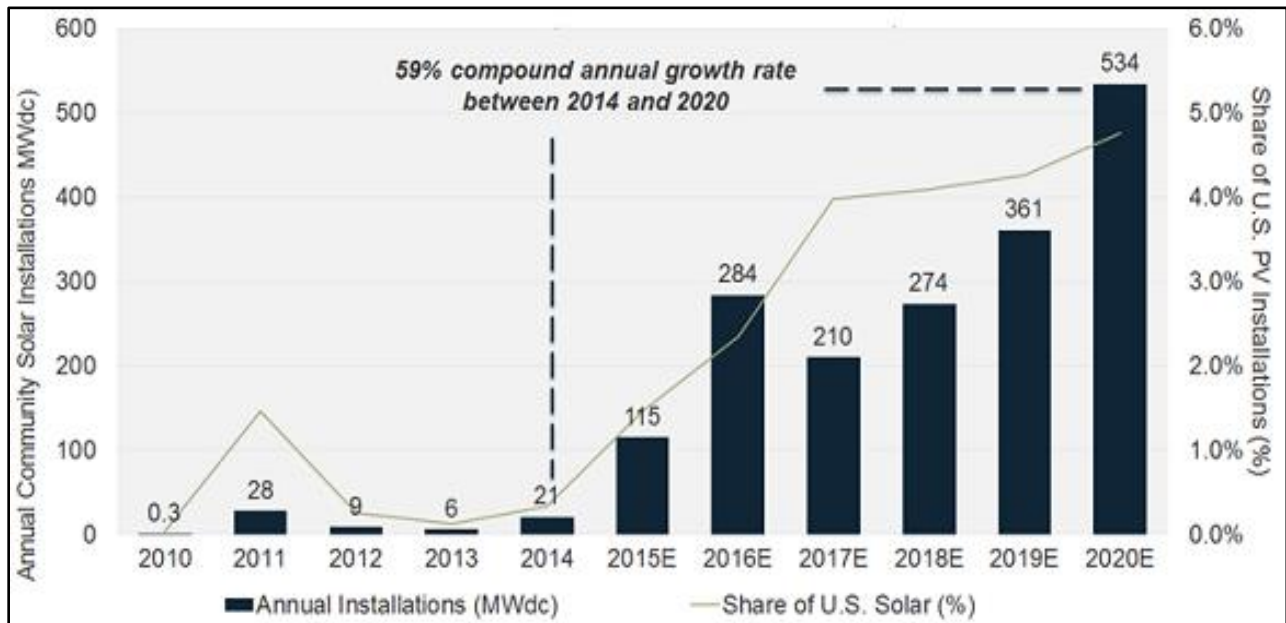


Note. Figure from Chwastyk and Sterling (2015).

Another recent report, entitled *U.S. Community Solar Market Outlook 2015–2020*, claimed that “over the next two years, community solar in the U.S. is poised to see its market size increase sevenfold, and by 2020 GTM Research expects U.S. community solar to be a half-gigawatt annual market” (Honeyman, 2015, para. 1). This report forecasted community shared solar’s total installed capacity figure to swell to 465 MW by the end of 2016, and approximately 1,800 MW by the end of 2020, as shown in Figure 10. These projections signify analysts’ expectations for a booming community shared solar market in the coming years.

Figure 10.

Annual Community Shared Solar Installation Projections in the U.S., 2010–2020



Note. Figure from Munsell (2015).

A recent IRS ruling also indicated that a Vermont man who invested in a community shared solar project would be eligible for the federal ITC under section 25D of the U.S. tax code (Clean Energy States Alliance, 2015). While this ruling currently applies only to this individual, it perhaps signals a larger trend of government agencies embracing community shared solar. Leading energy companies throughout the U.S. have also recently initiated the Coalition for Community Solar Access (CCSA), which is “the first-ever national trade association for community solar” (Pickerel, 2016, para. 1). The group’s mission is to “expand access to clean, local, affordable energy nationwide through community solar” (Pickerel, 2016, para. 2), which may also work to increase these community shared solar installation projections by opening markets and working with various stakeholders and policymakers.

2.6.2. Prior Literature

There is much existing academic literature and technical studies that explicitly outline the advantages of community shared solar. For example, Weinrub (2010) claims that community shared solar permits higher local control over energy, as well as command in how an expanded revenue base from said energy might be used by a locality. Other authors explain how community shared solar can work to provide financial benefits and mitigate concerns about climate change and rising energy costs (e.g., Bomberg & McEwan, 2012), as well as allowing for the achievement of solar economies of scale and ideal project locations (Coughlin et al., 2012).

Community shared solar can also contribute to collaborative emissions reductions goals as well as overall community cohesion (Hoffman & High-Pippert, 2010). The latter is a central consideration to community shared solar, as communal collaboration and unity are often cited as key to bringing civic members together for a common goal (KEMA, Inc., 2012; Bollinger & Gillingham, 2012; Bomberg & McEwan, 2012). Often, education and cooperation toward such a goal is established by way of social interactions (Irvine, Sawyer, & Grove, 2012). Community NEM is a key policy initiative toward enabling community solar, particularly by eliminating inequities in the market and allowing customers to aggregate their meters onto a solar array or garden (Sun Farm Network, 2008).

Despite the various benefits associated with community shared solar arrangements, as noted, there remain several key barricades to entry into the PV market. Bomberg and McEwan (2012) discussed how overcoming such challenging barriers are the specific reason why community groups mobilize in terms of renewable energy development. The authors indicated that there exist a number of formidable entry barriers, yet “mobilization depends less on political grievances or ideology, and more on the presence of resources and expertise to create and sustain

the group” (Bomberg & McEwan, 2012, p. 436). From three rural and three urban qualitative case studies, their findings indicated that symbolic and structural resources, as well as a shared identity or desire for strong, self-reliant communities, backed each group’s energy mobilization (Bomberg & McEwan, 2012).

Farrell (2010) also discussed barriers and complications toward community shared solar deployment. Such current barriers include “lack of access to federal tax incentives” and “onerous securities regulations of community solar entities” (Farrell, 2010, p. 1). Nine different community solar projects in seven different states are investigated in Farrell’s (2010) report, outlining all potential routes to deployment. Findings showed that community shared solar does not have a standardized model or approach, yet projects throughout the U.S. have found ways to overcome significant barriers and challenges to raising capital and utilizing various solar PV incentives (Farrell, 2010).

Other reports have demonstrated options for overcoming the various barriers to community shared solar projects, which are largely of the professional or technical (i.e., white paper) variety. For instance, Wiedman (2011) provided potential stakeholders with best practice rules and guidelines to utilize, focused on 1) the method of allocating the benefits of participation; 2) the valuation of the energy produced by the community renewables system; 3) the utility compensation for program administration; 4) financing options for community renewables; and 5) program administration. The National Renewable Energy Laboratory (2014b) discussed barriers such as “rules that limit project size or prohibit residential customers from obtaining credits” (p. 4), stating that adjustments to state interconnection and NEM policies were the best approach toward disabling these obstacles. Feldman, Brockway, Ulrich, and Margolis (2015) also focused on alterations to state policy, claiming that community NEM, value

of solar provisions, and other shared solar PV programs were the best approach to overcoming existing barriers. They claimed that this is even more important considering a majority of community shared solar projects are located in states with enabling legislation (Feldman et al., 2015).

Lastly, there are several existing reports that outline options and strategies for developing community shared solar projects and policy within respective states. Examples include Iowa (e.g., Chavez & Coughlin, 2013), Massachusetts (e.g., Beavers, McGuckin, & Sweet, 2013), Michigan (e.g., Konkle, 2013), Missouri (e.g., National Renewable Energy Laboratory, 2014a), and Vermont (e.g., Vermont Department of Financial Regulation, 2014), among others. Further, the National Renewable Energy Laboratory (2014c) has developed a ‘Community Solar Scenario Tool,’ which allows users to input location, PV system size, project costs, etc. to assess the impacts of a shared solar project on a utility and local economy. Other community shared solar reports and resources can be found from the National Renewable Energy Laboratory’s Solar Technical Assistance Team (2015) and the U.S. Department of Energy’s Green Power Network (2015).

2.6.3. Community Shared Solar Models and U.S. Legislation

Coughlin et al. (2012) most notoriously addressed the various incentives in place for community shared solar projects. Three sponsorship models are discussed in the report (i.e., utility, special purpose entity, and nonprofit), as are considerations of costs, benefits, financing, taxes, and legal matters. Coughlin et al. (2012) explained that the utility-sponsored community shared solar model is when an electric utility owns or operates a project that is open to voluntary ratepayer participation. Next, the special purpose entity model occurs when individuals join a business enterprise to develop a community shared solar project. Finally, the nonprofit model is

similar in the way a charitable nonprofit corporation administers a community shared solar project on behalf of donors or members. Hoyem (2013, p. 7) discusses a fourth potential model, micro-investment, which consists of an “on-line micro-funding platform to gather financial contributions from a wide array of stakeholders that may have no direct relationship with the host or live in geographic proximity to the site of the project.” These financiers, in turn, earn proceeds on their investments. This model is very similar to the special purpose entity model.

In most utility-sponsored projects, utility customers participate by contributing either an up-front or ongoing payment to support a solar PV project. These utility-sponsored projects generally have two potential models: customer-owned or rental. Under the customer-owned route, the electric utility sells a portion of the project’s solar panels to a member slightly higher than the average market rate, which helps fund the PV installation. Each customer receives a credit to their bill equal to the amount of power produced by their panels, minus a small percentage placed into an escrow account to cover operations and maintenance. This model allows the panels to eventually pay for themselves, which creates equity for the consumer.

Under the rental approach, a utility builds a community shared solar project, connects it to the grid, and retains complete ownership of the system (the participating customer has no ownership stake in the system). An eligible consumer then subscribes to a share of the project’s energy production, which is credited to their electric bill (Riley, Bencomo-Jasso, & Hoysal, 2012). The consumer faces no upfront costs and is usually guaranteed a certain savings rate by the contract. Although this system is more complicated for the utility to administer, it significantly lowers the financial entry barrier for consumers and is the most common form of utility shared solar in the U.S. today.

Under the special purpose entity model, a group of individuals choose to develop a community shared solar project as a special purpose entity, assuming the complexity of both forming and running a business. Since corporate law varies by state, there is a wide range of potential structures under which these groups may incorporate (e.g., limited liability company, corporation, partnership, etc.) (Coughlin et al., 2012). Regardless, the group must navigate the legal and financial hurdles of setting up a business, raising capital, and compliance with securities regulation. In addition, it must negotiate contracts among the participants, the site host and the utility, set up legal and financial processes for sharing benefits, and manage regular business operations. Given the complexity of forming a business, it is not surprising that many special purpose entities pursuing community shared solar are organized by other existing business entities with financial and legal understandings (Coughlin et al., 2012).

Nonprofit organizations such as schools and churches may also partner with local citizens to develop community shared solar projects. Under this model, supporters of the nonprofit organization help finance the system through tax-deductible donations or direct investment in the project. The donations route allows a nonprofit organization to build a solar array and sell the associated SRECs and excess power. This method is sometimes not considered ‘true’ community solar because donors might not receive electricity from the system. However, environmental stewardship and philanthropy often serve as intangible incentives for supporting nonprofit community solar. Under the direct investment model, the nonprofit solicits member investments, builds a solar garden or array, and must comply with state and federal securities regulations. While the nonprofit model is not eligible for the federal ITC, it may be eligible for grants or other sources of foundation funding that would not otherwise be available to a business (Coughlin et al., 2012). These three main model types are outlined in Table 5 below.

Table 5.

Summary of Community Shared Solar Models

	Utility-Sponsored	Special Purpose Entity	Nonprofit
Ownership	Electric utility or third party	Members of special purpose entity	Nonprofit organization (e.g., church)
Financing	Utility; ratepayer subscriptions	Member investments; grants	Member investments, grants, contributions
Subscribers	Utility ratepayers	Individual investors	Members; donors
Motivations	Offset electricity usage	Offset electricity usage; return on investment	Philanthropy; return on investment

Note. Adapted from Coughlin et al. (2012).

Goodward (2011) also outlined the utility-sponsored, special purpose entity, and nonprofit models of ownership, claiming that 11 states – Arizona, California, Colorado, Delaware, Florida, Illinois, Maine, Maryland, Massachusetts, Utah, and Washington – allow at least one of the noted types of community shared solar models. This number has increased since this report was published, as Oklahoma, Texas, Virginia, and others have announced small utility programs or pilot programs. Other reports have argued that utilities have the incentive to be at the forefront of community shared solar development, as its rewards apply to both the utility and customer (KEMA, Inc., 2012). The KEMA, Inc. (2012) report sketched various utility-sponsored community shared solar models, such as a utility-driven project through a green power based offer.

Asmus (2008) also argued that community shared solar projects are best operated by electric utility providers, and discussed its benefit as a safety net from an emergency management perspective (e.g., during blackouts). The SEPA has even developed a community shared solar handbook for utility providers to help them better understand the drivers and designs of various models (Siegrist, Barth, Campbell, Krishnamoorthy, & Taylor, 2013). The handbook noted the “differences between investor-owned utilities, municipal utilities and cooperative

utilities, [and the] major differences in company cultures and...political and regulatory environments. [Therefore,] even if one utility has a community solar program, it should not be assumed that another utility in the same state can easily apply the same program design” (Siegrist et al., 2013, p. 15).

Others have claimed that special purpose entity and nonprofit models, in which the community shared solar arrangement is organized by the consumers rather than the utility, is the preferable model toward increased deployment (e.g., Noll, Dawes, & Rai, 2014). Like Bollinger and Gillingham (2012) and Rai and Robinson (2013), Noll, Dawes, and Rai (2014) discussed the peer effects associated with community shared solar and how citizen groups offer the best path for DPV development considering its high upfront costs. Termed as “solar community organizations,” the quantitative analysis in this study showed that citizen groups and social interaction serve as a catalyst for community solar projects and localized benefits (Noll, Dawes, & Rai 2014), particularly for off-site projects.

Weinrub (2010) also discussed the collaboration of locally-generated solar PV. He stated, “businesses with large rooftops or parking lots can become small power companies that feed electricity into the grid” (Weinrub, 2010, p. 23). Furthermore, “community-scale decentralized generation allows more local control over energy and over how the expanded revenue base from that energy (and resultant tax base) is used, for example, in implementing a city’s climate action plan or economic development plan” (Weinrub, 2010, p. 23). This work showed that decentralized and community energy generation can stimulate economic development, revitalize local economies, reduce environmental ruin, and increase energy security (Weinrub, 2010). According to Hess (2013, p. 848), “locally owned and controlled

renewable energy could replace a utility-based system of centralized electricity based on fossil fuels and nuclear energy.”

States such as California, Massachusetts, and Colorado have particularly large installed DPV capacity figures in part due to their allowance for community shared solar arrangements. Currently, 14 states plus the District of Columbia have enacted formal community shared solar legislation, while six other states, including Virginia, have formally proposed such legislation (see Table 6).

Table 6.

Summary of Community Shared Solar Legislation in the U.S.

State	Policy Name	Status	Year
California	Virtual Net Metering / Senate Bill 43	Enacted	2013
Colorado	House Bill 1342 ¹	Enacted	2010
Connecticut	Senate Bill 928	Enacted	2015
Delaware	Community Net Metering Provisions (Order 7946)	Enacted	2010
District of Columbia	Community Renewables Energy Act	Enacted	2013
Hawaii	Senate Bill 1050 / House Bill 484	Enacted	2015
Maine	Net Energy Billing to Allow Shared Ownership	Enacted	2009
Maryland	House Bill 1087 / Senate Bill 481	Enacted	2015
Massachusetts	Virtual Net Metering / Senate Bill 2768	Enacted	2008
Minnesota	Solar Energy Jobs Act (HF 729)	Enacted	2013
New Hampshire	Group Net Metering / Senate Bill 98	Enacted	2013
New York	Community Net Metering / CASE 15-E-0082	Enacted	2015
Oregon	House Bill 2941	Enacted	2015
Vermont	Group Net Metering	Enacted	2006
Washington	Community Renewables Enabling Act (HB 1301)	Enacted	2013
Georgia	House Bill 657	Tabled	2014
Iowa	Senate File 2107	Tabled	2014
Michigan	House Bill 4878	Postponed	2015
Nebraska	Legislative Bill 557	Tabled	2013
New Mexico	Senate Bill 394	Tabled	2013
Virginia	House Bill No. 618*	Postponed	2016

Note. The data on state community shared solar legislation are adapted from the Shared Renewables HQ (2016) website.

¹Colorado passed House Bill 1284 in 2015 to expand participation in community solar gardens.

*Indicates most recent bill(s) proposed (Virginia's Legislative Information System, 2016c).

Though Virginia may lag behind some of its counterparts in terms of solar PV policy and installed capacity, it remains a state with copious solar potential due to its availability of sun resources and relatively robust economic base. However, community shared solar legislation has not passed to date.

While previous works have addressed the various financing and ownership options for community shared solar such as utility-sponsored, special purpose entity, and nonprofit (Goodward, 2011; Riley, Bencomo-Jasso, & Hoysal, 2012), no previous literature has specifically addressed the policymaking intricacies with such policy. Further, no literature has identified the arguments for and against community NEM or shared solar policy within specific states contexts. Therefore, Virginia serves as a relevant case study and proxy for other historically laggard states without community shared solar policy.

Moreover, several barriers to market entry exist in Virginia, such as a general lack of utility-level support for community NEM and shared solar, despite Dominion's new DCS program. Hence, further research is needed into the perspectives, opportunities, and barriers for community shared solar in order to determine the best path(s) forward given Virginia's unique regulatory landscape. Understanding such perspectives will help discern why legislation for community NEM and shared solar has not passed in Virginia despite multiple attempts, as well as the prospects for enacting such legislation moving forward considering the state's policy communities and policy monopolies.

2.7. Summary and Synthesis

The overall aim of PET is to explain long periods of policy stability punctuated by concentrated and intense periods of change. A combination of bounded rationality and agenda setting explains how policy monopolies can be created and destroyed. The production of a policy monopoly follows the successful definition of a policy problem, as well as limits the number of participants in the policy process. This often follows a burst of wider public and governmental enthusiasm for policy change. After the main policy decision is made, the details are left to policy experts and specialists in government. This allows the participants to frame the process as technical to reduce public interest or exclude those groups considered to have no expertise. The lack of attention or external involvement allows communities to build up a policy-delivering infrastructure that is difficult to dismantle, even during focusing events or periods of negative attention.

State solar PV policy decisions do not often pass without the influence of focusing events that trigger shifts in the existing equilibrium. To illustrate, standard NEM legislation did not pass in Virginia until the year 2000 (Database of State Incentives for Renewables and Efficiency, 2015d), as a byproduct of the key negative focusing events that had occurred in the energy industry decades before (e.g., 1970s oil crises, nuclear disasters), and since there was a concentrated policy push for NEM throughout the U.S. at the time. The Three Mile Island and Chernobyl nuclear disasters, coupled with the local nuclear reactor accident in Surry, Virginia in 1988, started to raise awareness and alter public cognition of some of these energy and environmental issues. Other nuclear accidents, oil spills, and coal mine disasters throughout the 1990s (e.g., the South Mountain No. 3 Mine Explosion in Norton, Virginia) (Chartrand, 1992) continued to push public perceptions away from these non-renewable energy sources and toward

cleaner and renewable ones. Virginia's IOUs did not fight as hard against NEM legislation at the time due to negligible market penetration figures. However, since the new millennium, Virginia's solar PV policy marketplace has been relatively motionless, due to the lack of key triggering events that drive public perceptions toward solar PV and renewables, as well as the influence of key lobbying groups increasingly combatting these technologies. However, this may change in the coming years, particularly as other states increasingly adopt community NEM or shared solar policy.

Sticking with this Virginia case study, the state does have a number of policies programs to encourage DPV deployment, yet still lags behind its U.S. counterparts. It has been shown that renewable energies such as solar PV can be momentous in combatting climate change, as well as providing energy security and economic developments to states. However, it remains unclear as to what public policy approaches Virginia and other states should take considering the plethora of policy approaches relevant at the state-level today (e.g., NEM).

Through the PET framework, state policymakers may be restricted on the community NEM and shared solar issue by bounded rationality (i.e., they are too busy and, thus, must focus on their agenda) and disproportionate attention (i.e., overall lack of consideration). Large IOUs typically frame and help set an agenda that embraces the status quo, ultimately hindering the expansion of novel solutions such as community NEM. These policy monopolies often solve problems on the same terms as previous ones, often with the intent of dismissing alternative policy mechanisms that may exist (Baumgartner & Jones, 1993).

Venue shopping may be a way to alleviate such circumstances. However, since solar policy must pass via central legislation, other audiences (such as the courts or other levels of government) simply do not have as much authority as state legislatures. Put another way, policy

change, will most likely only occur once the vested interests and the overall stickiness of such a culture becomes punctuated by large shifts in utilities' and legislature's attitude to allow for increased deployment of DPV. Increased attention and public participation may also assist in altering the existing equilibrium. Dramatic triggering or focusing events may stimulate such punctuation, as well.

In Virginia, other than a trifling alteration to the state's NEM policy that increased its residential capacity limit from 10 kW to 20 kW (i.e., HB 1983) (Cosby, 2011), Virginians are in another long period of stasis concerning NEM. While in 2013 the General Assembly did pass HB 1695 to permit this kind of NEM to eligible agricultural customers (i.e., they allow farmers to aggregate their house meters with their barn) (Database of State Incentives for Renewables and Efficiency, 2015c), Virginia's laws remain antiquated relative to other states with more advanced community-oriented solar policy. This study helps discern the effect of NEM at encouraging DPV, as well as study the perspectives (i.e., policy images) associated with community NEM and shared solar throughout the U.S. Utilizing the PET framework, this research fills a key gap by assessing the possibilities for such policy mechanisms in the future, considering state's – such as Virginia's – dominating policy communities and policy monopolies.

3. METHODOLOGY

The purpose of this study was to determine the factors that influence the development or presence of non-utility solar PV, as well as better comprehend the policy perspectives that exist throughout the U.S. concerning community shared solar. Since there is limited literature that examines arguments for and against community NEM or shared solar policy adoption, the research design addresses the following questions:

1. Compared with other state-level policies and non-policy determinants, what impact does NEM have at increasing non-utility solar PV installed capacity throughout the U.S.?
2. What are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar throughout the U.S.?
3. What are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar in Virginia?
4. What are the key barriers and opportunities for community NEM and shared solar legislation to be adopted by other U.S. states?

3.1. Type of Study

This research utilized a multi-method approach to study the relationship between NEM and the deployment of non-utility solar PV, as well as investigate the policy perspectives surrounding community shared solar throughout the U.S. Due to the complexity of these issues, this study used a three-part methodology to answer the research questions, all with cross-sectional designs. This multimethodology approach is superior to forms of monomethod research because it operates multiple techniques, data, and perspectives (Mingers & Gill, 1997).

The study started with quantitative research, using numeric data at its core to discern the role of NEM in promoting non-utility PV investments. Moving forward, qualitative methods and data were used to directly answer research questions two through four. Employing these multiple research methods allowed for a more diverse range of research questions to be answered, as well as provided a fuller set of answers to these highly intricate issues.

More explicitly, the first methodology employed a multiple linear regression to establish a correlation between NEM and non-utility PV deployment. The second methodology utilized semi-structured, telephone interviews to better understand the policy perspectives that exist among policy experts in different state contexts concerning community shared solar policy adoption. The third methodology also used semi-structured telephone interviews to discern the various policy perspectives that exist in terms of community NEM and shared solar in the Commonwealth of Virginia, in order to help comprehend why such legislation has not been approved despite several efforts brought to the General Assembly. The first methodology corresponds with Research Question #1, the second methodology with Research Question #2, the third methodology with Research Question #3, and the synthesis of all results helped answer Research Question #4.

3.2. Methodology 1

First and foremost, this study employed a quantitative, multiple linear regression analysis with cross-sectional data from the years 2012–2013 to help cognize the influence of NEM at increasing non-utility solar PV installed capacity. This approach helped describe the key pattern of relation between the variables in the study while allowing for advanced control and prediction. The multiple linear regression technique offered greater variable control, allowed the introduction of several intervening variables, and allowed the researcher to predict which state-

level policy variables will have statistical significance with non-utility solar PV capacity based on the results. With cross-sectional data from these two years, this methodological approach allowed the researcher to describe the extent of the linear relationships between the dependent variable, and a number of independent, or control, variables. Despite not providing definite information about causation, this study design permitted the comparison of many different variables at the same time to test correlation. Establishing a strong statistical correlation between NEM and non-utility PV deployment justified the focus on the debates encircling NEM, as well as the investigation of community NEM within methodologies 2 and 3.

3.2.1. Sample

Due to the relatively small number of sampling units (i.e., U.S. states), and because relevant data was available for each unit in each year, there was no need to take a representative sample for this methodological approach. Probability and non-probability samples were not pertinent in this scenario since the accessibility of entire population inclusion existed. This situation offered a stronger methodological approach since there were no issues of sampling frame error and sample size complications (Frankfort-Nachmias & Nachmias, 2008).

3.2.2. Variable Definitions, Measurements, and Collection

Despite the complications with operationalizing the range of state-level policies as key independent variables in this study, most all were included since this research investigated which policies most impact the installation of solar PV at the residential and commercial levels. The precise state-level policy variables included in the study were interconnection and NEM ratings, the availability of state loan programs, tax credits, property and sales tax exemptions, and if consumers can sell credits within an SREC market. Non-policy determinants that may influence solar deployment included the presence of a deregulated electricity market, a year variable, state-

by-state per capita income, retail electricity prices, and solar insolation score averages. Nearly all variables had values unique to each year within the study (i.e., 2012–2013), with only solar insolation scores remaining static across years for a given state. Of course, if a state has (or does not have) a certain policy incentive (e.g., tax credits) over the two-year period, its values also remained static in this study.

The dependent variable (DV) in the analysis was the amount of grid-tied non-utility solar PV capacity installed in each state per year, per 100,000 residents, as found in annual U.S. Solar Market Trends reports by the IREC (Sherwood, 2013, 2014). While these IREC reports date back to 2008, they have only separated solar PV capacity by sector (i.e., utility, commercial, and residential) since 2012 (Sherwood, 2013). These reports define the capacity of a solar PV installation as “the maximum power that a system can produce,” measured “in direct current (DC) watts under Standard Test Conditions (WDC-STC) of 1000 W/m² solar irradiance and 25°C PV module temperature” (Sherwood, 2014, p. 27–28). Other similar studies have relied on an alternative data set from the NREL’s Open PV Project (e.g., Crago & Chernyakhovskiy, 2014; Kwan, 2012), yet the IREC reports are more detailed in their data collection methodology (i.e., they do not simply rely on data from willing contributors) and offer a robust set of figures concerning grid-tied PV installations (Sarzynski, Larrieu, & Shrimali, 2012). Therefore, the IREC reports are the best measures of non-utility solar PV deployment in the U.S. at this time.

The first of the independent variables (IV), interconnection standards, are defined as “the technical rules and procedures allowing customers to ‘plug in’ to the grid” (Freeing the Grid, 2013, p. 5). Next, NEM refers to “the billing arrangement by which customers realize savings from their systems, where 1 kWh generated by the customer has the same exact value as 1 kWh consumed by the customer” (Freeing the Grid, 2013, p. 5). Loan programs refer to whether or

not a state offers zero or low-interest loan programs for solar PV investments. Similarly, states may offer personal and/or corporate tax deductions for solar PV investments, or exemptions for solar equipment on state property or sales taxes. SREC markets may also be available to such investors, allowing them to sell credits for every MWh of solar electricity created. Though some PV projects may be eligible for broader ‘cash rebates,’ these were considered in this research study since they are costlier to government and often suffer from a lack of funding and are, therefore, not guaranteed on a year-to-year basis within a state. In addition to the differences in value and availability by year, such cash incentive programs were difficult to locate and quantify, or were only available at the local- or utility-level, such as Florida Power & Light’s Solar Rebate Program. Previous studies investigating these variables have also opted to exclude any cash incentive variables for similar reasons (e.g., Burns & Kang, 2012; Steward et al., 2014).

The data for all of these state solar PV policy variables were gathered from secondary sources. The independent variables of interconnection and NEM were measured via an elaborate grading system developed by another annual report by the Network for New Energy Choices, *Freeing the Grid*. This report “awards points for elements that promote participation, expand renewable energy generation, or otherwise advance the goals sought by [interconnection and] net metering. Conversely, the index issues demerits for program components that discourage participation or limit renewable energy generation” (Freeing the Grid, 2013, p. 16). While formal reliability metrics of these Freeing the Grid reports have not yet been established, most concerns about this secondary grading scheme are mitigated by their widespread use in prior literature (e.g., Krasko & Doris, 2013)

The financial policy incentives were operationalized by using dummy variables; for instance, if a state had a statewide loan program for solar PV investments, it received a value of

1, and a value of 0 otherwise (even if loan programs exist at the city, county, or utility-specific level). These values were derived from the Database of State Incentives for Renewables and Efficiency (2015a) website.

The study also included a variable for whether a state has a regulated or deregulated electricity market, in order to control for the differences that exist in state policy due to restructuring. Regulated electricity markets are defined as ones with high levels of state regulation, typically including vertically integrated utilities that control all aspects of the market (i.e., generation, transmission, and distribution) (Michaels, 2004). Conversely, deregulated electricity markets refer to states that permit various companies to contribute electricity generation and transmission (Borenstein & Bushnell, 2015). This variable was operationalized using dummies, with a state gathering a value of 0 if regulated, and 1 if deregulated, as found from U.S. Energy Information Administration (EIA) data. Year was another non-policy variable included, in order to control for and comprehend whether the year mattered. In this case, a value of 1 was given to all 2013 data, and 0 for 2012 data.

The last three non-policy determinants, or circumstantial factors that may influence solar PV deployment were: solar energy resources (i.e., average amount of sunlight), electricity prices, and per capita income. The Bureau of Economic Analysis (BEA) (2013, para. 12) defined per capita income as the “total personal income of the residents of a state divided by the population of the state.” In computing per capita personal income, the BEA uses the U.S. Census Bureau’s annual midyear population estimates (Bureau of Economic Analysis, 2013). This income is measured in U.S. dollars.

Next, electricity costs were included since the baseline cost of electricity that a consumer pays is a significant factor for measuring the cost-effectiveness of a solar PV investment (i.e., the

average cost per kWh of electricity produced by the PV installation must be compared to the price that one would otherwise pay for that electricity). Electricity costs were measured as average retail electricity price, averaged among residential, commercial, and industrial to accommodate all non-utility scale PV possibilities. The study gathered these figures from U.S. Energy Information Administration (EIA) (2013) data.

Finally, solar insolation is described as a quantity of solar radiation energy (measured in Btu's or watts per square meter) received on a surface area during a certain time (National Renewable Energy Laboratory, 2012). This variable was measured by the NREL (2012) as the average irradiance in kilowatt-hours per square meter per day (kWh/m²/day). The NREL has city-by-city site insolation data, and this study used the average solar insolation score for flat-plate collectors facing south at a fixed tilt for each of the Class I station cities in the U.S. to calculate statewide insolation averages (see: National Renewable Energy Laboratory, 2013).

All of these variables were subsequently transformed by taking their respective natural logarithm to correct for non-normality. This approach helped account for skewness due to pre-hoc concerns over the nature of the data, allowing the resulting coefficients to be interpreted as elasticities via a log-log model. However, including the range of dummy variables in this analysis causes difficulty in the natural logarithmic transformations since the natural log of 0 is undefined. Therefore, this study added a value of 1 to each of these dichotomized measurements (i.e., all zeros will become ones, and all ones will become twos), leaving the respective intervals between all variables constant. Overall, this transformation helped normalize the variables and reduce coefficient estimation bias, particularly in cases where the distributions were influenced by large outliers (e.g., per capita income in the District of Columbia).

3.2.3. Hypotheses

As this first part of the study aims to determine which factors are statistically significant determinants of the development of non-utility solar PV in the U.S., the overall postulation exists that states with higher interconnection and NEM scores, as well as available loans, tax incentives, and other programs, will have the highest amounts of solar PV installed within the time dimension. Therefore, 11 different research hypotheses were delineated, with all of the null hypotheses claiming to see no relationship between the variables. The research hypotheses are as follows:

H₁: If states have high interconnection grades, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₂: If states have high NEM grades, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₃: If states have an SREC market, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₄: If states have loan programs for solar, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₅: If states have tax deductions for solar, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₆: If states have property tax exemptions for solar, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₇: If states have sales tax exemptions for solar, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₈: If states have deregulated electricity markets, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₉: If states have high solar insolation scores, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₁₀: If states have high electricity costs, they will have greater amounts of population-weighted installed non-utility solar PV capacity

H₁₁: If states have high per capita incomes, they will have greater amounts of population-weighted installed non-utility solar PV capacity

Each directional hypothesis moves in the same orientation; this model speculated that an increase in any of the given independent variables would generate a subsequent increase in the dependent variable. The results thus indicated whether or not a given variable actually does have a statistically significant and positive impact on state-level non-utility solar PV capacity, and if so, the extent of that impact compared to those of any other statistically significant variables. Of course, there was a possibility of a decrease in the dependent variable based on the results, similar to how a number of prior research studies had mixed results.

3.2.4. Data Analysis

Using IBM SPSS Statistics Version 23.0, a multiple linear regression was conducted with the hypothesis that all of the independent variables will yield a positive relationship with the dependent variable. As part of this process, descriptive statistics, such as variable means and standard deviations, were compiled. The analysis focused on each respective state in the U.S. within the time frame of 2012–2013, plus the District of Columbia, yielding 102 total observations for the study. The study grouped its data by U.S. states, serving as the unit of analysis. Finally, the study employed a *hierarchical series* of OLS multiple regression analyses,

each of which adds a new category of predictors, in order to test the extent to which the three categories of independent variables (i.e., market-opening policies, all state policies, and then all factors (both policy and non-policy determinants)) influence the dependent variable. The researcher evaluated relevant changes in the regression coefficients and increments in explained variance in order to comprehend aggregate group impacts on non-utility installed PV capacity.

The final full model is represented as follows:

$$\log \text{NON_UTILITY_PV} = \beta_0 + \beta_1 \log \text{INTERCONNECTION} + \beta_2 \log \text{NEM} + \beta_3 \text{SRECS} + \beta_4 \text{LOANS} + \beta_5 \text{TAX_CREDITS} + \beta_6 \text{PROPERTY_TAX_EXEMPTION} + \beta_7 \text{SALES_TAX_EXEMPTION} + \beta_8 \text{DEREGULATION} + \beta_9 \text{YEAR} + \beta_{10} \log \text{INSOLATION} + \beta_{10} \log \text{ELECTRICITY_COST} + \beta_{11} \log \text{INCOME} + \text{error}$$

In which:

- NON_UTILITY_PV = Grid-connected, newly installed solar PV (MW_{DC}) per capita (residential and commercial) (**IREC**)
- INTERCONNECTION = Interconnection score from Freeing the Grid report (**FTG**)
- NEM = Net metering score from the Freeing the Grid report (**FTG**)
- SRECS = 1 if customers can sell credits within an SREC market, 0 if otherwise (**SRECTrade**)
- LOANS = 1 if state loan programs exist, 0 if otherwise (**DSIRE**)
- TAX_CREDITS = 1 if personal and/or corporate income tax credit exists, 0 if otherwise (**DSIRE**)
- PROPERTY_TAX_EXEMPTION = 1 if property tax exemption exists, 0 if otherwise (**DSIRE**)
- SALES_TAX_EXEMPTION = 1 if sales tax exemption exists, 0 if otherwise (**DSIRE**)

- DEREGULATION = 1 if deregulated electricity market, 0 if regulated (**EIA**)
- YEAR = 1 for 2013, 0 for 2012
- INSOLATION = Average yearly solar insolation measurement (kWh/m²/day) (**NREL**)
- ELECTRICITY_COST = Average retail electricity price (cents/kWh) (**EIA**)
- INCOME = Per capita income (US dollars) (**BEA**)

The full data set of dependent and independent variable measurements for each state within from 2013 is provided in Appendix A. Pooling the data and using this OLS model is appropriate since large differences exist in the installed non-utility PV capacity by year, in addition to several of the state policy variables. Further, protracted longitudinal analyses or panel data analyses are not suitable given the nature of the data, particularly since it only covers two years.

As noted, the time dimension of this study was 2012–2013, as these are the most recent, common years with publicly-available data for all of the variables. Uniquely, this study excluded state RPS as a key policy variable under the premise that such state-level legislative mandates for renewable energy generation are geared particularly toward utility providers, and, thus, their effect on DPV investments would be negligible, at best. While RPS may stimulate solar PV investments at the residential and commercial levels since such investors can sell renewable credits to utilities, this study instead controlled for this factor with the inclusion of the SREC market variable, causing the exclusion of whether a state has mandatory RPS or not.

Due to the fact that residential, non-residential, and utility scale solar capacity data had never been separated into categories prior to 2012, any previous analyses of solar PV installations had to deal with a lack of specific data, and, therefore, could not deduce the effect of determinants strictly on non-utility scale PV. This study's regression tests show the standardized

regression coefficients (i.e., betas) to not only determine what effect the independent variables had on non-utility PV installations, but also which were the most important when presented in this homogenous manner. In this investigation, statistical significance was established at the $p \leq 0.10$ level. Since the OLS regression is on cross-sectional data, there was no need to test for autocorrelation in residuals. This first methodological approach helped answer the first research question.

3.3. Methodology 2

The next methodological approach for this study focused on addressing the second research question: what are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar throughout the U.S.? This cross-sectional approach utilized semi-structured telephone interviews with policy experts and other key stakeholders throughout the U.S., particularly focused on their images and perspectives regarding community shared solar policy adoption. By conducting interviews with a variety of individuals in both states that have and have not adopted community NEM or shared solar policy, this methodology helped understand the forces and perspectives that have either helped or hindered the passing of such policy. This qualitative research used the case study approach to provide a detailed account of the viewpoints and characteristics of policy adoption that existed.

3.3.1. Sample

The sampling technique for the second methodological approach involved a purposive sample. Purposive samples, often called judgment samples, are selected based on the knowledge of a population and the purpose of the study. In other words, the subjects interviewed were selected due to a certain defining characteristic. The purpose of this second methodological approach was to understand the various perspectives that exist regarding community NEM and

shared solar project deployment. The purposive sampling technique was appropriate since the researcher needed to reach a targeted sample that is representative of the diverse cases (i.e., states) throughout the U.S.

Within the purposive sampling technique, the heterogeneous (or maximum variation) method occurred to capture a wide range of perspectives related to state community NEM policies and shared solar project development. Due to the fact that each sampling unit would probably exhibit a wide range of attributes and experiences concerning the community shared solar issue, this technique aided in gaining greater insight into the research question by investigating the situation from all angles.

The sample itself contained two distinct steps. First, the researcher organized each U.S. state plus the District of Columbia into a matrix based on whether they have community shared solar legislation or not, and whether they are ‘solar favorable’ or not. The data for whether a state has community shared solar legislation came from Shared Renewables HQ (2016) (see Table 6). Being ‘solar favorable’ tied the states back into the variables gathered for methodology 1, and was defined if state had high insolation scores and high electricity costs, since these are two key non-policy factors that would make a state more apt to deploy solar PV. The researcher multiplied these two continuous figures to calculate the new ‘solar favorable’ variable, and ranked each of the 51 subjects, in order from largest to smallest, and then selected the top 26 as solar favorable, and the remaining 25 as not solar favorable (see Appendix B for the full ranking). Using data from the Energy Information Administration (2010), the matrix also internally organized each state as regulated or deregulated. Finally, as shown in Table 7, a state listed in bold font indicates that they currently have an operational project online (as of

December 2013, the last year included in the analysis for methodology 1), as derived from Shared Renewables HQ (2015) spreadsheets.

The researcher then selected the case study states for the analysis on the basis of diversity, in the effort of including a variety of states with different circumstances and geographies. Two states were selected from each matrix quadrant, one with a regulated and one with a deregulated electricity market. This purposeful selection also accommodated for whether a state currently has an operational community shared solar project. In sum, the case study states selected included one state from each matrix category (and subcategory) to have a representative from each group. The selection also accommodated for geography to have a wide dispersion of states. The eight selected states are signified with asterisks in Table 7. Virginia was not included in this analysis since it is the focus of methodology 3, which explains its double asterisk.

Table 7.

Matrix of Solar Favorable and Community Shared Solar States

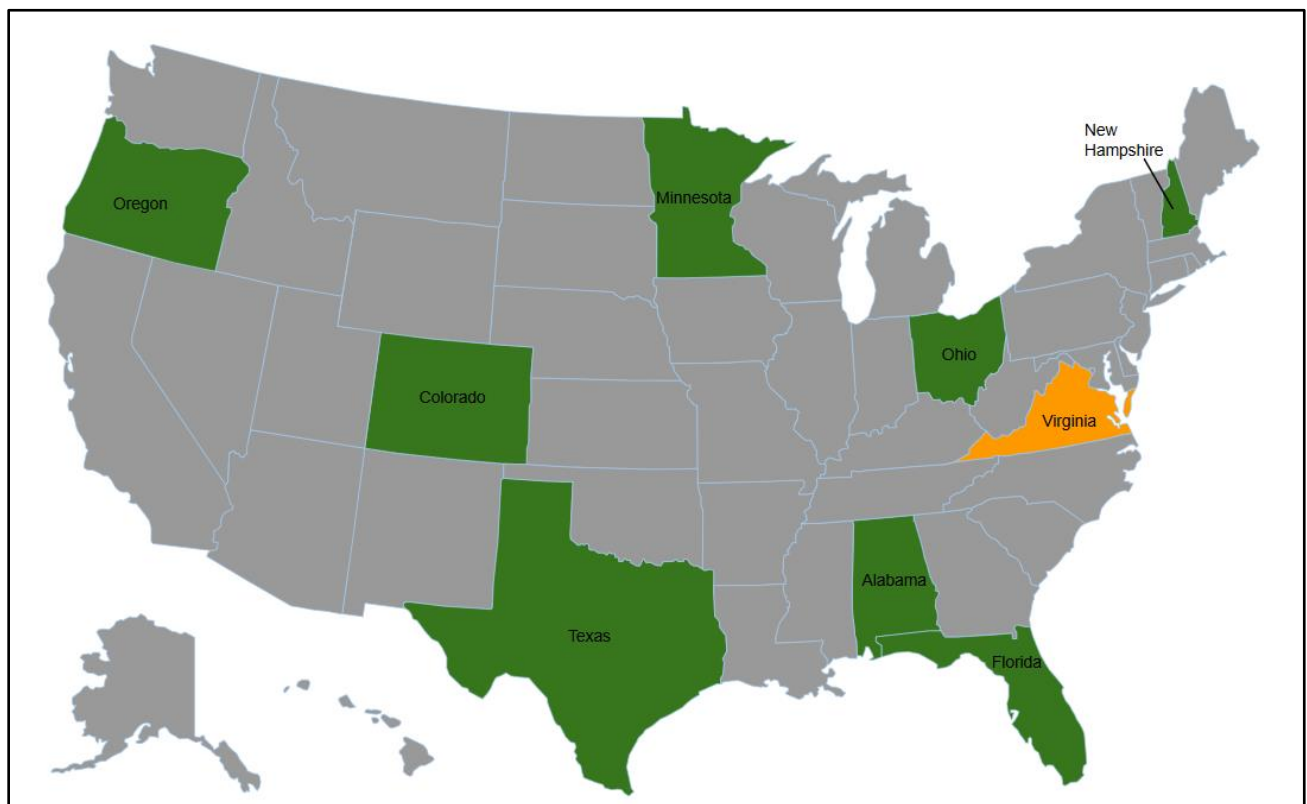
	Community Shared Solar Policy	No Community Shared Solar Policy
Solar Favorable	<p><u>REGULATED</u> California *Colorado Vermont Hawaii</p> <p><u>DEREGULATED</u> Maine Maryland Massachusetts Connecticut District of Columbia Delaware *New Hampshire New York</p>	<p><u>REGULATED</u> Arizona *Florida Georgia New Mexico Kansas Mississippi Missouri Nevada South Carolina Wisconsin</p> <p><u>DEREGULATED</u> Michigan New Jersey *Texas Rhode Island</p>
Not Solar Favorable	<p><u>REGULATED</u> *Minnesota Washington</p> <p><u>DEREGULATED</u> *Oregon</p>	<p><u>REGULATED</u> Kentucky North Carolina Tennessee Utah *Alabama Alaska Arkansas Idaho Indiana Iowa Louisiana Montana Nebraska North Dakota Oklahoma South Dakota **Virginia West Virginia Wyoming</p> <p><u>DEREGULATED</u> Illinois *Ohio Pennsylvania</p>

Note. Matrix organized each U.S. state by various categories.

Figure 11 provides an alternative depiction of the selected case study states by highlighting each on a U.S. map. As one can see, the case study states not only represent a diverse range of solar favorability and enabling policy, but also geography (both north-to-south and coast-to-coast) and, thus, insolation and other non-policy variable measurements.

Figure 11.

Map of Selected Case Study States



Note. Developed by author.

Next, the researcher chose four individuals from each selected state to interview, which represents the second step of the sampling technique. These individuals came from a variety of interests, including one from each of the solar energy industry, an environmental group, a government entity, and an electric utility within each selected state. The solar energy industry contact was first targeted from the Solar Energy Industries Association (SEIA), which lists an

industry representative contact for each chapter and within each state (see: <http://www.seia.org/about/seia/official-state-affiliates>). The researcher started with the Sierra Club for the environmental group contact, which is the “nation's largest and most influential grassroots environmental organization” (Sierra Club, 2016, para. 1). Like the SEIA, the Sierra Club has various chapters, including at least one per U.S. state (see: <http://www.sierraclub.org/chapters/default.aspx>), and lists contact information for individuals (typically a chairperson) associated with each chapter.

Next, the Database of State Incentives for Renewables and Efficiency lists a state government contact person (usually from the state’s energy agency or PUC) for each policy incentive, and the researcher used the respective state NEM information pages to determine this individual to call. Finally, the researcher interviewed an electric utility representative, first starting with each selected state’s largest IOU (by annual revenue) as derived from the Best Energy (2016) and Statista (2015) websites, and then working down the list. In this case, interviews were conducted with either a solar program manager or an executive knowledgeable on solar PV issues, as found from each respective utility’s website.

Despite this purposeful selection technique, challenges in gaining appropriate contacts stimulated the use of the snowball sampling technique. This was employed to ensure the target of at least one individual per group per U.S. state. During 2016, the researcher reached out to potential respondents from the state SEIAs, Sierra Club, Energy Agency / PUC, and large IOUs, who, quite often, supplied other respondents well-informed of the community shared solar issue within their state. For instance, several SEIA contacts supplied another solar industry contact within their state to use as a proxy for the initial target interview. This snowball sample emerged as being key to this research, providing “an efficient and economical way of finding cases that

may otherwise be difficult or impossible to locate or contact” (Hendricks, Blanken, & Adriaans, 1992, p. 17). In other words, not all respondents were actually affiliated with each case study state’s SEIA, Sierra Club, largest IOU, etc.

Overall, the researcher conducted interviews with four individuals (one from each stakeholder group) from each of the eight selected states, amounting to 32 total interviews. Specifically interviewing these multi-perspective policy experts from a variety of states via purposive and snowball sampling allowed the researcher to gain a better understanding of the viewpoints regarding community shared solar policy adoption.

3.3.2. Data Collection

Semi-structured interviews were selected for data collection to allow both the interviewer and interviewee to deviate in order to pursue a topic in greater detail. The flexibility of this approach also allowed for the discovery or elaboration of information that was important to interviewees but was not previously been thought of as pertinent by the researcher. The specific purpose of these semi-structured telephone interviews was to explore the policy perspectives of policy experts throughout the U.S. on the debates surrounding community NEM or shared solar policy adoption.

Such qualitative interview methods are believed to provide a deeper understanding of social phenomena than would be obtained from purely quantitative methods, such as questionnaires. Thus, these telephone interviews were the most appropriate technique since there are limited means to explore this topic in depth considering the geographic breadth of the U.S. (e.g., lack of feasibility of focus group research).

Specifically, the telephone interviews contained open-ended questions that were designed to generate respondent perspectives about ideas, opinions, and experiences concerning

community shared solar policy adoption and related debates (see Appendix C). The questions were constructed to be neutral, sensitive, and understandable to interviewees. In the spring of 2016, the researcher piloted the interview questions on colleagues and other respondents prior to more formal data collection. No concerns about clarity arose.

Overall, these semi-structured telephone interviews permitted the opportunity to obtain personal reactions and further expressions in reference to the second research question. This worked better than mail or email questionnaires, as community shared solar is a complex research topic that requires probing, feedback, and discussion. Finally, telephone interviews were preferable since they often garner a higher response rate and quality of data than other forms of survey research.

3.3.3. Data Analysis

The analysis of this qualitative interview data will be derived from the actual transcripts of the telephone interviews conducted. Since the semi-structured telephone interviews contained open-ended questions and discussions that diverged from the interview script, the interviews were tape recorded and later transcribed for analysis. Such transcription involved creating a complete, typed copy of the recorded interview by playing the recording back and typing each word that was spoken on the recording, noting who spoke which words. Verbatim transcriptions were produced after the completion of all interviews.

Once transcribed, the researcher imported the data into NVivo, Version 11. NVivo is designed to assist researchers with organizing, interpreting, and analyzing non-numeric, qualitative data. Once the transcripts were imported into NVivo, the researcher coded the data according to certain themes. Rubin and Rubin (1995) defined this coding process as “the process of grouping interviewees’ responses into categories that bring together the similar ideas,

concepts, or themes you have discovered, or steps or stages in a process” (p. 239). This was a grounded-theory approach, guided by Baumgartner and Jones’ (1993) PET as described in prior sections of this paper. The grounded-theory approach was appropriate in this scenario as it is a widely-accepted technique to study social perceptions by using the theory to discover what emerges in the data.

Since this methodology aimed to help answer the second and fourth research questions, the researcher deductively organized coding categories under two main themes: barriers and opportunities. Under barriers, the researcher coded for ‘bounded rationality,’ ‘lobbying / money power,’ ‘disproportionate attention,’ ‘electric utilities,’ and ‘regulations.’ In terms of opportunities, the researcher coded for ‘focusing event,’ ‘participation/attention,’ ‘collaboration,’ ‘policy networks,’ and ‘venue shopping.’ Definitions of these concepts are shown in Table 8.

Table 8.

Definitions of Transcript Coding Concepts

Concept	Definition	Overarching Theme
Bounded Rationality	Policymakers cannot separate from their agenda/objective to make decisions	<i>Barrier</i>
Lobbying / Money Power	Actions to influence policymakers, often through campaign contributions and other monetary means	<i>Barrier</i>
Disproportionate Attention	Policymakers tend to either ignore issues, or give them too much attention	<i>Barrier</i>
Electric Utilities	Electric power companies that may generate, transmit, and distribute electricity for consumption	<i>Barrier</i>
Regulations	A governmental law, rule, or policy that hinders community shared solar	<i>Barrier</i>
Focusing Event	Crises that raise attention on a particular issue (e.g., environmental)	<i>Opportunity</i>

Participation/Attention	Involvement and awareness in state energy policy issues	<i>Opportunity</i>
Collaboration	Cooperation with other actors and networks that may stimulate policy change	<i>Opportunity</i>
Policy Networks	Large, interconnected sets of individuals and groups which mobilize to influence state policy	<i>Opportunity</i>
Venue Shopping	Policy networks seeking out new audiences for policy proposals (e.g., courts)	<i>Opportunity</i>

Note. Developed by author.

Ultimately, these semi-structure interviews, transcript coding, and their analysis, provided reliable qualitative data that helped answer the second research question. Results and further analysis are provided in section 4.2.

3.4. Methodology 3

The third and final methodological approach for this study addressed the third research question, focused on understanding the competing policy perspectives that exist with regard to community NEM and shared solar in Virginia, as an in-depth case study and proxy for other laggard states without such policy. The third methodological approach was also cross-sectional and entailed semi-structured telephone interviews, this time with policy experts and key stakeholders specific to Virginia. This approach used the case study method to provide a detailed account of the views of various stakeholders for and against community NEM and shared solar in Virginia to provide a more academically-vetted understanding of the various policy perspectives on this issue.

3.4.1. Sample

The sample for this last part of the study focused on key Virginia stakeholders as derived from the Virginia SSG roster. Akin to the second methodological approach, a purposive sample

helped target potential interviewees from each of the stakeholder groupings. The SSG members were organized similar to methodology 2, grouped by the solar industry, environmental groups, state government, and electric utilities.

Specifically, the sample was gathered from the SSG roster, which is publicly available within the final group report found on the Virginia DMME website (see: <https://www.dmme.virginia.gov/DE/SolarStakeholderGroup.shtml>). This 2014 report, *Analyzing the Costs and Benefits of Distributed Solar Generation in Virginia*, listed each of the 49 members and their affiliation, and email addresses and phone numbers were gathered from the SSG chairperson. The researcher conducted four interviews within each of the four groups, resulting in 16 total interviews. In this purposeful selection process, preference was given to the SSG Steering Committee members, who were the leaders of the group and met more frequently than the larger SSG. Due to the tight-knit nature of this group, and willingness to discuss solar energy issues, the snowball sampling technique was unnecessary for this aspect of the research.

3.4.2. Data Collection

Much like the second methodological approach, the data collection for the third part of the study used semi-structured telephone interviews, allowing for probing. The purpose of this third methodology was to investigate the viewpoints and understandings of community NEM and shared solar, and how this influences policy action in Virginia. These telephone interviews were appropriate since Virginia is a large state, and was too costly and difficult to conduct in-person interviews or focus group research with these persons considering geographic location and scheduling issues.

Since the interview questions were very similar to those included within the second methodology, and those specific questions were piloted, the researcher did not pilot these

questions on respondents. Again, the questions concentrated on the respondents' policy perspectives of community NEM and shared solar considering Virginia's specific political environment and regulatory structures (see Appendix D).

3.4.3. Data Analysis

Similar to methodology 2, interview transcript coding and analysis helped identify central themes that arose in the telephone interviews with SSG members. Again, the interviews were recorded, transcribed, and then imported into NVivo to help organize and interpret the resulting qualitative data. Paralleling methodology 2, the data analysis focused on the deductive, PET-related themes and codes as outlined in Table 8. Results from this aspect of the research are presented in section 4.3.

3.5. Synthesis

A synthesis of the results from methodologies 1, 2, and 3 were used to answer the fourth and final research question: what are the key barriers and opportunities for community NEM and shared solar legislation to be adopted by other U.S. states? Utilizing the PET framework, this synthesis determined the potential for other states to adopt community or shared solar policy, which could be influenced by various perspectives, focusing events, lobbying, state regulations, venue shopping, and a number of other concepts. In this final step, comprehensive conclusions were drawn regarding community shared solar barriers and opportunities, using Virginia as a proxy for other laggard states yet to adopt such policy. Overall, this exploratory phase of the research methodology was useful in outlining the key challenges and prospects for a wider implementation of community shared solar policy throughout the U.S. (i.e., a pervasive policy change, or a punctuated equilibrium), as detailed in section 4.4.

3.6. Strengths and Limitations of the Methodological Approaches

3.6.1. Methodology 1

There were several strengths and limitations to these methodological approaches. For instance, the first methodological approach was particularly influenced by the use of the secondary data sources, which limited variable control and may have introduced measurement biases. Further, it is acknowledged that 102 observations was not a particularly large number for a multiple linear regression analysis. However, this situation was unavoidable given the limited availability of data on DPV deployment per state.

Additionally, the overarching focus on *state-level* policy incentives and other factors did not capture all of the dynamics that would influence solar PV deployment within states, at the city, county, or regional level. Some of the variables, particularly income, varied considerably within a state, and numerous local jurisdictions and utility providers offer solar PV financial incentives that are not captured in the generalized dummy measurements. This may have been particularly problematic in states where such incentives are offered by large cities that represent a significant portion of the state population. However, no reasonable alternative existed to control for this dynamic, as data on solar PV at the jurisdictional and county levels are extremely limited.

Lastly, lagging policy variables (particularly the dichotomous financial incentive variables) to reflect the number of years since their adoption would have been a worthy approach, especially since the influence of policy adoption does not occur immediately. However, creating lagged variables for these financial incentive policies was overly arduous, and, in most cases, not possible. While the Database of State Incentives for Renewables and Efficiency did include information on policy adoption dates, or links to the affiliated state

legislative documents, there were far too many cases with incomplete information regarding adoption years. There was not another appropriate database to gather information on these policy incentives, nor was there a way to develop a system to develop a researcher-constructed ranking scheme.

Despite these limitations, the regression model still helped identify correlations between the variables and the extent of newly installed DPV capacity. In addition, the easy access to public datasets was cost-efficient and time-saving. While the results did not prove direct causation, uncovering the extent of the linear relationship between the variables did shed light on how different policy approaches, including NEM, correspond to DPV capacity growth relative to other non-policy factors.

3.6.2. Methodologies 2 and 3

The second and third methodological approaches also offered key limitations and strengths. External reliability errors may have arisen in the telephone interviews since respondents may have felt they could not abort an interview at any time over the phone. This research was also more time-consuming than certain alternatives. Selection bias, confidentiality, and interviewer bias may have also been present, particularly if the researcher inadvertently prompted certain answers. However, most of these weaknesses were alleviated by how the researcher developed rapport with interviewees and peer debriefed. Moreover, the questioning process flexibility was a key advantage as it allowed for probing and clarity confirmation. Large amounts of qualitative data were collected over the course of just a few months, generating key insights to a topic that is understudied and not well understood.

3.7. Virginia Commonwealth University Institutional Review Board Considerations

Before any data collection actually took place, this study required a Virginia Commonwealth University Institutional Review Board (IRB) evaluation to ensure that the respective methodological approaches were not harming human subjects in any way. There are three main types of IRB review at VCU: exempt, expedited, and full (Virginia Commonwealth University Office of Research and Innovation, 2015b).

For all methodological approaches, this study qualified for exemption according to 45 CFR 46.101(b), category 2 of VCU's IRB on March 21, 2016. Since the first methodological approach used publicly-available secondary data that did not directly involve human subjects, no concerns were raised. The interview methodologies fell under VCU's IRB category 2, which allows exemption for "research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observations of public behavior" (Virginia Commonwealth University Office of Research and Innovation, 2015a, para. 3). After reviewing the sampling plan and questions (e.g., topics and language), the IRB reviewers determined that the telephone interviews were not going to impact human subjects and the study commenced at that point.

3.8. Study Limitations

While this research was helpful in providing data that helped answer the research questions, it remains vital to mention the key limitations of the study, overall. For instance, there were boundaries to the secondary data analysis as seen in the first methodological approach, predominantly in the way it does not study other state or local policy approaches for solar PV, nor other key variables that may influence the dependent variable outcomes (e.g., state political

preferences). However, the methodological procedures used in this first approach were set so that the research goals were not impossibly large to complete.

In the second and third methodological approaches to this study, it is important to recognize that the data gathered were only representative of the policy experts and key stakeholders who agreed to be interviewed. Since the latter part of this study was focused on the perspectives and implications for community NEM and shared solar in the Commonwealth of Virginia specifically, it would be an inaccuracy to claim that the data gathered is illustrative of all other laggard states. Further, the adoption of the PET framework may have been a limiting factor in the way it directed the course of study. Lastly, all of the steps involved in this research process were completed within 2016, which places a limit on the overall magnitude of the study since policymaking is a complex and ever-changing environment. Therefore, these conscious exclusionary decisions limit the research results to the population and timeframe used in the investigation.

4. RESEARCH FINDINGS

4.1. Methodology 1

The descriptive statistics in Table 9 show the minimum, maximum, and mean values of the variables employed in this analysis from the 102 observations. The negative minimum value for the interconnection variable reflects that fact that the Freeing the Grid reports do, in fact, levy a negative grade for those states in which it is particularly onerous to interconnect a residential or commercial solar PV system. All of the financial incentive policies were measured as dichotomous dummy variables, and their mean values, thus, indicate the percentage of states that have adopted each of those policies. It worth noting that the non-policy variable figures differ dramatically from state to state, particularly electricity costs, where Hawaii's per/kWh prices are roughly five times of those within the state of Washington.

Table 9.

Summary Statistics: All Variable Values by U.S. State

	Minimum	Maximum	Mean	Std. Deviation
NON_UTILITY_PV	.00	10.02	.55	1.371
INTERCONNECTION	-5.50	27.50	9.67	8.354
NEM	.00	25.00	11.34	6.808
SRECS	.00	1.00	.31	.466
LOANS	.00	1.00	.45	.500
TAX CREDITS	.00	1.00	.40	.493
PROPERTY TAX EXEMPTION	.00	1.00	.53	.502
SALES TAX EXEMPTION	.00	1.00	.40	.493
DEREGULATION	.00	1.00	.31	.466
INSULATION	2.42	5.45	4.24	.530
ELECTRICITY COST	6.90	34.04	10.67	4.055
INCOME	33.45	75.95	44.24	7.827

As shown in Table 10, the regression results demonstrate that policy-factors alone do not adequately explain the variation in state-level non-utility PV capacity growth, and, in fact, the majority of the variation appears to be attributable to non-policy factors. The first two models (i.e., market-opening and all state policy) result in very low adjusted R^2 values of 0.139 and 0.156, meaning that these policy models explain only 13.9% and 15.6% of the variance in the dependent variable, respectively. With the inclusion of all of the non-policy variables (in Model 3), the adjusted R^2 jumps to 0.665, indicating that the full model explains 66.5% of the variance in state-level non-utility PV capacity additions ($\text{Adj. } R^2 = .665$, $F(12, 89) = 17.719$, $p < 0.001$). In other words, including these non-policy factors in the regression model considerably increases its predictive ability. It is also worth noting that simply running a non-policy model (including only deregulation, year, insolation, electricity prices, and income) produces an adjusted R^2 of 0.606, compared to the 0.156 value for the policy-only model. Even more telling is the fact that the F-stat increases dramatically between these same two models, from 3.672 to 32.097, and the constant, which is originally not statistically significant, becomes so at the 99% level. All of these results, coupled with the lack of heteroscedasticity issues, convincingly demonstrate that the dependent variable of non-utility installed PV capacity per capita is more strongly influenced by non-policy determinants than state policy approaches. Since the resulting variance inflation factors were all well below two, no issues with variable multicollinearity were observed.

Table 10.

Policy and Non-Policy Impacts on Non-Utility Installed PV Capacity

Variable	Model 1: Market-Opening Policy	Model 2: All State Policy	Model 3: All Factors (Policy and Non-Policy Determinants)
INTERCONNECTION	.051 (.037)	.058 (.040)	-.010 (.028)

NEM	.138 (.048)***	.150 (.050)***	.096 (.033)***
SRECS	–	-.091 (.102)	.094 (.069)
LOANS	–	-.005 (.084)	.003 (.055)
TAX CREDITS	–	.189 (.085)**	.134 (.055)**
PROPERTY TAX EXEMPTION	–	.001 (.088)	.066 (.058)
SALES TAX EXEMPTION	–	.013 (.096)	.018 (.062)
DEREGULATION	–	–	-.079 (.077)
YEAR	–	–	-.041 (.052)
INSOLATION	–	–	1.523 (.279)***
ELECTRICITY COST	–	–	1.222 (.119)***
INCOME	–	–	.044 (.205)
Constant	-0.104	-0.195	-5.619***
N	102	102	102
R ²	0.156	0.215	0.705
Adjusted R ²	0.139	0.156	0.665

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Given these overall results, it is no surprise that the full model finds solar insolation and electricity costs to be the most significant predictors of installed non-utility solar PV capacity. Accounting for the logarithmic transformation, the coefficients indicate that a one-unit change in a state's solar insolation metric provokes, on average, 0.610 MW of newly-installed capacity per 100,000 residents, whereas a \$0.01/kWh increase in average state retail electricity prices leads to roughly 0.286 MW per 100,000. These findings are logical, since PV systems in locations with high solar insolation and high electricity prices have relatively shorter payback periods

compared to those in low-insolation and/or low-electricity price locations. While some prior studies suggest that states with higher incomes would have greater levels of PV installation, this variable is not significant in the model.

Nevertheless, these results should not be interpreted to suggest that policy approaches are not relevant to the growth of solar PV. Table 10 shows both NEM and personal or corporate income tax credits to be statistically significant and meaningful predictors of non-utility PV installations. Again, accounting for the logarithmic transformation, the coefficient for the income tax credits variable in the full model indicates that a state that has adopted these credits would have an expected increase of 0.331 MW of newly installed capacity per 100,000 residents over one that has not adopted them. To put this in context, the Commonwealth of Virginia, which had a 2013 population of approximately 8.27 million, had 2.1 MW of newly installed PV capacity in 2013, or 30 kW per 100,000 residents, without income tax credits. Had the state adopted these credits, the results suggest an additional 27.4 MW would have been installed (0.331 MW per 100,000 times 82.7), assuming all other variables are held equal.

State NEM laws were another statistically significant state policy variable, showing that a one-unit change in a state's NEM grade, via the Freeing the Grid report, leads to 0.029 MW of newly installed capacity per 100,000 residents. To continue with the Virginia example, the state's NEM score of 5.0 ranked it among the bottom 10 states in 2013. An increase to a median score of 12.0 would produce an expected increase of 0.203 MW per 100,000 residents, or 16.8 MW of additional capacity, again assuming that all other variables hold even. This is a meaningful difference considering how frequently and by what ranges the states' Freeing the Grid scores change on a year-to-year basis. To illustrate, Virginia's NEM scores, dating back to

2007, have fluctuated dramatically and been steadily declining since 2009, as shown in Table 11.

Table 11.

Virginia's NEM Policy Scores from Freeing the Grid, 2007–2013

Year	Virginia NEM Score
2013	5.0
2012	6.0
2011	9.0
2010	10.0
2009	13.0
2008	7.5
2007	7.5
Average	8.3

Note. Data compiled by author from annual Freeing the Grid reports.

Other than personal or corporate income tax credits, all of the other financial incentive independent variables are statistically insignificant in the full model. The results for the deregulation variable also had a negative coefficient. However, this result could be an oversimplification, stemming from the use of dichotomous dummy variables, as the details of these financial incentive policies vary widely from state to state. Here, the researcher fails to reject the null hypothesis of how such incentives and other variables impact non-utility solar PV capacity installed.

The researcher also investigated the standardized regression coefficients (i.e., betas) for the independent variables to determine their relative influence on non-utility PV installations when controlling for the different units in which they are measured (i.e., presented in a homogenous manner), as shown in Table 12.

Table 12.

Standardized Correlates of Non-Utility Installed PV Capacity

Variable	Model 1: Market-Opening Policy	Model 2: All State Policy	Model 3: All Factors (Policy and Non-Policy Determinants)
INTERCONNECTION	.145	.167	-.030
NEM	.303***	.330***	.211***
SRECS	–	-.095	.098
LOANS	–	-.005	.003
TAX CREDITS	–	.210**	.149**
PROPERTY TAX EXEMPTION	–	.001	.074
SALES TAX EXEMPTION	–	.014	.020
DEREGULATION	–	–	-.083
YEAR	–	–	-.047
INSOLATION	–	–	.358***
ELECTRICITY COST	–	–	.710***
INCOME	–	–	.016
Constant	-0.104	-0.195	-5.619***
Adjusted R ²	0.139	0.156	0.665

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Note. Inclusion of all policy and non-policy determinants makes the constant in the most comprehensive model statistically significant at the 99% level.

According to these standardized coefficients, electricity price has, by far, the strongest influence on non-utility solar PV installation, followed by solar insolation, then NEM and income tax credits. These results reinforce the earlier points that non-policy factors are most

important, specifically those that help determine the pay-back period for a PV investment, and that NEM and income tax credits are the most important state policy factors.

The other state policy variables (e.g., solar loans and tax exemptions) do not produce positive or meaningful results in any of these hierarchical models. This may be a result of how states that have instituted such financial incentives most often do so in states with low insolation values (often in northern states) who are trying to kick-start their solar marketplaces. In addition, to the overall lag for incentives to become important may be a contributor to these poor results.

In order to fully discern the impact of the included independent variables on the amount of newly-installed non-utility PV capacity, the researcher also ran a supplementary analysis using *total* installed PV capacity (including utility-scale installations) in 2012–2013 as the dependent variable. This also allowed for a more direct comparison to prior studies that utilized this same dependent variable measurement. As presented in Table 13, these results suggest that state retail electricity rates, as expected, do not play a statistically significant or meaningful role in encouraging PV when incorporating utility installations, though insolation remains a major driver. However, more telling is how this analysis confirms NEM's role as the most influential state policy, which is consistent with prior research that examines aggregate PV installation figures. While the availability of tax credits no longer serves as a meaningful predictor, this comparison strengthens the overall results by verifying the influence of available solar energy resources and NEM policies at encouraging PV installations.

Table 13.

Standardized Correlates of Total Installed PV Capacity (Utility and Non-Utility)

Variable	Model 1: Market-Opening Policy	Model 2: All State Policy	Model 3: All Factors (Policy and Non-Policy Determinants)
INTERCONNECTION	-.077	-.041	.023
NEM	.249**	.264**	.271**
SRECS	–	-.198*	-.121
LOANS	–	.041	.123
TAX_CREDITS	–	-.102	-.147
PROPERTY TAX EXEMPTION	–	.087	.077
SALES TAX EXEMPTION	–	.027	.020
DEREGULATION	–	–	-.152
YEAR	–	–	.019
INSOLATION	–	–	.203**
ELECTRICITY COST	–	–	-.106
INCOME	–	–	.070
Constant	-15.970	-16.279	-537.169
Adjusted R ²	0.074	0.165	0.215

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Throughout all models, the results suggest that the specific inclusion of the non-policy factors (e.g., insolation and electricity prices) has made the model considerably increase its predictive ability. However, state tax credits, and NEM particularly, also emerge as meaningful predictors of non-utility PV installations at the state level. The implications of these results are discussed in greater depth in section 5.2.

In a state such as Virginia, these findings help describe how low electricity costs, as a key non-policy factor, have been a primary barrier to state solar PV installations. On the policy side, inadequate NEM scores and a lack of tax credits have obstructed PV deployment, despite the fact that Virginia has respectable interconnection standards and solar insolation scores. Virginia’s summary statistics, along with U.S. ranks, are shown in Table 14. These figures are generally representative of other laggard solar policy states, often in the U.S. south, that lack tax credits/exemptions and have weak or non-existent NEM policies.

Table 14.

Summary of Virginia Solar Energy Policy Variables

Variable	VA Value, 2013 (Rank)
NON UTILITY PV	0.03 (t-34 th)
INTERCONNECTION	22 (6 th)
NET METERING	5 (t-41 st)
SRECS	1 (t-first)
LOANS	0 (t-last)
TAX CREDITS	0 (t-last)
PROPERTY TAX EXEMPTION	0 (t-last)
SALES TAX EXEMPTION	0 (t-last)
DEREGULATION	0 (t-last)
INSOLATION	4.22 (24 th)
ELECTRICITY COST	9.32 (35 th)
INCOME	39.56 (35 th)

4.2. Methodology 2

Beyond the quantitative analysis employed for this research study, the researcher conducted in-depth telephone interviews with solar energy expert stakeholders to further

understand the complexities surrounding state community NEM and shared solar policy adoption. All approached respondents were informed of the research project (see Appendix E), its approval by VCU's Institutional Review Board, their voluntary participation, and that the interview was to be recorded digitally. Only those who provided verbal consent proceeded to participate in the research interview. All interviews were conducted between June and September of 2016.

All interviews were then transcribed and verified by the researcher. This qualitative data was analyzed in NVivo, Version 11 using a grounded-theory approach, guided by Baumgartner and Jones' (1993) PET and selective coding from this theoretical scheme described in Table 8. Wolcott's (1994) interpretivism approach also directed the analysis of this interview data in the way that description, analysis, and interpretation helped to explain the connections and patterns between respondents. Wolcott (1994) discussed examination, enquiry, and experience as methods to gain multiple perspectives of complex issues underlying the research, and, through this frame, the researcher was able to better structure and understand how the respondents constructed perspectives about an event, action, or perception, and why. This method is widely-accepted in program evaluation and qualitative research, and, coupled with the theory, helped provide structure to meaningfully present data. All interview transcripts were numbered with integers and randomly scrambled to further protect respondents' confidentiality.

4.2.1. Visibility of Solar Energy Issues

A widely-known anecdote exists that most consumers are generally ignorant of where their energy comes from or how it is produced. This concept is interesting when thinking about perceptions of solar energy issues specifically and how visible they are within states. One of the interview questions asked about the prominence of solar energy issues in a respondents' state,

including the level of activism around them, and the results generally showed a lack of visibility. Most respondents answered this question from a perspective of how *others*, not themselves, felt about the visibility of solar energy issues in their state, particularly with regard to public discourse and policymaking.

To illustrate, one respondent claimed, “it is not that visible unless you are part of the solar industry, associated energy groups, or are investing in solar for your own property” (Personal Interview #15, Solar Industry). Several government respondents indicated that these issues do not get much attention, particularly when compared to education, healthcare, and other hotter-button issues. While some respondents did indicate a higher level of visibility, particularly in the more progressive case study states that already had community NEM or shared solar policies, the most common trend was that solar energy does not receive a very high level of activism or engagement from those outside of the industry or affluent investors: “It varies across the state. In certain, more affluent communities, there's a solid level of awareness of solar energy issues. However, I have not seen a high degree of activism on this from the general public” (Personal Interview #9, Environmental Group). This perhaps signals an overall lack of attention and involvement in state energy policy issues, especially regarding solar, through the PET framework.

4.2.2. Key Arguments Against Community Shared Solar

The main themes that emerged in the arguments against community solar for the U.S. interviews were largely driven by opposition from electric utility companies arguing that community solar is a logistical nightmare. One respondent indicated that “it is unwieldy for utilities to put together these types of projects” (Personal Interview #14, Environmental Group), as the implementation of community solar projects may lead to administrative confusion about

customer credits, grid de-stabilization, and overall management issues. Another key issue was the concern about cross-subsidization: “community solar and net metering may unfairly subsidize those who invest in solar and penalize non-solar ratepayers” (Personal Interview #19, Government). Several respondents agreed that this subsidization issue was a main reason against community shared solar in how investors would significantly reduce the electricity they consume, and, thus, place an unfair shift of the fixed costs to non-solar customers. According to these arguments, utilities and other interests were apprehensive about raising base electricity rates to cover the costs associated with increasing solar penetration.

Several other respondents, including those from electric utilities, also pointed to how community shared solar disrupts the utility business model and profits as customers purchase less electricity: “[utilities] worry about their business model and profit flows” (Personal Interview #7, Solar Industry). Finally, many respondents indicated that community shared solar was just too expensive at this point. A respondent in a deregulated state explained how their “energy supply mix [was] already 95% carbon-emission free. Investing in expensive community solar projects does not make much economic sense” (Personal Interview #30, Electric Utility). These are the key themes that materialized when asking what arguments opponents of community shared solar policy have made.

4.2.3. Key Arguments For Community Shared Solar

The main arguments that emerged in the arguments for community solar for the U.S. interviews were mainly driven by support from the solar industry, environmental community, and self-identified liberal-leaning government officials. The largest and most prominent claim was that community shared solar opens market access to those unable to invest in and house their own PV system, for reasons such as excessive shading, poor roof orientation, inadequate roof

support, lack of home or property ownership, and lack of funds for a large initial investment, among others: “community solar provides access to those with shaded roofs, renters, and those unable to afford their own PV system” (Personal Interview #40, Solar Industry). Alongside this concept was the emerging theme that the market could specifically be opened to lower-income individuals and cities, and perhaps college towns, with a high percentage of renters who could not otherwise invest in a solar PV system.

Other key arguments for the use of community NEM and shared solar was how it allows a wider range of consumers to lower their energy bills with limited to no upkeep since, in most scenarios, investors do not have to own and maintain the PV system themselves. Further, under several community solar models, customers can join or leave the program whenever they want, which minimizes their risk. Often times, these customers can carry their subscription with them when moving within their electric utility’s territory. Several participants further noted environmental benefits, such as carbon emissions reductions, and how that can enhance local energy security and stability: “[community solar] increases the amount of energy being produced locally and, thus, represents energy independence” (Personal Interview #47, Environmental Group). Lastly, others noted how community shared solar positively impacts jobs and local economies, has a lower installed cost per watt than traditional rooftop solar via economies of scale, and may enhance grid resiliency: “it creates local jobs, allows customers to stabilize their electricity rates, and displaces the need for fossil fuels. It is easy for consumers to make an initial investment” (Personal Interview #41, Government).

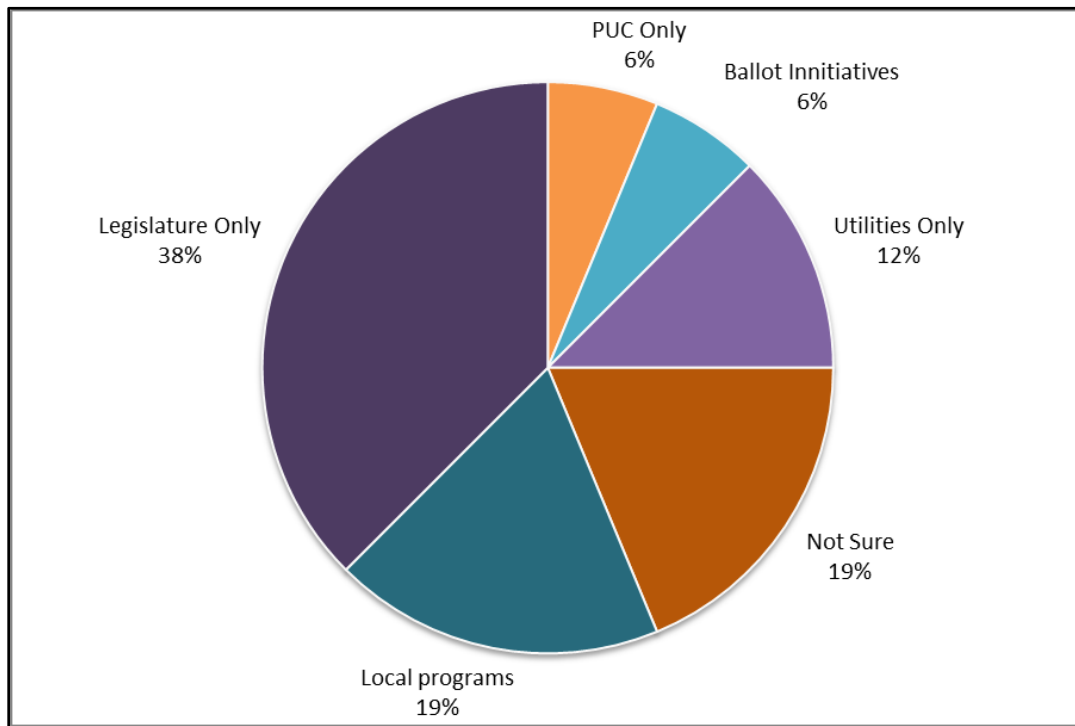
4.2.4. How to Pursue Community Shared Solar

One of the most thought-provoking findings from the nationwide interviews was the overall disagreement or lack of clarity in how states should pursue community shared solar.

Focusing solely on the case study states without community NEM or shared solar policies (i.e., Alabama, Florida, Ohio, and Texas), respondents (n = 16) offered disparate approaches in terms of where the community solar issue has been pursued if already advanced by the state, or how their state should pursue community solar in the future if they have not already (see Figure 12).

Figure 12.

Where Has/Should Community Solar Been/Be Pursued?



Note. Developed by author.

This breakdown suggests that there is general confusion or variance in how states should adopt policies or pursue community shared solar programs. While the largest percentage of respondents believed pursuing formal legislation was the most appropriate route, several others believed that local or utility programs were the optimal method to implement shared solar. Some mentioned ballot initiatives or PUC involvement, while about one-fifth (19%) were not sure. This is particularly interesting when juxtaposed with the results of this question from the states

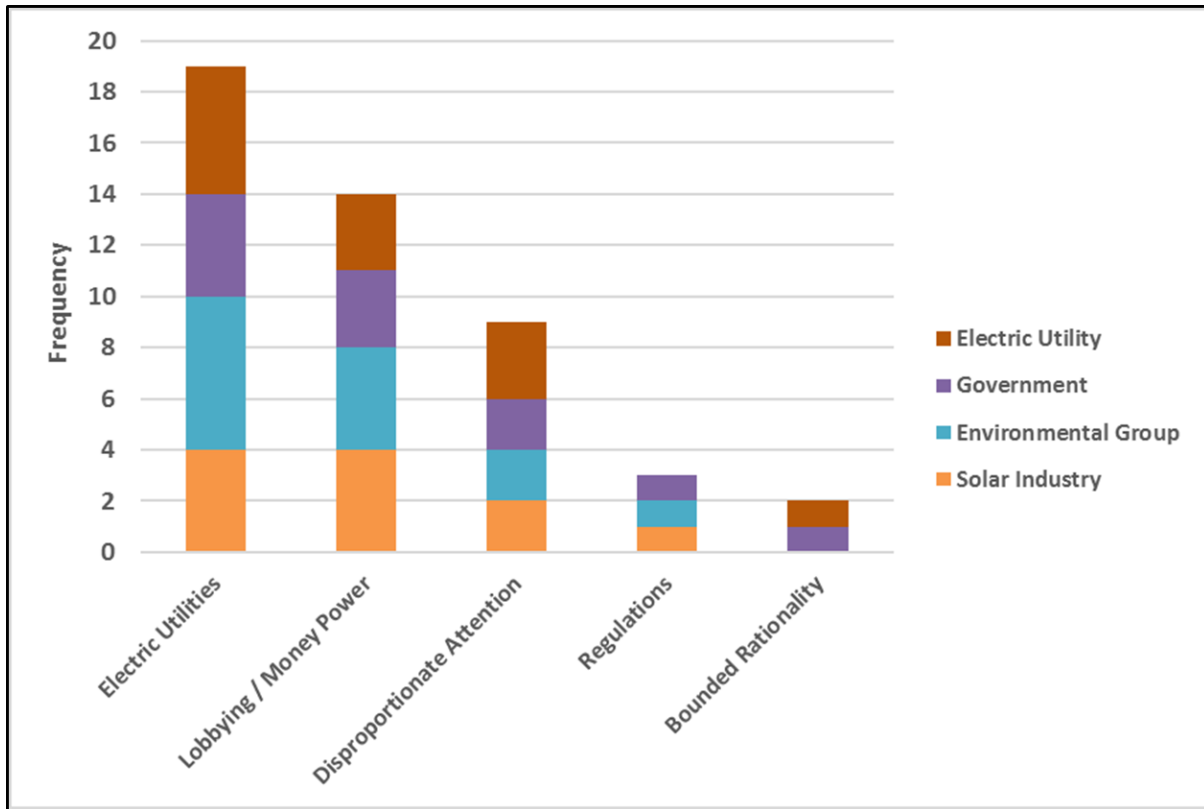
that already had community NEM or shared solar policies in place, where respondents overwhelmingly indicated that central legislation was the route to community solar. This is a logical result, since one can assume that these solar energy experts knew how their state implemented their respective program. Regardless, this theme suggests that respondents in states without community solar either were unfamiliar or unaware with how to best implement or deploy such programs. Alternatively, respondents suggested that community solar perhaps ought to be pursued in other venues (e.g., by electric utilities) instead of the legislature since they believed it would never pass there (Baumgartner and Jones' 'venue shopping' concept).

4.2.5. Barriers

Out of the several potential barrier concepts to community shared solar policy implementation, the three largest that surfaced, in order of frequency, were electric utilities, lobbying / money power, and disproportionate attention, as illustrated in Figure 13. Some respondents alluded to bounded rationality themes, while others mentioned regulations, such as the taxation of solar, but a large number of policy experts mentioned electric utility pushback at some point during their interview.

Figure 13.

Frequency of Barriers to Community Shared Solar Adoption – U.S. Interviews



Note. Developed by author.

To exemplify, one respondent said, “utilities would be upset about losing control of so much energy generation” (Personal Interview #7, Solar Industry). Despite the recent emergence of utility-based community solar programs, another respondent indicated, “recently, large electric power generation utilities have begun promoting policies that appear to support community solar energy; however, they are often designed to do just the opposite” (Personal Interview #35, Environmental Group). While some respondents in states that had already implemented statewide community shared solar policy stressed how utilities were cooperative in the rulemaking process, there was an overall idea that electric utilities were the key roadblock to community shared solar. Even utility respondents noted this, particularly in light of cross-

subsidization and NEM concerns: “utilities are careful about how cost is transferred to the end user” (Personal Interview #18, Electric Utility). Others mentioned how some utilities are looking at community shared solar as a way to pull consumers from utilizing NEM policies and change the economics in their favor.

Along with the discussion of electric utilities as a barrier was the related topic of lobbying efforts, most often utilizing money, to influence elected officials in the policymaking process. While some respondents noted overall “negative perceptions of solar by the members of the legislature” (Environmental Group), several others explained how these perceptions were often facilitated by electric utility lobbying to sway state policy decisions: “our utilities have huge streams of monopoly-shielded revenue that they use to hire lobbyists and lawyers to dominate the legislature and public utility commission” (Personal Interview #4, Environmental Group). One respondent noted that there was no limit to this lobbying and spending: “the public officials our state are in the back pocket of the electric utilities. Utilities will not allow community solar to pass. There’s no limit to the amount of money that they will spend to get what they want” (Personal Interview #7, Solar Industry). However, as a broader theme, lobbying was highlighted through other groups as well, such as described: “there was plenty of grass-roots lobbying from people and NGOs such as [our] Sustainable Energy Association, in addition to the solar companies” (Personal Interview #19, Government). Overall, it is apparent that lobbying and the use of money power has a fundamental role in the solar energy policymaking realm throughout the U.S.

Finally, Baumgartner and Jones’ disproportionate attention theme emerged several times in the interviews, though not as frequently as electric utilities and lobbying. One participant noted how “community solar [was] not something that has been on policymakers’ radar; they are

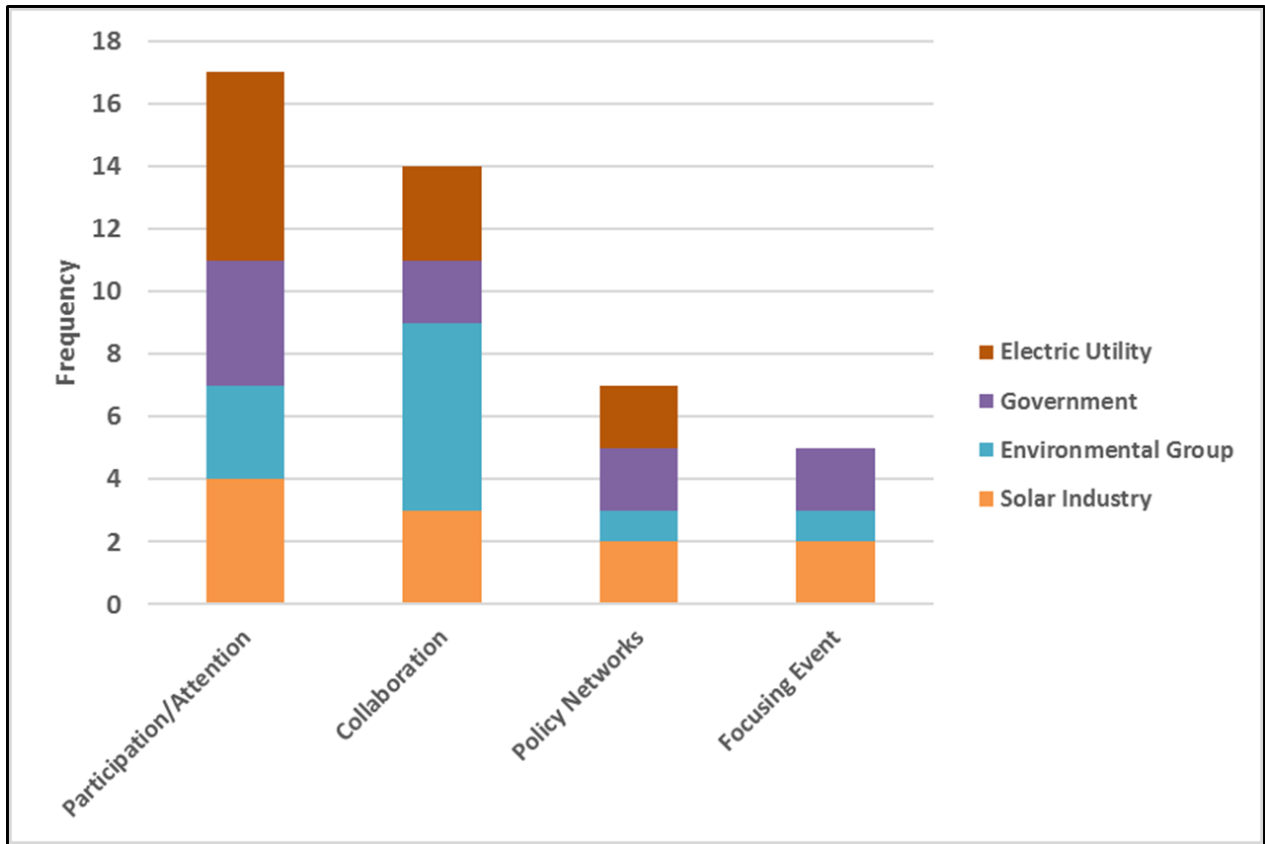
just not paying close attention to these issues” (Personal Interview #15, Solar Industry). Others mentioned how solar, and renewable energy as a whole, has become more of a focus in recent years, but that politicians do get bogged down and cannot devote time to everything. Another policy expert mentioned how “our delegates either do not understand complex net metering or community solar issues, or they just ignore them since they have so many issues to deal with” (Personal Interview #23, Solar Industry). Certainly the overall lack of attention for solar energy policy issues on behalf of public officials and other key stakeholders has hindered the discourse and consideration of community shared solar legislation, at least through the eyes of the sample respondents.

4.2.6. Opportunities

Out of the several potential opportunity concepts to community shared solar policy implementation, the four largest that surfaced, in order of frequency, were participation/attention, collaboration, policy networks, and focusing events, as illustrated in Figure 14.

Figure 14.

Frequency of Opportunities to Community Shared Solar Adoption – U.S. Interviews



Note. Developed by author.

The most frequently mentioned opportunity for community shared solar in the future was the theme of participation and attention. All stakeholder groups interviewed mentioned it as a key opening to develop community shared solar legislation, including electric utility respondents. This quote displays a common response gained by the researcher: “if more people participated and paid attention to these issues, [community solar] would have a better chance in our state” (Personal Interview #47, Environmental Group). Others talked about unique attributes of their state that helped pass legislation: “being a small state with a tradition of local governance, it can be easier to participate in the policy arena compared to other states” (Personal Interview #19, Government). A common theme emerged around education, raising awareness

and attention, and participation by a wide variety of groups as prerequisites to pass formal legislation and develop community shared solar programs, particularly in states that had already had this policy. Respondents in states that currently do not have community solar policy also realized this as an opportunity moving toward the future. One respondent took this one step further by explaining how electric cooperatives, rather than IOUs, should raise attention by developing their own projects independent of enabling legislation: “citizen participation is an opportunity, especially within electric co-ops, since co-ops would rather do a big community solar project than encourage their members to install solar on their roofs, which puts the solar out of the co-ops’ control” (Personal Interview #14, Solar Industry).

Next, the related theme of collaboration presented itself as a fundamental opportunity. Nearly all respondents in states that had already passed community NEM or shared solar legislation mentioned how numerous individuals and groups, from a variety of perspectives, came together to draft language that all parties were comfortable with. This often came from participation in active stakeholder groups. An interviewee in a deregulated state with community solar policy claimed, “our community solar requirements are one component of a larger piece of legislation that was collaboratively developed by the state’s major IOUs and the state’s politicians” (Personal Interview #30, Electric Utility). Others, especially in states without this policy, noted that there were opportunities for shared solar if there were better collaboration between the solar industry, environmental groups, electric utilities, and a wider variety of stakeholders. One policy expert interestingly noted, “proponents’ ability to build diverse coalitions and get utilities to neutral or supportive positions have been the key elements of successful bills outside of partisan willpower” (Personal Interview #41, Government).

Policy networks, through the PET framework, represent this collaborative association at a much larger scale, involving a more comprehensive set of individuals and groups that mobilize to influence state policy. Though these larger networks are often less stable by nature of their less frequent meeting, they symbolize the associations between advocacy groups and governmental officials, which was noted in several interviews as important to policy adoption. An interviewee in a regulated state said that “solar energy advocates, climate change advocates, environmental groups, some utilities, and legislators with a high interest in the area worked together to pass this legislation” (Personal Interview #46, Electric Utility). Others were more specific about how state-level Sustainable Energy Association chapters, for instance, helped mobilize an informed citizenry at a larger scale, often through meetings and media. Still others noted the unique political framework that existed during a state’s policy adoption phase: “[our] governor, environmental groups, and solar developers primarily led the charge. It received bipartisan support” (Personal Interview #22, Electric Utility, regulated state).

Finally, the advent of focusing events were mentioned by some people as a forward-looking opportunity for community shared solar. Several mentioned the November 2016 election as an event that could sway energy policy, both at the state and federal levels. Others mentioned energy cost shifts as an event that could serve as a precondition to policy adoption: “it is going to take a big bump in the cost of natural gas and it is going to require that people start realizing solar is a way that they can cheaply and efficiently power their home” (Personal Interview #20, Environmental Group). Interestingly, one policy expert in a state with enabling policy discussed how community shared solar actually started outside of legislation: “in April of 2009, the first community solar facility was built, and, in 2010, the state passed the Community Solar Garden Act” (Personal Interview #41, Government). The focusing event theme is well

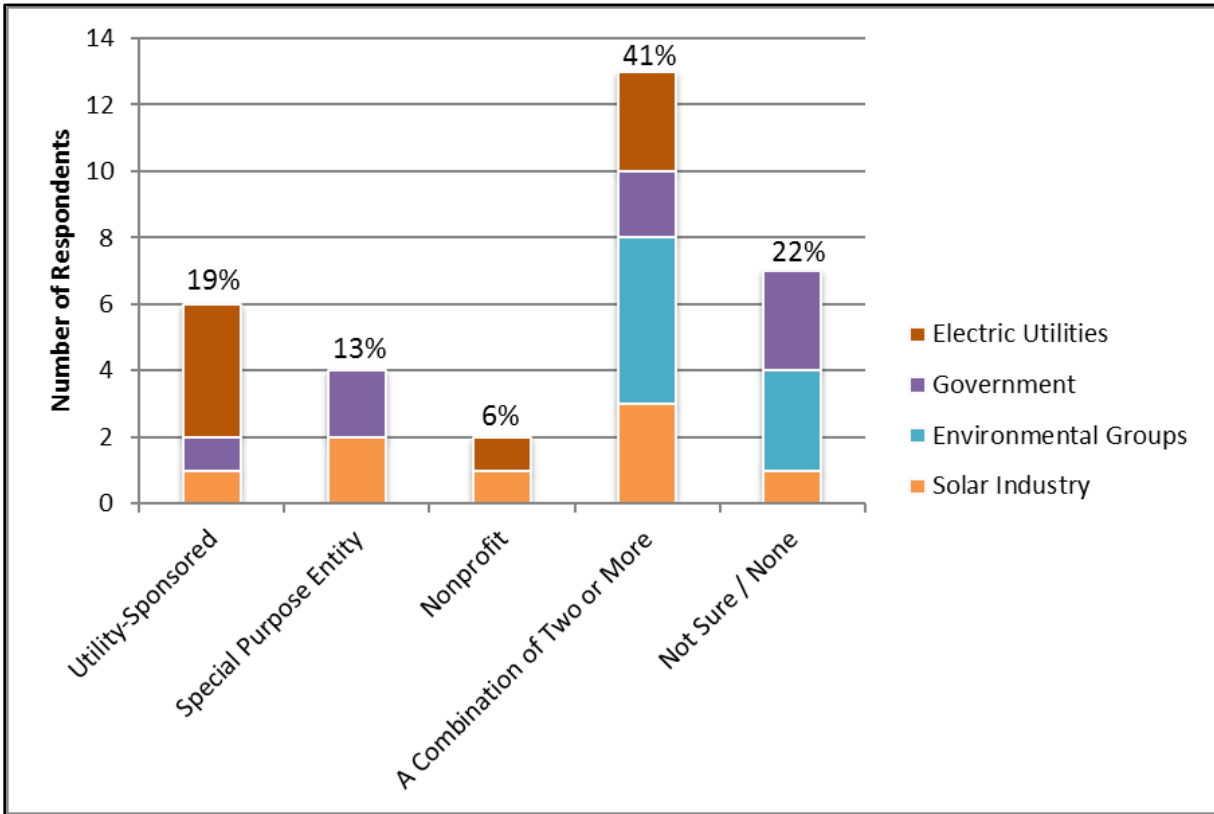
summed up by this interviewee's response: "it will take a drastic change in the political environment or event, plus the cost economics to make sense for consumers, for community shared solar to ever happen here" (Personal Interview #11, Environmental Group).

4.2.7. Community Shared Solar Model Preferences

Among all U.S. interviews (n = 32), the researcher asked what the preferred community shared solar model was to each policy expert. While some respondents were adamant about a specific model (i.e., utility-sponsored, special purpose entity, or nonprofit) for various reasons, the largest percentage of respondents indicated a preference for diversity and flexibility in how community solar should take place. Depending on project size and geography, respondents often claimed that "each model should be tried by having flexible enough rules to accommodate several types of organizational and operational models. Having diverse options is best for the consumers" (Personal Interview #27, Environmental Group). Others did note issues regarding electric utility providers and restructuring: "it depends on which market you are looking at. For a regulated market, utility-owned (or utility-controlled via a PPA) seems to be the only real choice" (Personal Interview #40, Solar Industry). Regardless, interviewees generally indicated that all three models could work depending on context, and that policy proposals should not include language that limits community shared solar to one standard. These results are displayed in Figure 15.

Figure 15.

Community Shared Solar Model Preferences – U.S. Interviews



Note. Developed by author.

While a large contingent, especially electric utility respondents, did back the utility community solar model, and a number of respondents were not sure or decided to skip the question, almost two-fifths indicated that at least two, or all three, common models would work well in their respective state.

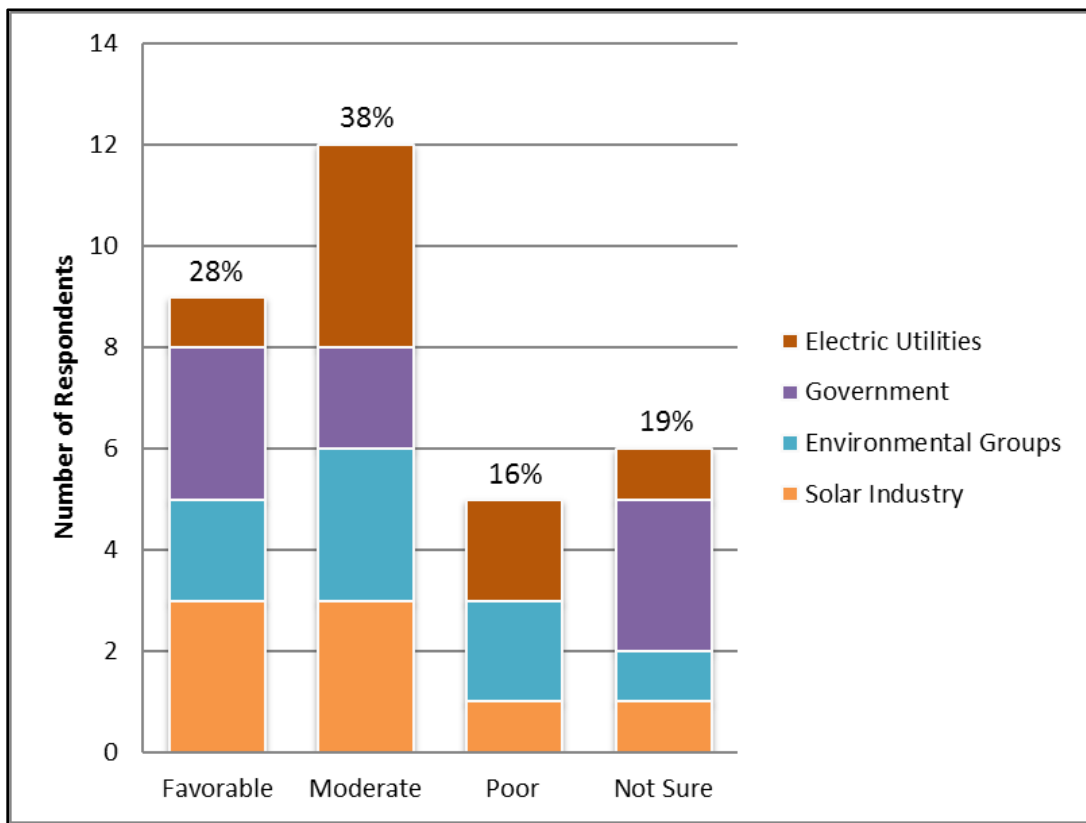
4.2.8. Community Shared Solar Outlook

Finally, the interviewer asked about the outlook for community shared solar moving toward the future, and a large majority were confident or moderately confident that this market would continue or begin to develop both in their state and throughout the U.S.: “I think that community solar will continue to flourish in [our state] in the coming years, and I think a lot of

other states are going to adopt similar policies or shared solar models” (Personal Interview #17, Solar Industry). Some policy experts, especially those from electric utilities or in historically conservative political states, were less in favor of community solar and legislative mandates. Almost one-fifth (19%) of respondents were not sure how community shared solar would diffuse or look in the coming years. Figure 16 illuminates these findings.

Figure 16.

Outlook for Community Shared Solar – U.S. Interviews



Note. Developed by author.

4.2.9. Conclusion

Overall, the U.S. interview process helped the researcher understand some of the key obstacles and opportunities for community shared solar adoption by U.S. states. Generally, according to the interviewees, there is limited solar energy visibility in states outside of the solar

industry and various advocates. Key barriers to community shared solar policy adoption were driven by electric utilities, especially for-profit IOUs, via legislative lobbying and money power. However, respondents indicated that opportunities do exist in the form of increased attention, participation, and collaboration among key stakeholders and citizens who could become involved in the policy process. Despite the general confusion about how best to implement community shared solar as seen from the respondents in the states without such policy, mobilizing various groups, such as state SEIAs, environmental advocacy groups, and others were a best practice to help pass such policy. Bi-partisan support was noted as key by several respondents, but not always necessary. Most agreed that flexibility in community shared solar models was key in terms of opening the market to the largest number of consumers. While some programs were started by IOUs and smaller electric cooperatives, several participants agreed that formal community NEM legislation was the best driver for increased community shared solar deployment, particularly by allowing access to the special purpose entity model.

4.3. Methodology 3

The researcher also conducted semi-structured telephone interviews with key policy experts throughout Virginia between June and September of 2016. Again, all potential respondents were educated on the overarching purpose of this research project, IRB approval, recording, and voluntary participation. The interview transcripts were also numbered and randomly scrambled, explaining the subsequent presentation of quotes. The results of the Virginia interviews closely paralleled those at the national level. While no formal question was asked regarding the visibility of solar energy issues, several respondents indicated the overall lack of prominence in the public's eye. The following sections discuss the key arguments for

and against community shared solar, barriers and opportunities, model preferences, and outlook according to the Virginia interviews.

4.3.1. Key Arguments Against Community Shared Solar

The emerging themes from the Virginia interviews correspond with the national arguments against community shared solar: reluctance from electric utility providers and concern about profits, grid complications, cross-subsidization, and project logistics. However, the Virginia interview responses more overtly uncovered the role conservative politics plays in state energy policy decisions: “within Virginia’s General Assembly, there is a strong conservative Southwest Virginia coal country influence within commerce and labor. In fact, the Chairman of this committee is a coal country guy, and since every solar bill is sent there, they do not get good hearings” (Personal Interview #36, Environmental Group). One solar industry respondent’s response (Personal Interview #12) most accurately depicted many of the received answers, particularly those received by the solar industry and environmental group respondents:

Electric utilities are doing everything they can to push back against net-metered and community shared solar - not because of technical or ratepayer constraints, but because it’s a disruption to their business model. In Virginia, utilities have relied on their financial influence in the General Assembly and public ignorance to posit a narrative that benefits their business model at the expense of solar adoption. Community solar represents some challenges as far as quantifying the benefits of offsite community generation, but if their constituency wants to have community solar, then the tradeoff for them being a monopoly utility is they should respond to the needs of the customers. They could say all they want about issues of it being challenging or whatnot. But really, they are there to serve us, not the other way around. People want to be able to choose their own energy and utilities will have to evolve to accommodate that or risk being obsolete and irrelevant.

Virginia interviewees were also more willing to admit that the arguments about logistical project management issues were not a strong enough reason oppose shared solar policies.

However, most electric utility respondents believed that projects were difficult to manage, and also claimed that community solar concerns were more about fairness for non-participating customers than utility profits. Further, in the regulated state, one electric utility representative indicated the “desire to see the utilities manage community solar projects and not have third parties develop projects...it’s not fair to allow deregulated business enterprises to connect to the electric grid when they have to go through stringent regulatory requirements” (Personal Interview #3).

4.3.2. Key Arguments For Community Shared Solar

Similar to the national arguments for community shared solar, Virginia respondents discussed opening market access to a wider variety of consumers, environmental benefits, job creation, and energy bill reductions, among others. These viewpoints were largely from the solar industry, environmental groups, and certain governmental policy experts. One respondent mentioned “self-sufficiency gained by generating electricity within the community” (Personal Interview #24, Environmental Group). A few respondents mentioned electric grid resiliency as another key benefit: “greater resilience and long-term costs for the overall electric grid, since additional (often-idle) power plants are needed and there is greater diversity of generation sources that reduce stress on the electric grid” (Personal Interview #32, Government). All respondents noted the push on these key benefits from the solar energy industry and environmental community, especially from groups such as the Maryland/DC/Virginia Solar Energy Industries Association (MDV-SEIA), VA SUN, the Sierra Club, the Piedmont Environment Council, the Virginia Conservation Network, and the Chesapeake Climate Action Network, plus other installers and smaller advocacy nonprofits.

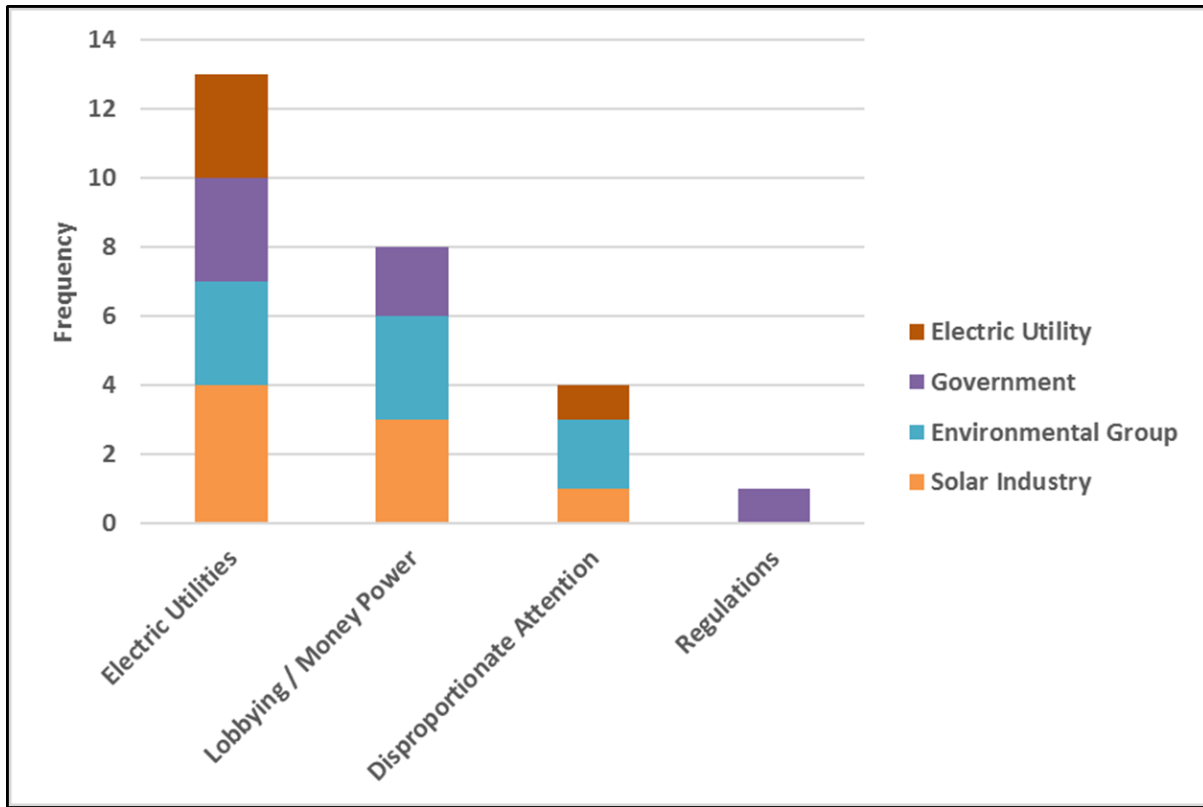
Several respondents also discussed how community shared solar may impact those who could not make a large upfront investment: “maybe one has a monthly payment of \$50 or \$100 per month instead of spending \$10,000 upfront” (Personal Interview #12, Solar Industry), including millennials. Others mentioned how this was aided by PPAs. As a whole, the electric utility participants noted similar potential benefits of community shared solar, but also believed that this was being excessively pushed by “solar installers seeking additional business opportunities” (Personal Interview #25, Electric Utility). Nevertheless, increasing access, decreasing energy costs, and environmental benefits were mentioned by nearly every respondent.

4.3.3. Barriers

The trend of community shared solar barriers as mentioned by the Virginia respondents were also in line with the U.S. interview results. As shown in Figure 17, electric utilities, lobbying, and disproportionate attention were the major themes that emerged through the PET framework. One respondent mentioned regulations, while none mentioned bounded rationality or any other theme not previously identified.

Figure 17.

Frequency of Barriers to Community Shared Solar Adoption – Virginia Interviews



Note. Developed by author.

According to the policy experts interviewed, electric utilities presented the largest barrier to community shared solar policy adoption in Virginia. Many indicated that the utilities and their political allies in the state legislature have created notable obstacles to this policy, pushing rhetoric that solar PV is too intermittent and cannot totally replace existing energy generation sources. Several respondents reiterated the subsidization issue, and also mentioned that without supportive policies, the solar model would not be standing on its own. Others mentioned how these “parties are worried about raising electric rates and grid complications” (Personal Interview #11, Environmental Group) and how community shared solar threatens utilities’ regulated monopoly status. However, one government official noted how Virginia’s IOUs and large

electric cooperatives are “overtly supportive because the State Corporation Commission and the Governor’s Office are pressuring them to be more proactive” (Personal Interview #10). Despite this, electric utilities still all expressed concerns with sales reductions and fairness: “there will be repercussions in the form of rate increases, shareholder financial deterioration, or service quality degradation” (Personal Interview #43, Electric Utility).

Relatedly, the theme of lobbying and money power strongly emerged in the Virginia interviews. Several policy experts noted the financial influence in the state’s General Assembly: “the largest obstacles are the utilities and their money power, developing negative perceptions of solar by the members of the General Assembly” (Personal Interview #36, Environmental Group). Others were more specific about groups that influenced Virginia’s politicians: “fossil fuel interests fund elected officials hostile to community solar (e.g. Koch, ALEC, the Heritage Foundation, etc.)” (Personal Interview #32, Government). Electric utility respondents often pointed to how their lobbying centered on fairness and that they should be compensated if mandated to do community solar projects. Overall, a majority of respondents pointed to how electric utility lobbying and their monetary influence is, by far, the biggest barrier to community solar enabling legislation in Virginia.

Only a handful of Virginia interviewees alluded to disproportionate attention as a critical barrier. One environmental group respondent adequately summed up the general lack of attention to the community shared solar issue: “only a handful of legislators care about clean energy. It’s tough because these people are only in session for a limited amount of time and everyone is trying to get on their agenda” (Personal Interview #11). Others noted how policymakers, taken as a whole, generally ignored this issue, especially in the past, with all of the other policy items on the table: “with all of the other things they have to consider in a short

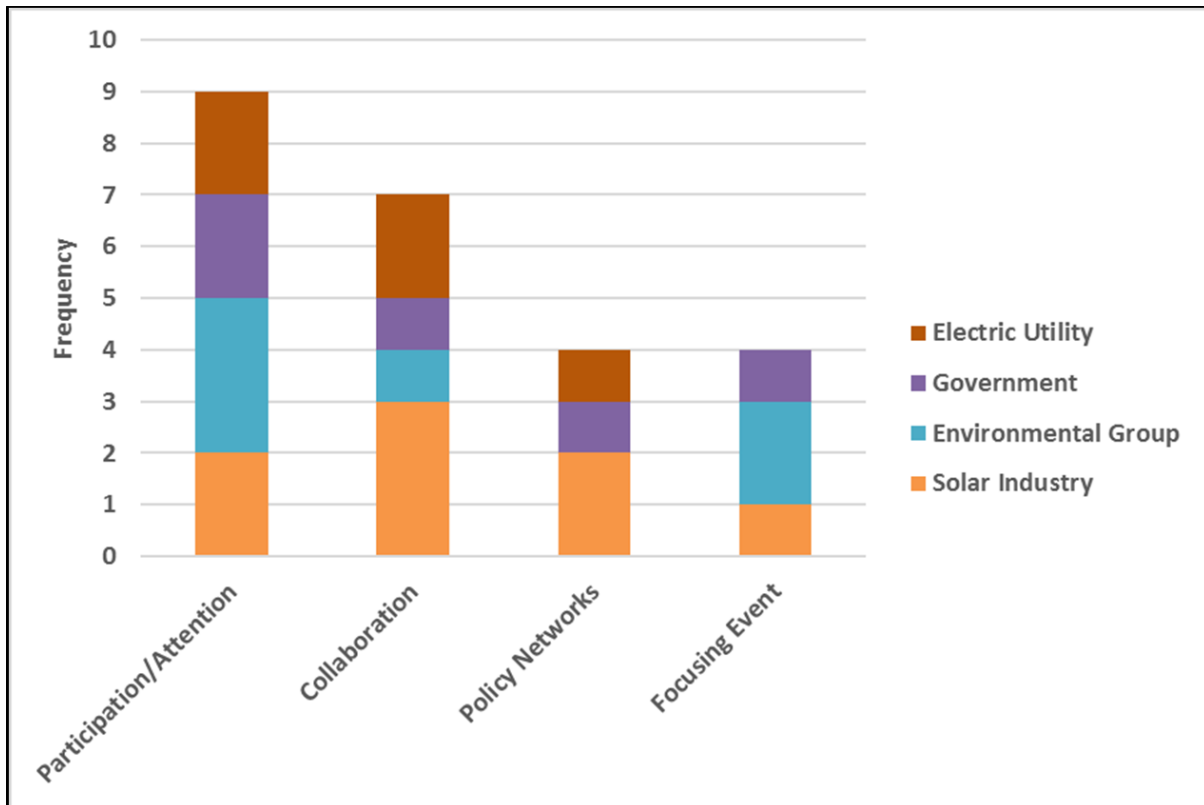
period of time, it's just too difficult [to consider community NEM or shared solar]" (Personal Interview #12, Solar Industry).

4.3.4. Opportunities

The lack of community solar attention from legislators and the citizenry was also spun as a significant opportunity by a variety of respondents. As depicted in Figure 18, Virginia experts believed that increased attention and participation, collaboration, and the use of policy networks could help push the policy forward in the future. A few respondents mentioned key events, such as the election, that could also alter energy policy decisions in the state.

Figure 18.

Frequency of Opportunities to Community Shared Solar Adoption – Virginia Interviews



Note. Developed by author.

Across all of these themes, a majority of respondents noted how active devotion and contribution to energy policy issues can incent policy shifts. Several noted their prior involvement on stakeholder groups, such as the solar trade group (MDV-SEIA), Virginia Conservation Network lobbying days, the SSG, and the newly-formed Virginia Renewable Energy Alliance and Solar Energy Development Authority, among others. One representative summed up the participation/attention theme: “community solar will only have a chance if people start paying greater attention to it” (Personal Interview #11, Environmental Group).

While the U.S. interview responses indicated that collaboration between policy networks helped mobilize large groups of people to implement community NEM or shared solar policy, Virginia individuals recognized this as an important theme if the state were ever to pass the policy. One respondent noted that environmental groups and the solar industry had not always been on the same page: “that has been one of the slight tension areas...there have been times that some of our lobbying has come close to lobbying for the solar industry...[which] puts us into a funny position with them. We are very much pushing for the distributed solar model and some of them are pushing so much on the industrial side, but they are wanting to do bigger projects than we are” (Personal Interview #36, Environmental Group). If these groups were able to harmonize and concur on a strategic lobbying strategy, they may be able to work together better to develop a broader network of supporters of community shared solar in Virginia, including electric utilities, and public policy officials.

Finally, a few individuals discussed the potential for key events or crises that could raise attention or shift state energy policy in a new direction. A few brought up the upcoming election, but more discussed the potential for a fundamental change in utility business models. Others mentioned federal policy, such as EPA’s CPP, and how that might stimulate Virginia

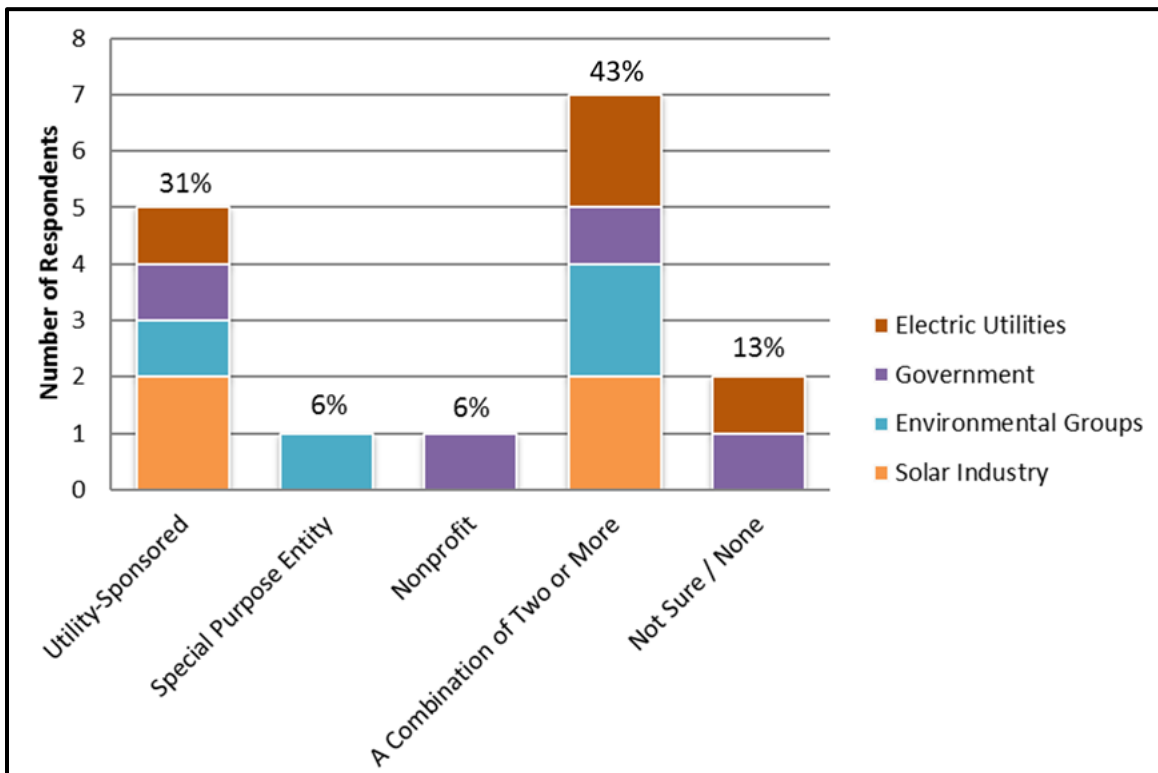
energy policy: “I believe that rising awareness of climate change and increased environmental regulations will trigger policy changes and further spur the clean energy technology industry. I believe that the EPA Clean Power Plan, if continued, will provide top-down regulatory pressure for more solar friendly policies and within the next 10 years, the energy landscape in Virginia may look very different but will likely include community shared solar” (Personal Interview #2, Solar Industry). On the whole, this theme was highlighted by various discussions of energy cost shifts, and Virginia’s complex and conservative political environment, and how events that would alter this equilibrium may provide reason for community solar adoption.

4.3.5. Community Shared Solar Model Preferences

Similar to the U.S. interviews, the interviewer proceeded to ask about community shared solar model preferences. While roughly 40% agreed that a combination of two or more models was optimal in both sets of interviews, a much higher percentage of Virginia respondents (n = 16) believed the utility sponsored model would work best in the state (31% compared to 19% nationwide) as shown in Figure 19.

Figure 19.

Community Shared Solar Model Preferences – Virginia



Note. Developed by author.

This dialogue centered around what would work best in Virginia at this point, regardless of policy: “I think utility based community solar - something like the BARC project - is probably the most doable in Virginia at this point” (Personal Interview #12, Solar Industry). Others mentioned how this model was the best opportunity to kick start community shared solar in Virginia given utility opposition to anything else. Utility respondents generally agreed, though noted that utilities would not implement programs independent of mandates if there was even a threat of raising costs for non-participating ratepayers. A large group of policy experts believed that utility sponsored community solar was the way to start, but that it was not the long-term solution to community solar. In particular, solar industry and environmental group respondents

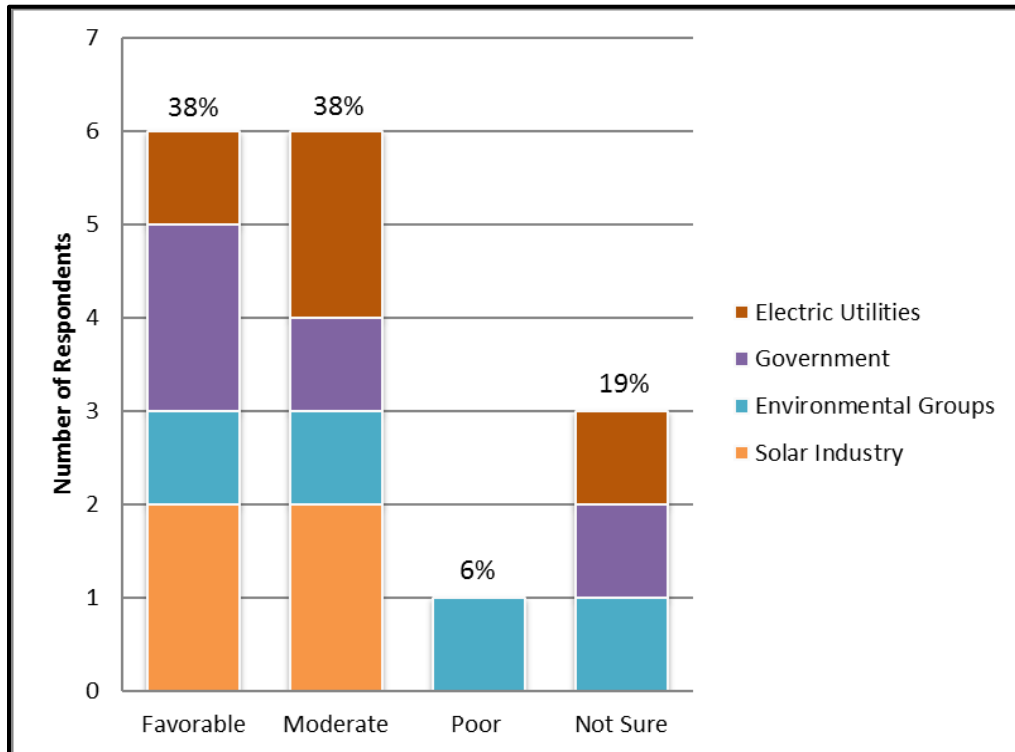
were proponents of the nonprofit model, as well as community NEM policies that allowed groups of ratepayers to band together and develop their own projects via a special purpose entity project.

4.3.6. Community Shared Solar Outlook

To conclude, the 16 Virginia policy experts were asked to describe their outlook for community shared solar looking toward the future. Despite the general pushback on community solar in the state, including the tabling of at least four relevant proposed bills, the Virginia respondents actually had a more favorable outlook on shared solar in the state than the U.S. respondents did. While the ‘moderate’ and ‘unsure’ outlooks interestingly remained identical across respondent groups, 10% more had a favorable outlook, while 10% less had a poor outlook, as seen in Figure 20.

Figure 20.

Outlook for Community Shared Solar – Virginia



Note. Developed by author.

It should be noted that there was an active stakeholder group process that was underway to address community shared solar in Virginia at the time of these interviews. This may have enhanced this favorability metric due to the attention the issue was specifically receiving. This group, along with its purpose and implications, is further discussed in section 5.3.

4.3.7. Conclusion

Taken as a whole, the Virginia interviews raised many of the same arguments for and against community shared solar as the U.S. interviews did. However, the Virginia respondents were much more adamant and specific about conservative politics and coal country money lobbying's role in the state's policymaking process. Proposed bills to implement community NEM or shared solar policies in Virginia have failed multiple times, and the policy expert respondents were certain that large electric utility influence was the central barrier to this. However, similar to the U.S. interviews, there was a positive outlook for future proposals by enhanced attention and collaboration from key stakeholders from all perspectives. Perhaps initiated by utility programs such as BARC and Dominion's newly-announced programs, community solar may have a chance at eventually passing in Virginia as attention, interest, and consumer demand rise, according to the interviewees. Focusing events, such as elections, climate change policies, potential natural disasters, and energy cost swings may also push the state's policy equilibrium elsewhere.

5. SUMMARY, POLICY IMPLICATIONS, AND RECOMMENDATIONS

5.1. Overview

Across the United States (U.S.), solar energy policy has become a subject of fervent debate, particularly at the state level. Installed non-utility solar photovoltaic (PV) capacity (i.e., solar energy systems primarily owned by homeowners and businesses) in the U.S. now totals over 3,000 megawatts (MW), an increase of 755% since 2010 (GTM Research, 2016), stimulated in large part by decreasing module costs. Solar energy advocates have pushed for favorable public policy incentives to encourage solar PV deployment for economic development, environmental, and energy security reasons. However, some electric utilities and other stakeholders have pushed for more restrictive solar energy policies, citing decreased revenue, grid complications, and customer fairness issues. Such debates have stimulated a myriad of in-depth policy evaluation studies that investigate the effectiveness of the range of incentives to encourage distributed solar PV investment.

Most policies to encourage solar PV in the U.S. are enacted at the state level, meaning these programs can vary greatly. These diverse state solar policy approaches can ultimately be broken down into two central categories: market-opening policies and financial incentive policies. The former helps standardize market access through low (or no) cost to government programs such as interconnection standards, net energy metering (NEM) laws, and renewable portfolio standards (RPS). Conversely, financial incentive policies enhance state PV markets by offering direct financial support or fee/tax exemptions. This may include property or sales tax

exemptions, personal or corporate tax credits, low-interest loan programs, grant programs, and other incentives.

Previous academic literature has assessed the efficacy of solar PV policy tools at the state level, most often employing multiple regression analyses to weigh the effects of these policies compared to other non-policy factors such as a state's average solar insolation, electricity prices, and demographic conditions. As a whole, this prior research has shown varied results regarding the impact of these policy and non-policy factors on solar PV capacity growth. However, most of the studies that incorporated NEM found it to be a significant driver of PV deployment.

As one approach to encourage the deployment of community shared solar arrays or gardens, community NEM refers to an arrangement that permits several electric utility customers to use the NEM framework to share the costs and benefits of ownership in a local (typically off-site) solar PV facility. In turn, this allows renters, low-income individuals, business owners, homeowners with shaded roofs, and others to participate in solar investment. Community NEM is often the key policy initiative toward enabling shared solar, which has been shown in prior literature to achieve economies of scale, ideal project locations (Coughlin et al., 2012), collaborative emissions reductions goals, and enhanced community cohesion (Hoffman & High-Pippert, 2010), among other positive attributes. Only 14 states plus the District of Columbia currently allow community NEM and shared solar implementation via formal state legislation, and, therefore, this research aimed to better understand the forces behind such policy adoption throughout the country.

This research aimed to better comprehend the effect of state-level policies, particularly NEM, to incentivize solar PV systems. It also focused on the policy perspectives that exist

around community NEM, both throughout the U.S. and Virginia. The following research questions guided this research:

1. Compared with other state-level policies and non-policy determinants, what impact does NEM have at increasing non-utility solar PV installed capacity throughout the U.S.?
2. What are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar throughout the U.S.?
3. What are policy experts' arguments on the factors that influence the adoption of community NEM and shared solar in Virginia?
4. What are the key barriers and opportunities for community NEM and shared solar legislation to be adopted by other U.S. states?

This dissertation employed a multi-method approach, first focused on identifying the key drivers behind the newly-installed deployment of grid-tied non-utility solar PV at the state level. The first step employed multiple regression analyses to evaluate the impact of various state-level policy and non-policy factors on the amount of non-utility solar PV capacity installed in each state in 2012 and 2013. Cross-sectional secondary data was used for each U.S. state, plus the District of Columbia, over the two years, resulting in 102 total observations. The final full model included two market-opening policies (NEM and interconnection), five financial incentives (SRECS, loans for solar PV, personal or corporate tax credits, property tax exemptions, and sales tax exemptions), and five non-policy factors (deregulated electricity market, year, solar insolation, electricity costs, and per capita income).

The next phase of the project investigated key barriers and opportunities for state community NEM and shared solar policy adoption, both throughout the U.S. and Virginia. This research involved semi-structured telephone interviews with policy experts from four key

stakeholder group categories – the solar industry, environmental groups, government officials, and electric utility representatives – between June and September of 2016. These in-depth interviews asked about the visibility of solar energy issues, arguments for and against community shared solar, model preferences (i.e., utility owned, special purpose entity, or nonprofit), key barriers and opportunities, and the overall outlook for this policy in the future. The interviews were recorded, transcribed, and then analyzed in NVivo. Guided by Baumgartner and Jones' (1993) Punctuated Equilibrium Theory and selective coding from this theoretical scheme, a grounded theory approach helped organize the perspectives on the factors surrounding community NEM and shared solar legislation. Coding categories were systematized under two main themes: barriers (i.e., bounded rationality, lobbying / money power, disproportionate attention, electric utilities, and regulations) and opportunities (i.e., focusing events, participation/attention, collaboration, policy networks, and venue shopping).

The U.S. and Virginia were selected as the sample geographies for two key reasons. First, a nation-wide approach offers a better comprehension of the barriers and opportunities for community NEM policy adoption in different state contexts, particularly considering the diverse regulatory, political, geographic, financial, environmental, and other factors that vary among U.S. states. Eight case study states were ultimately selected for this analysis – Alabama, Colorado, Florida, Minnesota, New Hampshire, Ohio, Oregon, and Texas – with one representative from each of the four stakeholder groups, resulting in 32 total U.S. interviews. Second, Virginia was selected as a representative laggard state that has yet to adopt community NEM or shared solar legislation, despite it being proposed to the state's legislature four times. In Virginia, four policy experts from each of the groups were interviewed, for a total of 16 additional interviews.

5.2. Regression Analysis

Prior studies have provided substantial evidence that state-level solar energy policies help to increase PV market penetration. This study's analysis differed from past research by specifically investigating the factors influencing non-utility solar PV capacity at the state level. This distinction is important, as many state solar energy policy incentives are directed at residential and commercial solar PV customers.

The regression findings indicate that non-policy factors – specifically solar insolation and electricity prices – have the most statistically significant and meaningful overall influence on the extent of annual PV capacity installations at the state level. This result is logical since the amount of electricity that a PV installation produces is a direct function of the amount of solar insolation energy that it receives, and the price of electricity that the PV owner would otherwise purchase represents the effective value of the electricity that the system produces. Combine these two factors together, and an investment in solar PV is most cost-effective in locations with high solar insolation and high electricity prices.

Nevertheless, these results should not be taken to suggest that state-level solar PV policy is an ineffective or irrelevant factor in the growth of state-level solar PV. Rather, the more compelling and valuable findings come from the examination of the results for the individual policy variables to determine which ones have been most effective. In this sense, NEM and income tax credits are the key state policy approaches that encourage DPV investment. Tax credits materialized as a significant state policy incentive, resulting in an expected increase of 0.331 MW of newly installed capacity per 100,000 residents if a state had them. However, state NEM laws emerged as the most influential and statistically significant state policy variable, showing that a one-unit change in a state's NEM grade leads to 0.029 MW of newly installed

capacity per 100,000 residents. While the vast majority of DPV installations in the U.S. are net-metered (Sherwood, 2013), the effectiveness of NEM policies and the extent to which they ease PV investment varies greatly (Interstate Renewable Energy Council and The Vote Solar Initiative, 2013). These findings are particularly significant in the context of recent state efforts to limit NEM, such as through the stand-by charge system initiated in Virginia (Shapiro, 2011), or to eliminate it altogether.

The results also point to how other financial incentive policies – property and sales tax exemptions, state solar loan programs, and SREC markets – have been relatively ineffective, at least within 2012–2013. The poor results for SRECs likely reflect the fact that SREC market prices dropped considerably between 2011–2013, due to increasing supply and decreased demand, in every market except for that of the District of Columbia (Barbose, Weaver, & Darghouth, 2014). It is also noteworthy that SREC markets are typically only found in the eastern U.S. (e.g., Mid-Atlantic and some Mid-West states).

A few possible explanations can be considered for the poor results of the other remaining financial incentive variables (i.e., property tax exemptions, sales tax exemptions, and loan programs). First, such policies may be popular among states that wish to kick-start nascent solar markets, and, as other studies have suggested, a lag may occur before they become effective (Doris & Gelman, 2011). Further, tax exemptions and loans may be considered unnecessary in pro-solar states that have instead adopted more aggressive income tax credits. Relatedly, weaker incentives such as loans may also be unnecessary in states where a combination of other policy and non-policy factors already create a favorable environment for solar. In fact, among the top five states by non-utility installed PV capacity (i.e., Hawaii, Massachusetts, Arizona,

New Jersey, and California), only Hawaii had a loan program in 2013, while all had top seven insolation scores and/or electricity prices.

State policymakers and other interested parties can use this evidence to construct more effective policy approaches for solar energy. For example, the findings show that among financial incentive programs, personal or corporate income tax credits are far more important than loan programs or property or sales tax exemptions. While these findings do not end the debate on which financial incentive policies ought to be developed or enhanced to encourage non-utility PV installations, they do provide strong evidence that income tax credits are powerful facilitators for investment. Most important to this study, strong NEM policies are shown to be an extremely effective state policy incentive. To address the first research question, NEM has the most statistically significant and meaningful impact (increasing newly-installed capacity by 0.029 MW per 100,000 people) when compared with other state-level policies and non-policy determinants. This finding supports arguments for raising NEM system caps, removing fees, and allowing community NEM arrangements. These stronger, more refined policy approaches, including NEM, will be needed to advance non-utility solar PV installations, particularly in those states where circumstantial non-policy factors are less favorable.

5.3. U.S. Stakeholder Interviews

The U.S. solar energy policy expert interviews conducted contain mixed results about the perspectives surrounding community NEM and shared solar. Still in its infancy, limited concrete evidence is available to determine whether community shared solar is an economic strain or a potential boon. Skeptics have pointed out that community NEM and shared solar may lead to lower electric utility profits, perhaps leading to subsequent electricity rate hikes. Several interview respondents expressed concerns that community shared solar participants are

subsidized by ratepayers who are not participating in solar. Others, particularly those from electric utility providers, explained how this was a form of a regressive tax which takes a larger percent of costs from lower-income individuals to supplement those, often more affluent, individuals who were investing in solar. One respondent phrased this as a ‘reverse Robin Hood effect.’ Moreover, skeptics claim that the difficulty of community shared solar project management will lead to enormous wasted funds over failed projects.

However, most policy experts shared positive arguments and had a favorable outlook for community NEM and shared solar throughout the U.S. Several proponents argued that the potential benefits to energy consumers and the environment outweigh some of the expressed drawbacks. The most commonly-cited argument was how community shared solar enables renters, low-earners, and those with shaded roofs, among others, to access solar energy. This market expansion, and the accompanying increase in solar PV generation, could be instrumental in the larger movement toward environmentally-friendly renewables and climate change adaptation. In addition, advocates believed that the construction, maintenance, and software development jobs needed to create shared solar facilities would strengthen local economies. Lower energy costs for shared solar participants would only bolster these benefits.

Nevertheless, the interviews showed that the barriers to community NEM and shared solar development are more than ideological. Since this would enable more consumers to engage in NEM, a practice which IOUs and other electric utilities see as a burden, advocacy for shared solar has been met with strong lobbying efforts. Moreover, policymakers’ overall awareness of community NEM and shared solar is still relatively low, which falls in line with the level of awareness from the general public. With electric utility lobbying being policymakers’ primary exposure to community shared solar, and the myriad of other policy issues (e.g.,

healthcare, education, etc.) making it impractical for them to investigate community solar themselves, the chance of legislation facilitating its development passing is severely diminished.

Despite these barriers, there remain several key opportunities for community shared solar to expand throughout the country. Increased participation in existing community solar study efforts or projects could increase awareness of their benefits, thus motivating favorable discourse. However, for community NEM legislation to actually pass, greater collaboration between the solar industry, environmental groups, government agencies and officials, and electric utility providers is required. Formal policy networks, including groups such as state SEIA and Sierra Club chapters, have taken note of this, and have worked to inspire state solar policy. Moreover, current or future focusing or triggering events, such as the presidential election or the rise of alternate energy prices, may have a role in bringing solar issues to the public mind, perhaps encouraging people to learn more about community NEM and shared solar.

Until these opportunities gain steam, community shared solar may emerge independent of formal community NEM enabling legislation, particularly via utility programs. Electric utility respondents noted the positive efficiencies of community solar in the interviews, and, in the short term, a lot of growth is likely to come from cooperative and municipal utilities, where there is already a lot of traction. There are also opportunities for IOUs to facilitate development once some of the regulatory, credit, and project management issues are worked out. Other states may follow suit from the 14 U.S. states plus D.C. which have already implemented community NEM policies, but there may be a lag as they learn best practices from these leader states.

5.4. Virginia Stakeholder Interviews

The Virginia interviews displayed nearly identical arguments for and against community shared solar. The results also suggest that prior community shared solar legislative proposals

failed to pass in the state due to escalating stresses from IOUs, the solar industry, and nonprofits on this unique issue. The electric utilities in the state lobbied the Virginia General Assembly to table all of the community solar bills, and were successful with big money and corporate dominance in this state-level political process. To illustrate, further research shows that the 10 delegates (all from the Republican Party) who were against 2014's HB 1158 collectively received over \$45,000 in campaign contributions from Dominion in 2013 alone (Virginia Public Access Project, 2014a). The same trends emerge when investigating the other proposed community solar related bills. Overall, since 1997, Dominion has donated well over \$14 million to Virginia legislative candidates through its political action committee and other organizations (Virginia Public Access Project, 2016).

In fact, electric utility lobbying efforts emerged in nearly every interview as the central impediment to community NEM and shared solar policy adoption in Virginia. For instance, Terry Kilgore, the chairman of the aforementioned special subcommittee on energy, received \$23,500 from Dominion in 2013 (Virginia Public Access Project, 2014b), and \$31,000 in 2011 (National Institute on Money in State Politics, 2014) for reelection efforts, making Dominion his largest campaign contributor in these elections. As recent lobbying expense documents show, "Dominion...had at least eight lobbyists as employees and four additional lobbyists as contractors" (Elsner, 2014, para. 5). Via money, access, and lobbying, Virginia's IOUs have been able to maintain considerable control over issues they disfavor and guide public outcomes. This, coupled with the historically conservative political environment, and lack of attention and awareness on the community NEM and shared solar issue, has contributed to its lack of progress in Virginia. Through the PET framework, HB's 672, 1158, 1636, and 618 did not pass in Virginia due to the long-existing stickiness concerning shared solar and community NEM,

disproportionate attention of legislators, and the influence of money and corporate dominance in politics.

Nevertheless, through increased participation and collaboration, community solar may have a future in the state. This may initially be prompted by the solar industry and environmental advocacy groups, who do possess power in numbers and organizing ability. However, these groups often have a difficult time competing with the large IOUs in politicization. It may still take substantial awareness-raising and enhanced collaboration between multi-perspective stakeholder groups to push this conversation forward. In summary, despite these key barriers, the arguments, perspectives, and overall outlook for community NEM and shared solar, remains relatively strong in Virginia.

5.5. Synthesis

State policymakers can use the evidence presented in the regression analysis to better comprehend the cost-effective use of public dollars, as well as future policy analysis and implementation measures. Particularly, these findings show that better NEM policies advance the PV installation market more emphatically than other state-level incentives. Thus, policymakers should continue to pursue favorable NEM legislation should they desire to advance state solar PV markets. In recent years, statewide value of solar studies have been attempting to quantify the impacts that net-metered solar PV provides to utilities, ratepayers, and society as a whole, and several states have recently implemented monthly stand-by charges to offset some of the potential costs that non-utility solar may pose to utility providers. However, this research shows that favorable state NEM policies most heavily incite PV investments, providing evidence for the conservation or advancement (e.g., through community NEM) of this policy form.

As it were, community NEM and shared solar presents an opportunity to broaden the solar market and may be critical in expanding solar energy production in the coming years. About one-third of U.S. states have already passed community NEM or shared solar legislation, and the overall outlook from the interview respondents seems favorable. However, public knowledge of community solar remains low. To further exemplify, a recent SEPA study claimed that only 20% of surveyed utility customer participants reported familiarity with community shared solar (SolarServer, 2016). Despite this, community shared solar is expected to approach \$2.5 billion in market value by 2020, an enormous leap from its 2015 value of \$175 million (SolarServer, 2016). This growth will be bolstered by the efforts of the National Community Solar Partnership, which hopes to enable 1 GW of low- and moderate-income solar by 2020 (U.S. Department of Energy, 2015).

Despite the push for community NEM policies and significant discussion of this issue from IOUs, a large percentage of the 60–80 currently-operating community shared solar projects in the U.S. are run by electric cooperatives (Stumo-Langer 2016). Seemingly, these cooperatives will play a major role in the expansion of community shared solar in the immediate future. Cooperatives have access to unlimited fundraising and are unique in how they retain any economic benefits for their member-owners. Moreover, because cooperatives mostly service rural areas, their land resources are ideal for large solar PV installations. A 2015 Federal Energy Regulatory Commission (FERC) ruling allows cooperatives to now override restrictive contracts with energy companies, enabling investment in renewable energy sources (Sol Systems 2016). This ruling will enable energy cooperatives to add over 375 MW of solar capacity between 2016 and 2018 (Sol Systems 2016), perhaps paving the way for more cooperative-based community solar projects. However, small customer bases will limit scale in broader terms.

Investor-owned utility community shared solar may be a path forward, but these firms may offer poorer payback for projects, or their projects may be specifically designed to discourage customers from individual solar PV ownership. Interviewees believed that IOUs are starting to see that solar makes sense economically, exemplified by their pledges to add hundreds of MW of solar energy to their respective generation portfolios. However, for the most part, there is still considerable push back on policies that incent customers to generate their own electricity via solar. Utilities are especially cautious about community shared solar energy and its sales reduction threat that produces unwelcome financial impacts. Perhaps PPAs, coupled with a blended rate approach in which utilities continue to add more community solar acreage over time, may be an opportunity. Utilities will also need to consider subscription terms and cancellation policies. It remains to be seen whether large IOUs will study, design, and market these types of programs that may threaten their traditional business model, or whether this may be a chance to become a more flexible, consumer-focused ‘next-generation’ utility.

While community NEM is currently incentivizing community shared solar projects across the country, other models, such as these utility-based programs, are clearly developing that allow customers to invest in states without community NEM. The Beavers, McGuckin, and Sweet (2013) report for the Massachusetts Department of Energy Resources claims that other community shared solar programs may eventually displace formal community NEM policy as state NEM quotas are filled and alternate solar models become more commonplace. This observation may apply to other states, as well. However, as noted, it remains to be seen whether utilities will implement shared solar programs for their ratepayers without policy, especially IOUs. Many policy experts agree that ‘true’ community solar ought to be flexible and allow nonprofit and special purpose entity models, which currently requires enabling community NEM

legislation to implement. Promoting flexibility and competitive markets may drive innovation and efficiency when solar developers and electric utilities have equal access. However, current legal limitations to sharing electricity output are a substantial barrier to more community shared solar projects being built throughout the country.

The Commonwealth of Virginia lags behind other U.S. states as a result of the tabling or postponing of HB's 672, 1158, 1636, and 618. While community NEM would have allowed for the expansion of shared solar arrays, electric utility lobbying, disproportionate attention, and the overall stickiness of Virginia's state policymaking culture has hindered the passing of such a bill. Specifically, Dominion has helped defeat countless proposals to encourage solar in the state, and with the exception of a small pilot program, it has stood firm against allowing third parties to sell electricity in Virginia. Community NEM and the allowance of shared solar may never pass in Virginia without a sizeable shift in the current equilibrium, possibly seen via a (or series of) focusing event(s) or a change in the political culture. Minimizing corporate dominance in politics may also be helpful. However, if such shifts or changes occur, Virginia could utilize favorable state solar policy, coupled with its strong non-policy factors, to promote a powerful DPV future, regardless of customer class or geographic distance.

The evidence presented here suggests that state-level solar policy is not created without much input from parties who have a vested interest in influencing such decisions. Adding to the existing PET, this analysis shows that lobbyists from various organizations help set the political agenda in Virginia by financially supporting political officials who advocate their views – in turn, making it more attractive for them to pass legislation. The respective motivations, manipulations, and overall infiltration of those seeking political power incomparably shapes policy formulation.

While a number of states have passed formal community NEM policy, a number of other states continue to actively discuss such policy. California has been an exemplary leader in community shared solar, especially considering its 2015 mandate requiring its IOUs to deploy 600 MW of shared solar by 2020 (California Legislative Information, 2013). It has also particularly encouraged solar installations on low-income, multi-unit housing properties through virtual NEM. This strategy allows multifamily affordable building owners to install a single solar PV system, and the utility allocates the kWh's produced by the PV system to both the building owners' and the tenants' individual utility accounts. Often, states that have been successful at passing some form of community shared solar legislation have eased electric utilities' minds by focusing on group billing arrangements (i.e., a landlord of a multi-unit building is responsible for allocating costs to individual tenants according to tenant leases) or virtual NEM policies (i.e., credits are generated by a single PV system to offset load at multiple retail electric accounts). Colorado, Delaware, Massachusetts, and California have relied on virtual NEM to distribute economic benefits of shared PV systems, among other states, which has allowed them to be successful in passing such legislation.

Since prior proposed community shared solar legislation in Virginia and elsewhere have focused on the specific establishment of community NEM, perhaps a path forward is for future legislative proposals to more narrowly focus on group billing and virtual NEM policies. This would allow a customer with multiple meters to distribute credits to different accounts, such as renters in a multi-unit building. More narrowly focusing the bill language would also allow legislators to utilize best practices from other states who have passed these types of policies, easing electric utility providers into the community shared solar idea. More robust community NEM policies could follow.

Another key path forward for Virginia and other states without community NEM policy is the creation of stakeholder groups to discuss and research these issues. In the summer of 2016, the Solar Research Institute (SRI) developed the Virginia Community Solar Advisory Council (VACSAC) to develop program parameters and a strategy for bringing community shared solar to Virginia. The VACSAC includes representatives from various energy companies and organizations (Solar Research Institute, 2016a). The council initially developed the program's strategy, including utility billing arrangement options, the minimum generation required for a facility in Virginia, and specific generation requirements for each utility's territory. The council then outlined five topics to consider: measures of success, length of pilot, and low-income inclusion; program size, facility size caps, and inclusion of large-scale facilities; RFP key terms and carbon treatment; subscriptions, bill credits, and utility margin; marketing, billing, and consumer protection. The VACSAC accepted feedback online and during in-person sessions throughout September from all involved companies, organizations, and citizens in order to determine what approach should be taken on each attribute of the program (Solar Research Institute, 2016b).

At the same time, other grassroots efforts are being taken to bring community shared solar to Virginia. For instance, VA SUN recently released a 'Declaration of Solar Rights' that requests three key policy changes, including the option for Virginians to lease solar panels to permit community solar (Delman, 2016). A coalition of existing groups, the Distributed Solar Collaborative, is also assessing community shared solar models from other states to push for such a policy in Virginia. These developments, coupled with the VACSAC, has recently mobilized several stakeholders to push the community shared solar conversation forward in the state by targeting favorable legislation. Having a paid facilitator who has electric utility

experience may also be useful in getting a diverse group of stakeholders to produce actionable results.

Further, as noted, the BARC Electric Cooperative recently finished a 550 kW community solar system that provides 25% of the energy needs for 212 homes and businesses (Peirobon, 2016; Roselund, 2016). BARC's project demonstrates the increasing demand for community shared solar in the state, particularly due to how fast it sold out and the subsequent wait list that was developed for a potential second phase of the project (Virginia Department of Housing and Community Development, 2016). This project has received a lot of favorable press since its development, and perhaps represents a path forward for community shared solar in the state. Results from the U.S. interviews showed that community solar was sometimes initiated outside of the policy process, as cooperative and municipal utilities continue to develop community solar programs through their own altruism and customer demand. Such utility-owned community solar programs could represent a significant step forward for Virginia and other states at influencing formal policy mandates in the future. Such was the case in Colorado.

Of course, it is worth noting that there are additional policy and non-policy factors which may increase the amount of distributed solar capacity in the future. For instance, the federal investment tax credit, which is currently equal to 30% of expenditures, provides a strong incentive for home- and business-owners to invest in solar PV systems. Typically, this federal tax credit can be coupled with state personal or corporate tax credits, if offered, to further inspire solar PV investment. In essence, the simultaneity of these federal and state tax credits for solar can work in tandem to create a strong incentive for future deployment, also meaning that the scaling back (or potential termination) of the federal tax credit system may ultimately hinder state solar investments. Further, technological changes, such as different types of solar beyond

common PV panels, increased energy storage capacity, etc., may alter the landscape of solar PV investments. For example, technological advancements beyond PV's standard silicon materials, such as nanopillar, perovskite, and other types of hybrid cells, as well as advancements such as solar tape, solar thermal, etc., may provide cheaper and more efficient means of generating electric current in the future. Improved energy storage technologies, such as lithium-ion batteries, have become cheaper and more abundant in recent years, which may also alter the use of solar energy in the future, resulting in key repercussions for how policy is crafted.

5.6. Questions for Future Research and Conclusion

As state-level solar policies continue to age, their impacts on PV investments will become more vibrant since it often takes time for projects to develop after a policy environment is developed. Further research could refine the analysis in the regression analysis by providing more precise data on the actual SREC market prices or loan and tax credit terms for each state in each year, rather than using dichotomous dummy variables. Alternatively, using the age of a given policy, rather than a dummy variable, may produce better results by accounting for the policy lag factor. However, data availability will be a challenge for either of these approaches. Future studies could also include additional policy approaches, such as participation in regional climate agreements or availability of third-party financing programs, which can make DPV investments more desirable to state residents. The incorporation of cash incentives may also be valuable to these analyses. The addition of these independent variables will be possible as more data becomes available on year-to-year non-utility solar PV installations, thus increasing the number of cases in the model.

Fourteen states plus the District of Columbia have now passed community NEM or shared solar legislation, and utilities of every variety – in both regulated and deregulated

electricity markets – are developing programs across the country. Nearly every solar firm also has an interest in community solar. Further research on community NEM or shared solar policy adoption ought to better understand processes to consumer education about this model. Future studies should also better understand the best models for utilities, such as ownership-based or subscription-based projects, for IOUs, electric cooperatives, and municipal utilities alike. If full retail NEM is eventually replaced or phased out, better understanding how utilities can offer community solar to their customers can help to offer viable solar market access. Clarity on state-level policy adoption, particularly surrounding models, bill language, capacity sizes, and other specific details would also be helpful for states looking to enact legislation. Knowing how to define program standards can, in turn, provide simplicity for potential project developers.

Overall, this research suggests that state NEM laws are a strong policy form to encourage non-utility solar PV installations. Moving forward, community NEM perhaps represents a solid and viable approach to kick-start community solar projects, but, as shown in the interview data, there remain several barriers to widespread policy adoption. This study provides evidence that utilities in regulated electricity states wield enormous power over legislators, swaying energy policy decisions in their favor. State policymakers and advocates will have to continue to navigate this institutional climate when considering future policy decisions. Understanding the perspectives on NEM and community shared solar in Virginia is specifically useful in understanding these processes as a proxy for other historically laggard states when it comes to energy policy, helping to decipher the future of community NEM policy throughout the U.S. It is indisputable that public policy is a fluid process, and, therefore, community shared solar education and model flexibility are key. It is also certain that key challenges and prospects exist

for a wider implementation of community NEM and shared solar policy throughout the U.S., which may only be seen via a pervasive policy change event or a punctuated equilibrium.

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APPENDICES

Appendix A.

Summary of all Variable Measurements by State, 2013

The following table demonstrates the entire data set of dependent and independent variable measurements for each state, based on year 2013 data. A check (√) indicates that a state has adopted the policy incentive. The summary row at the bottom shows average scores for all continuous variables, and the number of states that have adopted each policy measured by a dummy variable (indicated with an asterisk).

State	MW PV / 100K	NEM	Interconnection	SRECs	Loans	Tax Credits	Prop. Tax Ex.	Sal. Tax Ex.	Deregulation	Insolation	Elec. Price	Per Cap. Income
Alabama	0.02	0	0		√					4.45	9.56	36.48
Alaska	0.03	7	0		√					2.42	16.19	50.15
Arizona	2.66	17	0			√	√	√		5.45	10.96	36.98
Arkansas	0.01	14.5	0							4.55	8.27	36.70
California	1.71	22.5	27.5				√			4.98	15.89	48.43
Colorado	1.08	25	18.5		√		√	√		4.88	10.42	46.90
Connecticut	0.88	20	20		√		√	√	√	3.80	15.50	60.66
Delaware	1.31	23.5	19.5	√	√				√	4.10	10.87	44.82
D.C.	0.40	17	18.5	√			√		√	4.20	11.99	75.33
Florida	0.08	12	10	√		√	√	√		4.80	10.29	41.50
Georgia	0.22	0.5	0							4.58	10.31	37.85
Hawaii	10.0 2	14	20		√	√				5.13	32.86	45.20
Idaho	0.05	0	0		√	√				4.35	8.15	36.15
Illinois	0.00	14.5	21	√	√		√		√	4.00	8.21	46.98
Indiana	0.02	11.5	18	√			√	√		4.00	8.82	38.62

State	MW PV / 100K	NEM	Interconnection	SRECs	Loans	Tax Credits	Prop. Tax Ex.	Sal. Tax Ex.	Deregulation	Insolation	Elec. Price	Per Cap. Income
Iowa	0.11	10.5	17.5		√	√	√	√		4.05	9.11	44.76
Kansas	0.02	11.5	0				√			4.63	10.07	44.42
Kentucky	0.07	11.5	9	√		√		√		4.07	7.84	36.21
Louisiana	0.60	10	0		√	√	√			4.58	8.43	41.20
Maine	0.19	12	19.5						√	3.75	11.53	40.92
Maryland	0.99	22.5	20.5	√	√	√	√	√	√	4.00	12.21	53.83
Massachusetts	2.91	18.5	22.5	√		√	√	√	√	3.90	14.74	57.25
Michigan	0.02	10	14	√					√	3.72	11.71	39.06
Minnesota	0.03	14.5	10.5		√			√		3.76	10.08	47.50
Mississippi	0.01	0	0		√					4.55	9.49	33.91
Missouri	0.50	13.5	0		√		√			4.30	10.62	40.66
Montana	0.09	6	12.5		√	√	√			3.92	8.76	39.37
Nebraska	0.01	9	0		√	√		√		4.34	9.49	47.16
Nevada	0.44	18.5	19.5		√		√	√		5.02	10.00	39.24
New Hampshire	0.31	18	9	√	√				√	3.90	13.85	51.01
New Jersey	2.15	22	20.5	√			√	√	√	3.95	14.62	55.39
New Mexico	1.15	9.5	22.5			√	√	√		5.40	10.22	35.97
New York	0.29	16	16.5		√	√	√	√	√	3.76	16.52	54.46
North Carolina	0.26	7	20.5	√		√	√			4.42	9.61	38.68
North Dakota	0.01	5	0			√	√			3.90	8.89	53.18
Ohio	0.12	15	19	√	√		√		√	3.80	9.56	41.05
Oklahoma	0.01	3	0			√				4.65	8.34	41.86
Oregon	0.16	18.5	24		√	√	√		√	3.92	8.29	39.85
Pennsylvania	0.12	23	17.5	√	√				√	3.84	10.06	46.20
Rhode Island	0.00	11	18.5				√	√	√	3.90	13.90	46.99
South Carolina	0.01	4.5	5		√	√				4.53	9.45	35.83
South Dakota	0.00	0	15				√	√		4.18	9.37	46.04
Tennessee	0.30	0	0				√	√		4.30	9.63	39.56
Texas	0.11	0	8.5			√	√		√	4.91	9.10	43.86
Utah	0.21	15.5	25			√		√		4.80	8.85	36.64
Vermont	1.10	17	21.5			√	√	√		3.70	14.41	45.48
Virginia	0.03	5	22	√						4.22	9.32	48.84

State	MW PV / 100K	NEM	Interconnection	SRECs	Loans	Tax Credits	Prop. Tax Ex.	Sal. Tax Ex.	Deregulation	Insolation	Elec. Price	Per Cap. Income
Washington	0.11	12.5	19.5					√		3.50	6.97	47.72
West Virginia	0.03	18	17.5	√						3.87	7.93	35.53
Wisconsin	0.02	5.5	9.5				√	√		3.86	11.22	43.24
Wyoming	0.07	10.5	0							4.44	7.61	52.83
Totals* / Avgs.	0.61	11.83	12.85	16*	23*	21*	29*	22*	16*	4.24	10.98	44.48

Note. Data gathered from the Interstate Renewable Energy Council and The Vote Solar Initiative (2013), SRECTrade (2015a), Energy Information Administration (2010), and the Database of State Incentives for Renewables and Efficiency (2014).

Appendix B.

Summary of ‘Solar Favorable’ States, 2013 Data

The following table demonstrates author-calculated solar favorable states, defined as states with high solar insolation scores and high electricity costs. These two values are multiplied to calculate and rank solar favorability, with Hawaii to South Carolina being categorized as solar favorable, and Alabama to Washington as not solar favorable.

State	Solar Favorability Index	Insolation Score	Electricity Price (cents/kWh)
Hawaii	168.57	5.13	32.86
California	79.13	4.98	15.89
New York	62.12	3.76	16.52
Arizona	59.73	5.45	10.96
Connecticut	58.90	3.80	15.50
New Jersey	57.75	3.95	14.62
Massachusetts	57.49	3.90	14.74
New Mexico	55.19	5.40	10.22
Rhode Island	54.21	3.90	13.90
New Hampshire	54.02	3.90	13.85
Vermont	53.32	3.70	14.41
Colorado	50.85	4.88	10.42
D.C.	50.36	4.20	11.99
Nevada	50.20	5.02	10.00
Florida	49.39	4.80	10.29
Maryland	48.84	4.00	12.21
Georgia	47.22	4.58	10.31
Kansas	46.62	4.63	10.07
Missouri	45.67	4.30	10.62
Texas	44.68	4.91	9.10
Delaware	44.57	4.10	10.87
Michigan	43.56	3.72	11.71
Wisconsin	43.31	3.86	11.22
Maine	43.24	3.75	11.53
Mississippi	43.18	4.55	9.49

State	Solar Favorability Index	Insolation Score	Electricity Price (cents/kWh)
South Carolina	42.81	4.53	9.45
Alabama	42.54	4.45	9.56
Utah	42.48	4.80	8.85
North Carolina	42.48	4.42	9.61
Tennessee	41.41	4.30	9.63
Nebraska	41.19	4.34	9.49
Virginia	39.33	4.22	9.32
Alaska	39.18	2.42	16.19
South Dakota	39.17	4.18	9.37
Oklahoma	38.78	4.65	8.34
Pennsylvania	38.63	3.84	10.06
Louisiana	38.61	4.58	8.43
Minnesota	37.90	3.76	10.08
Arkansas	37.63	4.55	8.27
Iowa	36.90	4.05	9.11
Ohio	36.33	3.80	9.56
Idaho	35.45	4.35	8.15
Indiana	35.28	4.00	8.82
North Dakota	34.67	3.90	8.89
Montana	34.34	3.92	8.76
Wyoming	33.79	4.44	7.61
Illinois	32.84	4.00	8.21
Oregon	32.50	3.92	8.29
Kentucky	31.91	4.07	7.84
West Virginia	30.69	3.87	7.93
Washington	24.40	3.50	6.97
Average	46.54	4.24	10.98

Note. States are ranked by solar favorability index, highest to lowest. The top 26 states are deemed as solar favorable, while the remaining 25 states are not solar favorable. Insolation data gathered from the National Renewable Energy Laboratory (2013), and electricity price from the U.S. Energy Information Administration (2013). This solar favorability index is not weighted, despite the discrepancies in the raw figures, due to the fact that electricity prices were shown in

the regression results to be roughly a twice as strong predictor of new non-utility installed PV capacity at the state level. In other words, the solar favorability index is, indeed, more heavily influenced by electricity prices rather than solar insolation.

Appendix C.

Interview Questions for Methodology 2

1. What is your job title (including company or organization affiliation) and office location?
2. Please describe the extent and nature of your experience with solar energy policy.
3. What is the visibility of solar energy policy issues in your state, including the level of activism around them?
4. What arguments have supporters of community shared solar policy made?
5. What arguments have opponents of community shared solar policy made?

--If interviewee is in a state with community shared solar policy:

6. What individuals, groups, or events drove your state to pass community shared solar legislation? Was this policy passed with bi-partisan support?

7. What are your thoughts on the community shared solar legislation that your state has adopted?

--If interviewee is in a state without community shared solar policy:

6. What are your thoughts on your state not having community shared solar policy?

7. What are the primary obstacles to proposing or passing community shared solar legislation in your state?

8. Has the community solar issue been pursued entirely in the legislature, or have public referendums, court cases, executive actions, etc. played a role?

9. Are you familiar with the three community shared solar models (i.e., utility-owned, special purpose entity, and non-profit)? Which model do you believe works best in your state? Why?

10. Please describe any additional opportunities or barriers to community shared solar policy in your state.

11. What is your perspective on the future of community shared solar policy in your state and throughout the U.S.? Explain.

Appendix D.

Interview Questions for Methodology 3

1. What is your job title (including company or organization affiliation) and office location?
2. Please describe the extent and nature of your experience with solar energy policy.
3. Who are the supporters of community shared solar policy in Virginia, and what arguments have they made?
4. Who are the opponents of community shared solar policy in Virginia, and what arguments have they made?
5. How do you feel about Virginia not having community shared solar policy?
6. What are the primary obstacles to passing community shared solar legislation in Virginia?
7. Are you familiar with the three community shared solar models (i.e., utility-owned, special purpose entity, and non-profit)? Which model do you believe works best in Virginia? Why?
8. Are you familiar with the utility-owned community shared solar programs recently initiated by Dominion Virginia Power and the BARC Electric Cooperative? If so, what do you think are the strengths and weaknesses of these programs?
9. Please describe any additional opportunities or barriers to community shared solar policy in Virginia, particularly considering that legislation has not yet passed despite four attempts.
10. Do you believe community shared solar legislation will ever pass and gain popularity in Virginia? Why or why not?

Appendix E.

Phone Interview Introduction Script

Hi, my name is Gilbert Michaud and I am a Ph.D. Candidate at Virginia Commonwealth University (VCU), pursuing my degree in Public Policy & Administration. I am performing research for my dissertation on community shared solar in order to better understand the perspectives, barriers, and opportunities regarding these types of policies. To assist this process, I am conducting informational interviews with appropriate stakeholders from a variety of backgrounds. I am inviting you to participate based on purposive sampling and knowledge of solar energy issues.

The interview itself will be semi-structured and organized around roughly ten key questions, taking approximately 20–30 minutes to complete. This study and its questions have been approved by VCU's Institutional Review Board. All interview responses are anonymous, and your name will not be published in the final dissertation or any publicly-available materials. Your participation is entirely voluntary, you may skip any questions that you prefer not to answer, and you can stop at any time without penalty.

The interview will be recorded digitally and then transcribed by the interviewer. The transcriptions will only identify you by the organization and state that you represent, not by name. Only the general findings and select quotes from the interviews will be published, and the interview transcripts will not be published in their entirety. All interview recordings and transcriptions will be kept in a locked filing cabinet and destroyed approximately one year after the interview date. Should you have any questions, my phone number is (207) 749-6056 and email is michaudgl@vcu.edu.

Do you provide verbal consent to participate in this research interview?

--If yes: Okay, great (then start with question #1).

--If no: Thank you for your time and enjoy your day.

--After interview completion: Thank you for your participation in this research study.

VITA

Gilbert L. Michaud

Born: Fort Kent, Maine; 1988

Voinovich School of Leadership and Public Affairs
The Ridges, Building 21, Room 213
1 Ohio University
Athens, OH 45701
(740) 597-9085
michaudg@ohio.edu

Education

Doctor of Philosophy (Ph.D.), Public Policy and Administration, Virginia Commonwealth University. Richmond, Virginia (2013–2016)

- Dissertation Title: *Net energy metering and community shared solar deployment in the U.S.: Policy perspectives, barriers, and opportunities.*
- Dissertation Chair: Damian Pitt, Ph.D.; Committee Members: Elsie Harper-Anderson, Ph.D., Blue Wooldridge, DPA, & Linda Fernandez, Ph.D.
- Research Interests: Renewable energy policy, distributed generation, community solar photovoltaics, state politics, policy evaluation.
- Activities: Public Administration Students Association (PASA), Green Unity for VCU, VCU Community Engaged Research (CEnR) Interest Group, Ph.D. Student Colloquium, Ph.D. Student/Faculty Engagement Series.

Master of Science (M.S.), Community Economic Development, Southern New Hampshire University. Manchester, New Hampshire (2011–2013)

- Thesis Title: *How island and community wind projects can stimulate sustainable economic development through energy independence: Isle au Haut, Maine, USA.*
- Thesis Advisor: Eric L. Jacobs, Ph.D.
- Research Interests: Economic development, wind energy, cooperative organizations, environmental sustainability.

Bachelor of Arts (B.A.), Economics, University of Southern Maine. Portland, Maine (2006–2011)

- Activities: Students in Economic Interest, Students for Maine PIRG (Public Interest Research Group), USM Club Volleyball Team.

Employment

Cluster Analyst & Visiting Assistant Professor, George V. Voinovich School of Leadership and Public Affairs, Ohio University. (April 2016–Present).

- Conducting economic impact and feasibility studies, program evaluations, and other research associated with Ohio University’s US Economic Development Administration University Center; energy research with the Consortium for Energy, Economics & the Environment; developing courses for the Ohio Economic Development Institute certificate program; teaching courses in the Master of Public Administration program.

Graduate Teaching/Research Assistant, L. Douglas Wilder School of Government and Public Affairs, Virginia Commonwealth University. (August 2013–May 2016)

- Supporting Dr. Damian Pitt in energy policy research projects, teaching and grading assignments, writing professional/technical reports, grant proposals, and other related tasks (Fall 2013; Spring 2014; Summer 2014; Fall 2014; Spring 2015; Fall 2015; Spring 2016).
- Supporting Dr. Elsie Harper-Anderson with quantitative analysis for a project entitled “Mapping the Entrepreneurial Ecosystem” for a Kauffman Foundation grant (Summer 2015).
- Tutoring and advising student-athletes for Student Athlete Support Services at VCU University College (Fall 2015; Spring 2016).

HS Economics Content Author, Sapling Learning, Inc. (January 2013–March 2013)

- Writing clear and academically-engaging economics questions and solutions of varying difficulties for High School students utilizing the learning platform.

Editorial Research Director, US Business Executive Journal / TrueLine Publishing. (September 2011–September 2012)

- Conducting/directing editorial research and producing energy and power industry corporate and organizational case studies for US Business Executive.

Editorial Research Assistant, US Business Executive Journal / TrueLine Publishing. (June 2011–September 2011)

- Assisting in editorial research and case study development for the energy and power segment of US Business Executive.

Teaching Experience

- Guest Lecture – MPA 5850 / LPA 4850: Policy Analysis. *Markets and Government: U.S. Energy Policy*. Ohio University. October 17, 2016.
- Course Assistant – URSP 645: Sustainable Energy Planning & Policy. Virginia Commonwealth University. Fall 2015.
- Guest Lecture – URSP 645: Sustainable Energy Planning & Policy. *Solar energy & electricity: Technology and analytics for calculating system efficiency, production, and cost effectiveness*. Virginia Commonwealth University. October 21, 2015.
- Guest Lecture – CCJ 335: Social Science Statistics. *Confidence intervals and hypothesis testing*. Virginia Union University. October 6, 2015.
- Guest Lecture – URSP 645: Sustainable Energy Planning & Policy. *State energy policy and utility regulation*. Virginia Commonwealth University. September 16, 2015.
- Teaching Assistant – URSP 302: Land Use and Infrastructure Planning. Virginia Commonwealth University. Spring 2014; Spring 2015.
- Guest Lecture – URSP 621: Introduction to Geographic Information Systems. *Digital geography and basic geographic concepts*. Virginia Commonwealth University. September 8, 2014.

Invited Conference Presentations

- *Richmond, Virginia community solar impact analysis: Implications for future state-level policy proposals*. 47th Annual Mid-Continent Regional Science Association (MCRSA) Conference / 11th Biennial IMPLAN Conference. Charlotte, NC. June 9–11, 2016.
- *Greater Richmond region community solar feasibility study: Implications for Virginia's Clean Power Plan targets*. VA Power Dialog at the University of Richmond. Richmond, VA. April 8, 2016 (with Jonathan Knopf).
- *State-level policy and non-policy determinants' influence on non-utility photovoltaic installations in the US*. Association for Public Policy Analysis & Management (APPAM) Fall Research Conference. Miami, FL. November 12–14, 2015.
- *State-level solar policy in the US: A historical institutionalist approach*. American Society for Environmental History (ASEH) Annual Conference. Turning Protest Into Policy: Environmental Values and Governance in Changing Societies. Washington, DC. March 18–21, 2015.
- *Planning and permitting for solar energy use: An evaluation of “solarize” programs in Virginia*. Association of Collegiate Schools of Planning (ACSP) 54th Annual Conference. Philadelphia, PA. October 30–November 2, 2014 (with Damian Pitt).

- *Policies to incent residential and commercial solar deployment in the United States: An evolution of institutions and processes.* (Re)visions of the Future: Public Sociology, Environmental Justice, & the Crisis of Climate Change. George Mason University Public Sociology Conference. Arlington, VA. October 18, 2014.
- *An inquiry of residential solar photovoltaic deployment in the United States: Cost-efficient state-level policy, or circumstance?* College of William & Mary Graduate Research Symposium. Williamsburg, VA. March 21, 2014.

Publications/Papers

Academic Publications

- Michaud, G. (2016). Natural disasters and the United States' electricity grid: The role of FEMA and the value of micro-grids. *Michigan Journal of Public Affairs*, 13, 20–30.
- Michaud, G. (2016). Community shared solar in Virginia: Political and institutional barriers and possibilities. *Politics, Bureaucracy, and Justice*, 5(1), 1–15.
- Keener, S., Michaud, G. (2016). The role of geographic location on college campus sexual victimization rates in the U.S.: A new methodological approach. *New Visions for Public Affairs*, 8, 38–49.
- Pitt, D., Michaud, G. (2015). Assessing the value of distributed solar energy generation. *Current Sustainable/Renewable Energy Reports*, 2(3), 105–113.
- Michaud, G. (2015). Public choice and Arrow's impossibility theorem: Implications for the public policy discipline. *Virginia Policy Review*, 9(1), 21–31.
- Michaud, G. (2015). Epistemic pluralism in public policy: The critical theory and neuroscience perspectives. *Evans School Public Policy Review*, 5(1), 76–84.
- Michaud, G. (2015, September 22). SNAP and e-government: Do states understand the implications? *Public Administration Times*. <http://patimes.org/snap-e-government-states-understand-implications/>
- Michaud, G. (2012). *How island and community wind projects can stimulate sustainable economic development through energy independence: Isle au Haut, Maine, USA*. (Master's thesis). <http://academicarchive.snhu.edu/handle/10474/2410>

Working Papers

- Michaud, G., Jolley, G. J. (Forthcoming). State property and sales tax exemptions for solar energy. *State Tax Notes*.
- Michaud, G., Pitt, D. (Under Consideration). Non-utility photovoltaic deployment in the US: Evaluation of state-level policy drivers. *Review of Policy Research*.

Pitt, D., Michaud, G. (Under Consideration). Analyzing the costs and benefits of distributed solar energy in Virginia (USA): A case study of collaborative energy planning. *Journal of Environmental Planning and Management*.

Michaud, G., Jolley, G. J. (Under Consideration). Ohio's plastics industry cluster: Overcoming data suppression using proprietary databases. *Journal of Extension*.

Michaud, G., Jolley, G. J. (In Progress). Central and peripheral perspectives of macro public policy: Using pluralist epistemology to advance theory. *Critical Policy Studies*.

Michaud, G. (In Progress). Economic impact analysis of community solar gardens in Richmond, Virginia. *Journal of Regional Analysis and Policy*.

Michaud, G., Keener, S. (In Progress). Forms of capitalist economic systems: Ramifications for public policy theory and practice. *Economic Thought*.

Professional/Technical Reports

Jolley, G. J., Wilson, N., Michaud, G. (2016). *Wood industry economic contribution analysis: Impact to Ohio and Appalachian Ohio, June 2016 update*. Prepared for the Appalachian Partnership for Economic Growth (APEG).

Borchers, E., Fewster, W., Knopf, J., Tatge, A., Michaud, G. (2016). *Greater Richmond region community solar feasibility study*. Prepared for VA SUN. www.vasun.org/wp-content/uploads/2016/03/Greater-Richmond-Region-Community-Solar-Feasibility-Study-Prepared-for-VA-SUN.pdf

Burke, D., Michaud, G., Portier, M., Pitt, D. (2015). *Feasibility study for commercial sector "solarize" program*. Prepared for the Richmond Region Energy Alliance and VA SUN. <http://www.vasun.org/wp-content/uploads/2015/03/Feasibility-Study-for-Commercial-Sector-Solarize-Program-Final-1.pdf>

Allard, A., DePaola, M., Wright, W., Michaud, G., Pitt, D. (2015). *Solar energy feasibility study for the city of Richmond*. Prepared for the City of Richmond, Virginia.

Pitt, D., Michaud, G. (2014). *Analyzing the costs and benefits of distributed solar generation in Virginia*. A report on the work of the Virginia Distributed Solar Generation and Net Metering Stakeholder Group, as convened and facilitated by the Virginia Department of Environmental Quality and the Virginia Department of Mines, Minerals, and Energy. <http://mdvseia.org/wp-content/uploads/2014/12/SSG-Value-of-Solar-Study-Final-10-31-14.pdf>

Michaud, G. (2012). *Portland, Maine affordable housing development proposal*. Prepared for the Portland Housing Authority. Southern New Hampshire University, School of Community Economic Development.

Produced Trade Journal Articles

Osorno, C., Michaud, G. (2013). Quality Controlled Manufacturing Inc.: Investing in education. *US Business Executive, Winter I*, 125–127.

- Dudley, J., Michaud, G. (2012). Hycomp, Inc.: Customized compressors. *US Business Executive, Fall II*, 118–119.
- Osorno, C., Michaud, G. (2012). Cordova Electric Cooperative Inc.: Alaska's renewable energy trailblazers. *US Business Executive, Fall II*, 24–27.
- Osorno, C., Michaud, G. (2012). Danco Machine Inc.: Fielding the toughest technical demands. *US Business Executive, Fall II*, 111–113.
- Osorno, C., Michaud, G. (2012). Eolian Renewable Energy LLC: Clean energy with minimal impact, maximum productivity. *US Business Executive, Fall II*, 64–66.
- Osorno, C., Michaud, G. (2012). GreenLogic Energy: Exceeding expectations and performance projections. *US Business Executive, Fall II*, 67–69.
- Osorno, C., Michaud, G. (2012). K2 Energy Solutions Inc.: Building the batteries of a brighter tomorrow. *US Business Executive, Fall II*, 70–73.
- Osorno, C., Michaud, G. (2012). Renewable Energy Alaska Project: Creating a secure, stable and sustainable energy landscape. *US Business Executive, Fall II*, 22–23.
- Osorno, C., Michaud, G. (2012). Terrasond, Limited: Operating for the good of the economy and environment. *US Business Executive, Fall II*, 28–29.
- Dudley, J., Michaud, G. (2012). E2 Solar: A bright future. *US Business Executive, Fall I*, 103–104.
- Dudley, J., Michaud, G. (2012). GS Medical USA LLC: Spinal implant supplier. *US Business Executive, Fall I*, 108–110.
- Dudley, J., Michaud, G. (2012). Reed Candle Company: Surrounding the world with light. *US Business Executive, Fall I*, 64–67.
- Osorno, C., Michaud, G. (2012). D&K Engineering Inc.: An innovative product realization engine. *US Business Executive, Fall I*, 59–61.
- Cook, C., Michaud, G. (2012). Heber Light & Power: Low-cost electricity, high quality service. *US Business Executive, Summer*, 75–77
- Cook, C., Michaud, G. (2012). Quick Mount PV: Raising the roof on solar energy. *US Business Executive, Summer*, 83–87.
- Gundberg, E., Michaud, G. (2012). American Solar Direct, Inc.: Rapidly expanding in an emerging market. *US Business Executive, Summer*, 64–66.
- Gundberg, E., Michaud, G. (2012). Argand Energy Solutions LLC: Bringing power and peace of mind to the Carolinas. *US Business Executive, Summer*, 67–69.
- Gundberg, E., Michaud, G. (2012). Biodico: Helping the U.S. achieve energy independence. *US Business Executive, Summer*, 70–72.

- Gundberg, E., Michaud, G. (2012). Bloo Solar Inc.: Changing the world through innovation. *US Business Executive, Summer*, 73–74.
- Gundberg, E., Michaud, G. (2012). Sun Flare Systems, Inc.: A solar company on the verge of taking off. *US Business Executive, Summer*, 88–89.
- Osorno, C., Michaud, G. (2012). Henrico County Department of Public Utilities: Actively enhancing quality of life. *US Business Executive, Summer*, 78–82.
- Osorno, C., Michaud, G. (2012). Verengo Solar Plus: Helping deliver the solar revolution. *US Business Executive, Summer*, 90–92.
- Gundberg, E., Michaud, G. (2012). Alaska Village Electric Cooperative: Transforming inhospitable into pleasant. *US Business Executive, Spring*, 35–37.
- Gundberg, E., Michaud, G. (2012). Delta-Montrose Electric Association: Caring about customers and the environment. *US Business Executive, Spring*, 43–45.
- Gundberg, E., Michaud, G. (2012). Wyandotte Municipal Services: Leading the way in Michigan. *US Business Executive, Spring*, 55–56.
- Osorno, C., Michaud, G. (2012). Anaheim Public Utilities: Advancing technology and sustainability. *US Business Executive, Spring*, 38–39.
- Osorno, C., Michaud, G. (2012). Applied Energy Solutions LLC: Industry-Leading, proudly American technology. *US Business Executive, Spring*, 40–42.
- Osorno, C., Michaud, G. (2012). Free Hot Water: Bringing solar hot water into the American mainstream. *US Business Executive, Spring*, 46–48.
- Gundberg, E., Michaud, G. (2012). Vantage Energy LLC: Experts at what they do. *US Business Executive, Winter*, 88–93.
- Osorno, C., Michaud, G. (2012). Appleton Utilities Department: Commingling water and energy while enhancing quality of life. *US Business Executive, Winter*, 59–61.
- Osorno, C., Michaud, G. (2012). Central Minnesota Municipal Power Agency: Preparing for tomorrow's energy needs today. *US Business Executive, Winter*, 64–66.
- Osorno, C., Michaud, G. (2012). City of Manassas Utilities: Reliable, flexible, and uncompromising public services. *US Business Executive, Winter*, 67–68.
- Osorno, C., Michaud, G. (2012). Orrville Municipal Utilities: Preparing and planning for Orrville's economic future. *US Business Executive, Winter*, 72–74
- Osorno, C., Michaud, G. (2012). Patriot Renewables LLC: Clean energy is American energy. *US Business Executive, Winter*, 75–78

Osorno, C., Michaud, G. (2012). Peoples TWP: Western Pennsylvania's local choice for natural gas. *US Business Executive*, Winter, 79–80.

Service and Professional Activities

- Board Member: VA SUN (2016–2019).
- Co-Course Developer: OEDA Ohio Economic Development Institute Certificate Program (2016–2018).
- Co-PI: City of Belpre, Ohio Economic Development Strategic Plan (2016–2017).
- Co-PI: Small Business Administration Regional Innovation Cluster Grant (2016–2018).
- Ohio University Climate and Energy Taskforce (2016–2017).
- Advisory Panel Member: Council of Independent Colleges in Virginia (CICV) Solar Market Pathways Project (2015–2017).
- Reviewer: *Journal of Environmental Planning and Management* (2016).
- Reviewer: *The International Journal of Sustainability Policy and Practice* (2016).
- Virginia Renewable Energy Alliance Member (2015–2016).
- Student Assistant, Association for Public Policy Analysis & Management (APPAM) Fall Research Conference, Miami, FL (2015).
- First-year Ph.D. student mentoring program at VCU (2014–2015).
- Member, Promotion and Tenure Committee for Dr. Meghan Gough, VCU (2014).
- Alternate Chair of the Solar Stakeholder Group and Steering Committee in Virginia (2014).
- Treasurer, Students in Economic Interest, University of Southern Maine (2009–2011).

Software Proficiency

- Adobe Acrobat Pro, Blackboard, Cloud Computing (e.g., Dropbox; OneDrive), Google Calendar & Documents, Google Earth, IMPLAN, Microsoft Office Programs (e.g., Access; Excel; PowerPoint; Word), NREL JEDI Models, NVivo, Outlook, Skype, SPSS, Windows Operating System.

Conferences, Presentations, and Courses Attended

- State Science & Technology Institute (SSTI) 2016 Annual Conference. Columbus, Ohio. November 1–3, 2016.
- Ohio Economic Development Association (OEDA) 2016 Annual Summit. Dublin, Ohio. October 19–21, 2016.
- International Economic Development Council (IEDC) 2016 Annual Conference. Cleveland, Ohio. September 25–28, 2016.
- Ohio Economic Development Administration (OEDA) “Building Competitive Advantage to Win” Training. Athens, Ohio. September 8–9, 2016.
- CityWorks (X)Po Community Development Conference. Roanoke, Virginia. October 1–3, 2015.
- Virginia Department of Environmental Quality Public Listening Session on Federal Clean Power Plan Proposal. Henrico, Virginia. September 30, 2015.
- HHS Climate Justice Conference. National Institute of Environmental Health Sciences. Research Triangle Park, North Carolina. June 8–9, 2015.
- Solar Energy International: Introduction to Renewable Energy Course. Online. October–December, 2014.
- India Chair in Democracy and Civil Society: Popular Movements and the Popular Vote in Today’s India. Richmond, Virginia. September 22, 2014.
- AREOL: Action Research and Evaluation Online. Course on action research sponsored by the Action Learning Action Research Association. July–October, 2014.
- Fall Leadership Conference. Southern New Hampshire University. Bedford, New Hampshire. September 30, 2012.
- Massachusetts Institute of Technology Energy Conference. Boston, Massachusetts. March 4–5, 2011.
- NYU Financial History Seminar Series, "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles and Financial Crises, 1870–2008." New York, New York. April 23, 2011.
- From Impunity to Accountability: Africa’s Development in the 21st Century: The New School Center for Public Scholarship. New York, New York. November 18–19, 2010.
- Seton Hall Law Review: Securities Regulation and the Global Economic Crisis: What Does the Future Hold? Newark, New Jersey. October 30, 2009.
- Conference on Communication and Environment. University of Southern Maine. Portland, Maine. June 27–30, 2009.

- Consider Engineering Summer Program: University of Maine Engineering Department. Orono, Maine. July, 2005.

Awards and Grants

- Nominated member of the Virginia Commonwealth University Chapter of Pi Alpha, the National Honor Society for Public Affairs and Administration (2016).
- Precourt Energy Efficiency Center Student Fellowship (2015).
- CityWorks (X)Po Full Scholarship (2015).
- Virginia Commonwealth University Assistantship/Fellowship (full tuition support plus stipend) (2013–2015).
- Southern New Hampshire University Jane’s Trust Scholarship (2012–2013).
- University of Southern Maine Dean’s List (2008–2011).
- University of Southern Maine Merit Scholar (2008–2011).
- MBNA Maine Scholarship (2006–2007).
- Presidential Dirigo Scholarship (2006–2007).

Professional Memberships

- SOUL: Sustainable Ohio University Leaders (2016).
- MCRSA: Mid-Continent Regional Science Association (2016).
- ASPA: American Society for Public Administration (2015–2016).
- APPAM: Association of Public Policy Analysis and Management (2014–2016).
- FIRE: Foundation for Individual Rights in Education (2014–2016).
- SNHU School of Community Economic Development Northeast Regional Alumni Network (2013–2016).
- WEA: World Economics Association (2012–2016).
- ASEH: American Society for Environmental History (2014–2015).

- NACEDA: National Alliance of Community Economic Development Associations (2011–2013).

Certifications

- Ohio University Collaborative IRB Training Initiative (CITI) Certification: Conflict of Interest (2016–2020).
- VCU Collaborative IRB Training Initiative (CITI) Certification: Social and Behavioral Responsible Conduct of Research (2013–2017).
- IMPLAN Introductory Training Certificate (2016).
- VCU SPSS Level 1 and 2 Training Certificate (2015).
- VCU Integrity and Compliance Education Certification (2013–2016).
- VCU Information Security Awareness Certification (2013–2016).
- University of Southern Maine SOOT Certification (2009–2011).