Increasing Access to Solar Energy in Seattle, Washington through the Framework of Energy Democracy

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Abstract

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This thesis explores solar energy accessibility in Seattle, Washington. I examine current purchase and installation costs for solar energy for single family homes in Seattle, as well as existing barriers to solar energy for low and average-income residents. Four financing tools are evaluated through the framework of energy democracy: net metering, federal Investment Tax Credits, neighborhood and bulk solar purchasing, and community solar program models. The analysis of the tools based on their ability to advance energy democracy goals provides strategies and opportunities for equitably increasing access to solar energy for residents in Seattle.

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CHAPTER 1: INTRODUCTION

The current investment in fossil fuels is environmentally unsustainable and likely soon to be economically disadvantageous due to emerging renewable energy technologies. It is well documented that the fossil fuels that currently power homes and infrastructure are finite resources, making dependence upon them unsustainable. Current electricity infrastructure creates environmental problems at the household level, as most United States residents power their homes with fossil fuels. Due to the unpredictable nature of fossil fuel markets, individual residents' utilities bills can fluctuate drastically over time, which can cause budgeting difficulties for many low-income homeowners. Additionally, residents have little autonomy or control over where their electricity comes from, making energy autonomy and energy democracy currently unattainable for many. Because of these and other factors, powering homes with fossil fuels is both an environmental problem as well as a growing equity and economic problem.

As the global transition between fossil fuels and renewable resources begins to accelerate, it is essential to increase access to renewable energy among residents of all income levels in order to ensure that the transition is equitable and just. The purpose of this thesis is to evaluate the accessibility of rooftop solar in Seattle, Washington through the lens of energy democracy and equity. By examining several different existing financing options, as well as potential financing options and other mechanisms by which individuals and communities can transition to solar energy, this thesis aims to provide a better understanding of how and why individuals and communities should transition away from current energy sources to solar photovoltaic (PV) energy.

There are many different structural models to support residents in the switch to renewable energy, and renewable energy cooperatives are emerging as unique social, political, and economic

actors. While larger companies and, in some cases, cities or municipalities, continue to control the utility industry, changes in policy and the rise of solar incentives and tax credits could transform the utility industry despite the historical domination of utility companies in energy markets.

Governments, companies, and individual residents face complex decisions when it comes to sourcing energy to power our growing cities and societies around the world. The United States has not made sweeping changes in the energy industry since the industrial revolution, and a transition to renewable energy provides an opportunity to create a more efficient and equitable system for all residents. As many people across the country are looking to renewable energy for financial, environmental, and social reasons, we are in a window of opportunity that could change how we power our homes. This thesis focuses on Seattle, Washington, a progressive city in the Pacific Northwest with a well-known track record of environmentally-focused policy. Due to political and environmental conditions, Seattle has the potential to be among the first cities to allow or actively promote steps toward an equitable energy democracy. While the scope of this thesis is focused on Seattle, this research is generalizable at a broader scale, as many of the discussed solar financing structures are available or emerging in markets in major cities across the United States.

Instead of relying on traditional, typically fossil fuel-based energy through municipal utilities and large-scale grids, emerging technologies, particularly in rooftop solar, now allow many residents around the world to power their own homes through renewable energy harnessed from the sun in the form of solar photovoltaics, or solar PV. The increases in solar panel efficiency, decline in overall cost of solar panels, and increased energy autonomy among residents are a few of the factors that are encouraging more residents to install rooftop solar on their homes. Still, while the United States has seen a major increase in solar energy, solar provides only 0.5% of total

energy consumed in the country as of 2015.[1] Additionally, like many other new technologies, there is often an income gap among early adopters, and the transition to renewable energy is too often consolidated among wealthier homeowners who can pay large installment fees and other upfront costs.[2]

In the Seattle-metro area and beyond, residents at all income levels are beginning to demand cleaner and cheaper energy through a variety of strategies. It is essential for policymakers and planners to help make the transition to renewable energies, and particularly rooftop solar, equitable and just. A transition to a solar-prominent energy system in Seattle and other areas of the country would begin to right many wrongs of decades past regarding the imbalance of opportunities available to and burdens forced upon low-income communities and communities of color, offering sustainable energy with zero carbon emissions and the chance for communities to generate income from their own rooftop solar arrays.

One strategy for ensuring the transition to renewable energy is equitable and just is by adopting an energy democracy framework. A relatively new concept in academic and activist circles, energy democracy, which is defined in Chapter 2, provides a new opportunity for residents to gain autonomy and choice as cities around the world transition to renewable energy, including solar. As energy markets are transforming at a rapid pace around the world, we have an opportunity to shift toward a more equitable, environmental, and economically sustainable alternative through rooftop solar.[3]

[1] Institute for Energy Research, "Solar," 2016, http://instituteforenergyresearch.org/topics/encyclopedia/solar/.
[2] U.S. Department of Energy, "Closing the Solar Income Gap : Greater Access , Proven Policies , and Community Engagement," 2015.
[3] Pricewaterhouse Coopers, "Community Solar: Share the Sun Rooflessly," 2017.

1.1 Energy Conditions in Seattle

In order to have a comprehensive understanding of current conditions in Seattle, it is important to take a triple bottom line approach, looking at the environmental, economic, and equity components of the current state of solar. The following section explores rooftop solar in Seattle through these conditions, highlighting areas where current problems exist.

Currently, most Seattle residents get their energy from Seattle City Light, a department of the City of Seattle.[4] Seattle City Light sources the majority, about 88%, of its energy from hydroelectric power produced by dams on the Skagit and Pend Oreille Rivers, in addition to purchased hydroelectricity from Oregon's Bonneville Dam.[5] While hydroelectricity does not directly produce air pollutants unlike coal and natural gas power plants, the dams required to harness hydroelectric energy do not operate without harmful environmental consequences.

Large scale dams, like those that provide hydroelectric power for Seattle City Light, often harm the surrounding environment by blocking fish migrations and transforming the surrounding environment (in temperature, chemical composition, and sediment levels), among other related negative impacts.[6] Dams in the Pacific Northwest have contributed to major salmon die offs in recent years, exemplifying another reason why hydroelectric energy is not the environmentally-beneficial source it is so often touted to be.[7] Additionally, new studies related to the greenhouse gas (GHG) emissions from dam reservoirs reveal that CH^4 (methane) output is higher than previously thought.[8] In their 2016 study on GHG emissions from dams, Deemer et. al. (2016)

[4] Seattle City Light "How Our Electricity Is Generated." Accessed April 2018. http://www.seattle.gov/light/FuelMix/.
[5] Seattle City Light "How Our Electricity Is Generated." Accessed April 2018. http://www.seattle.gov/light/FuelMix/.
[6] "Environmental Impacts of Dams." Accessed April 11, 2018. https://www.internationalrivers.org/environmental-impacts-of-dams.
[7] Ibid.
[8] Bridget R. Deemer et al., "Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis," *BioScience* 66, no. 11 (2016): 949–64, doi:10.1093/biosci/biw117.

propose that the United Nations Intergovernmental Panel on Climate Change (IPCC) incorporate reservoir CH4 emissions into their GHG budgeting.[9]

In fact, the UN is reconsidering large scale dams as a source of renewable energy given new information related to the environmental and social impacts of large scale hydroelectric projects. In a 2016 report titled *Global Trends in Renewable Energy Investment*, the UN includes only hydropower projects between 1 megawatt (MW) and 50MW as renewable energy.[10] While large scale hydropower projects producing more than 50 MW are major energy providers globally, they are not considered renewable based on new UN definitions.[11] Locally, Washington has also changed its classification of hydroelectricity as a renewable energy source. Under state law I-937, also known as the Energy Independence Act, newly restricted eligibility for new, large scale hydroelectric facilities precludes some hydroelectric infrastructure from being counted in state goals for renewable energy.[12]

Another concern regarding the current reliance upon hydroelectricity in the Puget Sound region is related to forecasted snowpack loss in the coming decades. Because hydroelectric dams in the region are powered by snow melt from nearby mountain ranges, a reliable yearly snowpack is essential for electricity supplies. Within just twenty years, the Puget Sound region is projected to experience a 23 to 29 percent loss in yearly snowpack compared to 1970-1999 levels based on low to moderate greenhouse gas scenarios.[13] Yearly snowpack is likely to continue to decrease in the following decades as well, based on the same GHG scenarios.[14] Though many see

[9] Ibid.
[10] Frankfurt School of Finance & Management, UNEP, and Bloomberg New Energy Finance, "Global Trends in Renewable Energy," 2016, 84, http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf.
[11] Ibid.
[12] Department of Commerce Joint Committee on Energy Supply and Energy Conservation. "Background on the Energy Independence Act (Initiative 937)," no. Initiative 937 (2019): 1–2.
[13] Mauger, Guillaume. State of Knowledge: Climate Change in Puget Sound. 2015.
[14] Ibid.

hydroelectricity as a sustainable and renewable resource, it does not have the same longevity as solar and is subject to the forces of climate change.

In addition to the environmental vulnerabilities and impacts of hydroelectricity, the current utility system is a cost-burden for many residents in the Seattle-metropolitan area and around the country. As of 2015, approximately 1 in 5 families in the United States spends more than 20% of their monthly income on home energy.[15] In Washington state, approximately 175,875 families spend at least 13% of their income on home energy.[16] Because low-income families are disproportionately burdened by energy costs, in Seattle and around the country, the transition to renewable energy must put low-income families and communities of color at the forefront.

To date, approximately 11,000 households in Washington are powered by solar, and this number is expected to rise dramatically in the next several years, with a projection for annual solar installations in the state to nearly double from between 2018 and 2021.[17] Rooftop solar can be more affordable for many residents, through several different financing schemes, which are discussed further in sections below.

1.2 Solar Viability

While many see Seattle's notorious gray days and rainy weather as a barrier to solar adoption, the reliability of long hours of often uninterrupted summer sun and increasing efficiency of solar panels make Seattle a viable city for widespread solar adoption. Using a variety of data sources, numerous organizations have estimated projections for solar viability in Seattle. Google's Project Sunroof is a relatively new tool that uses 3D modeling from Google satellite imagery, weather data from the National Renewable Energy Laboratory (NREL), machine learning

[15] United States Department of Energy. "Open Data Catalog". Accessed April 2018.
[16] Ibid.
[17] Solar Energy Industries Association (SEIA), "Solar Spotlight: California," 2016, 1–2, http://www.seia.org/sites/default/files/CA State Factsheet_6.15.2016.pdf.

knowledge about building shapes, and other relevant data from national and state authorities to calculate how many buildings within city limits are solar-viable.[18] According to calculations from Project Sunroof, approximately 73% of buildings in Seattle are solar-viable.[19] While this includes commercial as well as residential buildings, it does indicate promise for Seattle's homes.

There is limited information related to equity and rooftop solar in Seattle. Because so few households in Seattle have rooftop solar, there is no clear correlation between income and the presence or absence of solar panels based on available data. Other tools offered by Project Sunroof include maps of median income by census tract and existing rooftop solar arrays. However, the low number of rooftop solar arrays show that most census tracts in residential areas outside of the downtown core have between 10 and 99 rooftop solar arrays, which does not offer enough information to draw conclusions related to income and the presence or absence of solar arrays.[20] Despite the lack of additional data and coarse resolution of the available map, some conclusions about the correlation between income and the presence of rooftop solar can be made based on other literature and information from other cities, which will be explored further in the literature review and discussion sections.

Finally, in conjunction with equity, rooftop solar has the potential to foster social capital and community connections through solar cooperative models and community solar bulk purchasing, among other group-focused financing options. Residents in other countries and a few places around the United States, including in the Mt. Pleasant neighborhood of Washington, D.C., have found that community solar provides ways for residents to engage with one another, leading to increased feelings of neighborliness and connection within a neighborhood. This triple bottom

[18] "Project Sunroof - Data Explorer | Seattle." Google Project Sunroof. Accessed April 12, 2018. https://www.google.com/get/sunroof/data-explorer/place/ChIJVTPokywQkFQRmtVEaUZlJRA/.
[19] Ibid.
[20] Ibid.

line framework can help ensure that recommendations meet economic, environmental, and equitable needs of Seattle residents.

1.3 Research Questions

This thesis asks two primary research questions. These questions are designed to address rooftop solar in Washington, and particularly in Seattle, through the lens of equity and access. The research questions are as follows:

1. What are the existing costs and barriers to solar, particularly for low and middle-income residents in Seattle?
2. Which solar financing strategies are equitable and in line with goals for energy democracy in Seattle and how can they be improved?

Additionally, some sub-questions support the exploration of the above-mentioned research questions. These sub-questions include:

1. Where are the gaps in access to rooftop solar, particularly in regard to low-income homeowners?
2. What are the current approaches to closing the access gap to rooftop solar and how are they succeeding or failing?
3. What are the current financial, political, and/or social barriers to installing rooftop solar in Washington compared to other states?
4. What are new opportunities and/or best practices for making the transition to renewable energy, and particularly rooftop solar, more equitable and in pursuit of broader energy democracy goals, particularly at the household level?

The answers to these questions can help policymakers and non-profits at the city and state level advocate for more equity-focused changes to help ensure that low-income residents are not

left behind in the transition to renewable energy. Equity-focused policy can also increase social capital and trust among policymakers, planners, and the community. Additionally, an energy democracy framework, explained in further detail below, can help ensure that the transition to renewable energy is just and sustainable. Although focused on a single city in the United States, this research can provide insight to similar studies in cities around the country by exploring existing frameworks for solar at the city scale.

1.4 Overview of Structure

This thesis includes six sections: introduction, literature review, methodology, results, discussion, and a final conclusion. The literature review discusses current conditions of solar financing, solar technology, and solar policies found in Washington, as well as equity and the terms and frameworks that will be used throughout the thesis. Focusing on theoretical literature, empirical research, and literature of practice, the literature review provides context for the current discussions around rooftop solar financing in Seattle. The methodology section discusses the methods for the research, including interview processes and financing analysis. The discussion section evaluates the interviews and policy documents in an effort to answer the research questions and provide recommendations for increasing access to rooftop solar in a way that is beneficial for low income residents and advances the goal of energy democracy, which is later defined. Limitations to the research can also be found in this section. Finally, a conclusion suggests ways in which the research can be applied more broadly to other questions related to rooftop solar and a just transition to equitable access to renewable energy in other geographic areas. Appendices and the bibliography of works cited are found at the end of the document. The following literature review will identify and define terms related to solar products, policy, and equity in order to begin answering the research questions.

CHAPTER 2: LITERATURE REVIEW

This literature review discusses current research related to solar financing, solar technology, and a framework for energy democracy and equity that will be used throughout the thesis. The section is divided into theory-based literature related to equity and infrastructure, empirical research, and literature of practice, including city and state reports. Major scholars, reports, and related documents will also be discussed. While information related to these topics is widely available, there are some gaps in existing research. These gaps help inform the research questions in pursuit of a more comprehensive understanding of solar access and equity in Seattle.

2.1 Theoretical Literature

Discussions of equity, resource allocation, and barriers, be they societal, institutional, or economic, require a theoretical framework. The theoretical literature section discusses several texts and scholars and their contributions to existing literature related to equity, resource allocation, and the emerging concept of energy democracy. Scholars Timothy Beatley, William Lucy, and their interpretations philosopher John Rawls and discussions of resource allocation, guide the theoretical framework related to equity and resources. In the past several years, the idea of energy democracy has emerged in academic and political spheres, particularly with regards to renewable energy. Scholars David J. Hess, Matthew J. Burke and Jennie C. Stephens, and Kacper Szulecki offer recent discussions on the evolving concept and how it relates to the individual transition to renewable energy. Finally, Denise Fairchild and Al Weinrub explore this concept in depth through case studies in their recent book *Energy Democracy* (2017). Ideas from these scholars inform the theoretical framework that, combined with a personal framework of equity, guides the analysis and discussion sections of this thesis.

Noted political philosopher John Rawls presented several new and expanded-upon concepts of justice over the course of his several decades of writing, influenced by earlier philosophers John Locke, Thomas Hobbes, and others. His seminal work, *A Theory of Justice* laid the groundwork for future political theorists in discussions related to justice, equity, and fairness.[21] Almost two decades later, Timothy Beatley expanded upon these concepts in "Equity and Distributional Issues in Infrastructure Planning: A Theoretical Perspective" (1988).[22]

Beatley notes that public infrastructure "holds important questions for social equity" offering both questions and answers related to a field that has otherwise been somewhat depoliticized.[23] Beatley asks for whom, by whom, and how decisions related to infrastructure and resource distribution should be made, concluding that affected actors and parties should be directly included in decision-making processes.[24] At the time of Beatley's writing, planners operated based on a utilitarian paradigm, attempting to offer up the most benefits for the most people involved in a given system or decision, a framework that Beatley advocated against. Rawls also criticized utilitarianism in *A Theory of Justice* (1971), particularly in his Second Principle (p. 302):

> Social and economic inequalities are to be arranged so that they are both (a) to the greatest benefit of the least advantaged, consistent with the savings principle, and (b) attached to offices and positions open to all under conditions of fair equality of opportunity.[25]

[21] Rawls, John. A Theory of Justice. Cambridge: Belknap Press of Harvard University Press. 1971.
[22] Timothy Beatley, "Equity and Distributional Issues in Infrastructure Planning: A Theoretical Perspective," *Public Infrastructure Planning and Management*, 1988, http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Equity+and+Distributional+Issues+in+Infrastructure+Planning:+A+theoretical+perspective#0.
[23] Ibid.
[24] Ibid.
[25] Rawls, John. A Theory of Justice. Cambridge: Belknap Press of Harvard University Press. 1971.

Like Rawls, Beatley advocates for public officials and planners to "maximize benefits for members of the least-advantaged economic and social group", which in the context of this thesis, are low-income residents currently without access to solar energy.[26]

Discussions of advantages and disadvantages are inextricably linked to the understanding of need, a topic discussed by both Beatley and Lucy. In the context of electricity, one could argue that in modern society in the United States, all residents need electricity, or at least need access to the opportunity for electricity. However, it is difficult to say with certainty whether or not residents need renewable energy, or solar specifically. Because electricity is not a guaranteed right to all residents, the concept of need is important here. Lucy argues that those who "need more service should get more, or they should pay less than others for the same service".[27] Meanwhile, Beatley discusses willingness and ability to pay as an important component in providing services to those who need it. Those who have the most resources are able to afford the most resources, argues Beatley, which makes Rawls' concepts of equity and access important in the debate regarding need.[28]

While current residents may not need energy provided by renewable resources more than they need energy provided by fossil fuels or other potentially harmful energy sources, Beatley brings up important concern for future generations as well as non-human species and the environment.[29] If future generations are to be considered, as Beatley argues, then residents do need renewable energy as soon as possible in order to mitigate or avoid future challenges and unnecessary hardship caused by climate change for future generations. As was outlined in the

[26] Timothy Beatley, "Equity and Distributional Issues in Infrastructure Planning: A Theoretical Perspective," *Public Infrastructure Planning and Management*, 1988, http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Equity+and+Distributional+Issues+in+Infrastructure+Planning:+A+theoretical+perspective#0. p. 211.

[28] Ibid.
[29] Ibid.

introduction, a precarious reliance upon hydroelectricity, as well as the environmental degradation caused by dams, currently forms the basis for the argument that renewable energy is not only a desire that environmentalists and others have, but also a necessity in order to protect and preserve the environment and well-being for future generations.

Operating on the assumptions provided by Rawls, Beatley, and Lucy, one can conclude that residents who are currently most disadvantaged or economically burdened, should be prioritized by planners and policy makers to receive positive benefits related to infrastructure, in this case, solar energy. Additionally, as it stands in the current climate change crisis, residents need access to renewable energy that keeps in mind future generations and non-human living species alike. The aforementioned scholars of the twentieth century provide an ethical framework for understanding need, resource distribution, equity, and infrastructure. Today, a new generation of scholars in the twenty-first century take these ideas a step further with the concept of energy democracy.

2.2 Energy Democracy

As Rawls, Beatley, and Lucy have set the stage for a better understanding of equity, need, and resource distribution, modern scholars, activists, and journalists are bringing in new concepts related to the idea of energy democracy. Challenging the existing paradigm of utility companies as profit-making and often monopolistic controllers of utilities, several authors offer new ways of envisioning more equitable energy structures. It is no coincidence that ideas about energy democracy come at a time when the energy industry faces difficult questions regarding a potential, if not inevitable, transition to renewable energy. By unpacking ideas and definitions related to energy democracy, one can create a framework by which to evaluate the current and potential financial, social, and environmental conditions in a given area.

As it is a relatively new term, energy democracy does not have a singular agreed upon definition to date.[30] The exact origin of the term energy democracy is also disputed, although some believe it dates back to radical intellectual circles and socialist movements in Europe.[31] However, several scholars offer up a few related definitions that can provide insight to the term and its importance in transition to a new energy economy.

Energy democracy can be defined as a new form of governance, as advocated by Szulecki, or a set of goals and actions including resisting the existing utility structure, reclaiming democratic control of utilities, and restructuring utility financing systems, as discussed by Burke and Stephens.[32] Others, including Fairchild and Weinrub, expand upon these concepts through case studies and anecdotal examples, but these two frameworks for energy democracy drive current discussions around energy democracy and autonomy through a triple-bottom line approach.[33] This thesis largely uses the understanding of energy democracy in recent work from these scholars, published in the last two years.

For the purpose of this thesis, energy democracy is defined as: a publicly-controlled system of producing and consuming energy that is attained through the resistance of current energy systems, reclamation of energy production, and restructuring of energy systems in favor of a new system that is equitable for all people. The primary concepts for understanding energy democracy can be summed up in these three parts: *resist*, *reclaim*, and *restructure*.[34] This definition is influenced by the previously mentioned scholars, primarily Burke and Stephens, and will be used as a framework for analysis.

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[30] Kacper Szulecki, "Conceptualizing Energy Democracy," *Environmental Politics* 27, no. 1 (2018): 21–41, doi:10.1080/09644016.2017.1387294.
[31] Ibid.
[32] Matthew J. Burke and Jennie C. Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions," *Energy Research and Social Science* 33, no. September (2017): 35–48, doi:10.1016/j.erss.2017.09.024.
[33] Denise Fairchild and Al Weinrub, eds., *Energy Democracy* (Washington, D.C.: Island Press, 2017).
[34] Burke and Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions."

Resistance to the dominant energy agenda and current paradigms encompasses intended outcomes such as ending fossil fuel subsidies, halting the privatization and marketization of energy, and forming new social alliances or groups in the name of energy democracy.[35] This can also include demand for accountability and rejection of the status quo in an industry that has otherwise been considered apolitical or depoliticized.[36] To date, it is extremely difficult for individual consumers who rely on the utility grid to resist current energy systems and structures.

Reclaiming the energy sector is an important goal in achieving energy democracy. Intended outcomes within this goal include democratizing energy corporations, normalizing public control of the energy sector, returning privatized parts of the energy sector to public control, and creating new energy companies, models, and financial investment systems under public control.[37] Reclaiming the energy sector requires action on the neighborhood and city-wide scale, but also on the individual household scale. Szulecki introduces the concept of the "prosumer", a portmanteau of "consumer" and "producer", highlighting the benefits of having rooftop solar for generating and using one's own energy, particularly in the context of rooftop solar.[38] While the traditional consumer of electricity has long been a passive actor, the "prosumer" is an involved actor who both receives benefits of energy and income while also contributing energy to be used by others in the case of surplus energy production.[39]

Burke and Stephens see net metering and virtual net metering as policy instruments that help achieve the goals of reclaiming the energy sector.[40] Net metering involves running produced solar energy "backwards" through the house meter in order to send energy back to the grid, for

[35] Ibid.
[36] Szulecki, "Conceptualizing Energy Democracy."
[37] Burke and Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions." 2017.
[38] Szulecki, "Conceptualizing Energy Democracy."
[39] Ibid.
[40] Burke and Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions." 2017.

which residents are compensated by energy credits toward future utility bills. Because net metering and virtual net metering allow residents with rooftop solar to reap financial benefits or energy credits from the energy they produce, these policies can help advance the overarching goals of energy democracy and equity only if they are attainable for low-income residents and wealthy residents alike.

Though not exactly the same as federal Investment Tax Credits (ITCs), public and municipal bonds for clean energy, such as the IRS Clean Renewable Energy Bonds which provide federal tax credits, can also act as a reclamation of the energy sector, according to Burke and Stephens.[41] In that they are often voter-approved and can fund renewable energy projects, public bonds and ITCs advance the energy democracy agenda.[42] Still, while the federal extension for ITCs has alleviated some fears regarding an uncertain future for renewable energy, some questions about the future of renewable energy bonds remain.[43] Additionally, questions about the equity of projects funded by ITCs and public bonds remain unanswered. Due to their prevalence and prominent role that they play in reducing upfront costs for solar, federal ITCs are one of the four tools analyzed in this thesis.

By incorporating these concepts of equity and energy democracy, a transformative framework by which current systems and potential projects and goals can be evaluated begins to emerge. Rawls, Beatley, and Lucy's understandings of justice, equity, need, and ability to pay underscore the importance of shifting toward a more equitable energy system. In answering questions about what that system may look like, Hess, Szulecki, Burke and Stephens, and Fairchild

[41] Ibid.
[42] Ibid.
[43] Paul Augustine and Emily McGavisk, "The next Big Thing in Renewable Energy: Shared Solar," *Electricity Journal* 29, no. 4 (2016): 36–42, doi:10.1016/j.tej.2016.04.006.

and Weinrub discuss a modern framework for energy democracy, which will be used to evaluate current and potential financing options for rooftop solar in Seattle.

Based upon the theoretical literature review, two theories guide the following research:

1. Residents in Seattle should have access to renewable energy, in this case in the form of rooftop solar or community solar programs from a nearby solar source for their own wellbeing, the wellbeing of future generations, and the wellbeing of other living species in the Puget Sound region and beyond.
2. The transition to a renewable energy democracy in Seattle that prioritizes small-scale and/or individual scale solar should be done is a way that is equitable to residents of all income levels, per Rawls' Second Principle, and in a way that is compatible with energy democracy frameworks.

The following sections, regarding empirical literature and literatures of practice, build upon the theoretical understanding of the importance of creating a new energy system that embraces Rawls' Second Principle as well as the concept of energy democracy, in order to build a more equitable system of solar energy in Seattle.

2.3 Empirical Literature

In addition to theory, empirical literature is important to understanding current and potential solar financing, best practices, and other information relevant to the these topics. This section outlines existing literature, including scholarly articles and best practices related to solar financing, technology, and infrastructure. Additionally, this section highlights important gaps in existing research that this thesis aims to fill.

2.3.1 Solar Financing

There are numerous ways for residents to pay for the upfront costs of rooftop solar arrays aside from individual homeowners paying out of pocket. Some of these financing structures are inequitable, and/or actively or passively oppose energy democracy. Focusing on net metering/virtual net metering, federal ITCs, and community solar adoption strategies including neighborhood solar bulk purchasing and community solar programs, existing literature varies in its conclusions as to whether or not these financing strategies provide incentives to residents, the degree to which they save money or generate money for residents, and the degree to which they are equitable financing systems. Other related studies and scholars of note are also discussed.

2.3.2 Net Metering and Virtual Net Metering

Some solar panels produce excess energy, particularly during the sunny summer months.[44] One of the easiest ways residents with rooftop solar can be paid based on the solar energy they provide to the grid is through net metering. When excess solar is produced it can be fed back into the city's grid for other residents to use. Net metering monitors the energy that is fed back into the grid, running "backwards" through meters compatible with net metering, in order to ensure that people are paid for the excess power that their solar arrays generate. This payment comes in the form of a check to the resident, or in the state of Washington, energy credits that go toward energy bills when the solar array is not generating energy.[45]

As some energy companies look toward distributed generation for grid resiliency, micro-grids or microgeneration units, usually powered by renewable energy have been found by some to

[44] Jenny Palm, "Household Installation of Solar Panels – Motives and Barriers in a 10-Year Perspective," *Energy Policy* 113, no. June 2017 (2018): 1–8, doi:10.1016/j.enpol.2017.10.047.
[45] Yoshihiro Yamamoto, "Pricing Electricity from Residential Photovoltaic Systems: A Comparison of Feed-in Tariffs, Net Metering, and Net Purchase and Sale," *Solar Energy* 86, no. 9 (2012): 2678–85, doi:10.1016/j.solener.2012.06.001.

be best suited to residential needs.[46] Still, micro-grids are not prevalent in the United States, so homeowners are more likely to turn to rooftop solar. Depending on energy needs, rooftop solar systems are able to displace traditional energy at differing percentages. One study associated with Energy Institute at Haas found that on average, lower-income residents install smaller systems and also consume less energy.[47] However, the poorest income bracket with photovoltaic systems displaced about 83% of their consumption with solar, the highest percentage observed across all income groups, reducing their energy bill by about 21 cents per kWh.[48] With advances in photovoltaic technology, residents can take advantage of net metering systems, generating small amounts of income for selling energy back to the grid, in addition to replacing traditional energy sources with solar for their own homes.

Additionally, another study found that net metering had several benefits compared to feed-in tariffs, which differ from net metering in a few ways. While net metering allows residents to sell surplus energy at retail rate or receive energy credits, feed-in tariffs allow residents to sell surplus energy at a defined rate over the course of a multi-year contract. In this study, by Y. Yamamoto (2012) net metering was more likely to produce more social welfare (defined here as "sum of consumer surplus, profit for the electric utility, and environmental benefits") than feed-in tariffs if there is a large reduction in electricity consumption.[49] However, despite the fact that many solar energy advocates are in favor of net metering, some studies have found that the benefit to residents generating energy is too low, either due to the retail rate or existing regulations.[50]

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[46] Carley, S. (2009). Distributed generation: An empirical analysis of primary motivators. *Energy Policy,37*(5), 1648-1659.
[47] Borenstein, S. (2015). *The Private Net Benefits of Residential Solar PV: The Role of Electricity Tariffs, Tax Incentives and Rebates*.
[48] Ibid.
[49] Yamamoto, Y. (2012). Pricing electricity from residential photovoltaic systems: A comparison of feed-in tariffs, net metering, and net purchase and sale. *Solar Energy, 86*(9), 2697.
[50] Hannah J Wiseman and Sara C Bronin, "Community-Scale Renewable Energy" 165 (2013).

2.3.3 Community-Oriented Solar Energy

While installing rooftop solar on a single house is a popular option, community-oriented and community-led energy projects also provide options and benefits for low-income residents who want to switch to renewable energy. In the form of bulk purchasing, CPPs, and solar co-ops, residents are able to make the transition to solar with their neighbors, which can provide numerous benefits. Several scholars in recent years have explored the benefits of community-oriented renewable energy systems, looking at grid restructuring, conditions necessary for community-owned solar, and other impacts or measures of success for community solar. While solar co-ops in their current iteration are relatively new, the history of energy cooperatives and collectives provides insight into the benefits and challenges of community-owned energy.

Kate Aronoff's "How to Socialize America's Energy" gives a brief history of Rural Electric Cooperatives (RECs) of the 1930s, many of which still exist today.[51] Created in the 1930s, Rural Electric Cooperatives were comprised of multiple owner-customers, as is the case with traditional co-ops, but over time, only a small fraction of the 42 million people across the country in approximately 900 RECs engage with their co-ops.[52] While there are approximately 20 small RECs in rural Washington, none of these organizations serve the population in Seattle.[53] Still, Aronoff argues that urban areas can learn from the lessons of RECs. Due to the democratic nature of co-ops, they fit into the reclaim and restructure components within the energy democracy agenda.[54] While RECs align with energy democracy in theory, most do not engage with customers in their current iterations, making further engagement and access to information key to reaping the community benefits of RECs.

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[51] Kate Aronoff, "How to Socialize America's Energy" 63, no. 2 (2016): 38–47.
[52] Ibid.
[53] "WRECA: Washington Rural Electric Cooperative Assn." WRECA. Accessed April 12, 2018. https://www.wreca.coop/.
[54] Ibid.

In addition to galvanizing RECs in rural areas, Aronoff also argues that Community Choice Aggregation (CCA) programs can help residents take control of their energy even if they do not have the means or property to purchase their own solar.[55] CCAs can allow residents to "aggregate" buying power through government to decide where their energy comes from. This can prompt utility companies to invest in renewable energy, sometimes in the form of solar micro or medium-size grids.[56] A major benefit of CCAs and organizing communities around solar is alignment with the energy democracy agenda in resisting, reclaiming, and restructuring existing systems.

Several scholars, most notably Gretchen Bakke, author of *The Grid*, explore small-scale residential solar and grid defection, echoing activist-journalist Naomi Klein's call for residents to take control of their energy sources instead of relying on the traditional utility model, which can be a cost burden for many residents.[57] In some cases, residents in some areas are able to power their own homes solely from their own "nano-grids" and abstain from using the public electricity grid entirely.[58] Aligning with the resistance arm of the energy democracy agenda, individual nano-grids and grid defection can help residents usher in the transition to renewable energy without major involvement from other stakeholders.

When residents do choose to invest in renewable energy as a group, there are a variety of factors that play into this decision process.[59] Looking at motivations that drive individuals to invest in community renewable energy projects, one study found that even within a cooperative group, members "cannot be regarded as one homogeneous group in terms of motivations."[60] Timing and incentives are important when members decided to join cooperatives. According to the same study,

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[55] Ibid.
[56] Ibid.
[57] Gretchen Bakke, *The Grid* (New York: Bloomsbury, 2016).
[58] Ibid.
[59] Thomas Bauwens, "Explaining the Diversity of Motivations behind Community Renewable Energy," *Energy Policy* 93 (2016), doi:10.1016/j.enpol.2016.03.017.
[60] Ibid. p.286.

environmental values and social identification were among the top reasons early adopters joined renewable energy cooperatives, while material incentives were more influential for later adopters.[61] This study, among others, helps explain motivators for joining renewable energy cooperatives, which can help inform which incentives to prioritize when reaching out to potential members for future community solar projects.

Also referencing RECs, another study explains how the long history of cooperatives, dating back 150 years ago to agricultural co-ops, has set the stage for modern renewable energy co-ops.[62] Although solar cooperative members can financially benefit from the cooperative structure, particularly through net metering, maximization of profit is not typically the main goal for involvement.[63] A recent 2015 study from University of Toronto provides insight into the economic, social, and environmental benefits of community renewable energy.[64]

This study found that revenue generated by renewable energy co-ops is more likely to stay in the community where the energy is generated compared to revenue that comes from out-of-state projects.[65] In several cases, renewable co-op members chose to use the revenue for community development or other projects that might enhance community life, exemplifying the reclaim arm of energy democracy.[66] In addition to investing money back into communities, renewable energy co-operatives often employ local installers and can involve partnering with local businesses or organizations for funding.[67]

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[61] Ibid.
[62] Wiseman and Bronin, "Community-Scale Renewable Energy."
[63] Ibid.
[64] Mumtaz Derya Tarhan, "Renewable Energy Cooperatives: A Review of Demonstrated Impacts and Limitations," *Journal of Entrepreneurial and Organizational Diversity* 4, no. 1 (2015): 104–20, doi:http://dx.doi.org/10.5947/jeod.2015.006.
[65] Ibid.
[66] Ibid.
[67] Ibid.

2.3.4 Barriers to Community-Oriented Solar Energy

While there are several financial, social, and environmental benefits to solar co-ops, numerous barriers to starting and sustaining renewable co-ops remain. Financial barriers to market entry are commonly cited reasons for not participating in a renewable energy co-op.[68] Because they often lack access to the necessary capital to start a renewable energy co-op, some residents, according to Walker and others, are overly reliant upon supportive policy and government incentives.[69] Legal barriers are also cited, as well as a lack of access to information.[70]

Though barriers persist, renewable energy co-ops continue to increase in most parts of the world, and particularly in Europe. Drawing best practices from western countries outside of North America, European scholars Benjamin Huybrechts and Gordon Walker provide detailed accounts of the history of renewable energy and renewable energy co-ops in Europe.[71] In many ways, European solar markets can be seen as a model for solar co-ops in the United States as solar co-ops are employed with more regularity in forward-thinking nations such as the United Kingdom and Germany.[72] Not surprisingly, several countries in Europe, specifically Germany and some Scandinavian countries, are leading the world in installed solar capacity.[73] Walker et. al. found that in addition to financial benefits of renewable energy co-ops, community involvement in renewable energy co-ops was associated with bringing communities closer together in a meaningful way.[74]

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[68] Gordon Walker, "What Are the Barriers and Incentives for Community-Owned Means of Energy Production and Use?," *Energy Policy* 36, no. 12 (December 1, 2008): 4401–5, doi:10.1016/J.ENPOL.2008.09.032.
[69] Ibid.
[70] Wiseman and Bronin, "Community-Scale Renewable Energy."
[71] Gordon Walker "What Are the Barriers and Incentives for Community-Owned Means of Energy Production and Use?"; Benjamin Huybrechts and Sybille Mertens, "The relevance of the cooperative model in the field of renewable energy by Die Relevanz Des Genossenschaftlichen Modells Auf Dem Gebiet Der," 2014, 193–212.
[72] Gordon Walker "What Are the Barriers and Incentives for Community-Owned Means of Energy Production and Use?"
[73] IRENA, "Renewable Energy Prospects: United States of America," no. January (2015): 243.
[74] Gordon Walker and Patrick Devine-Wright, "Community Renewable Energy: What Should It Mean?," *Energy Policy* 36, no. 2 (2008): 497–500, doi:10.1016/j.enpol.2007.10.019.

Renewable energy co-ops in many ways resist, reclaim, and restructure current dominant energy systems, through public control and other factors. However, as previously mentioned, the cooperative components of RECs are not always recognized or used to their most democratic potential. Many RECs also contribute to equity goals by distributing revenue made through net metering among residents who participate. Because buy-in to renewable energy co-ops does not necessarily require home ownership, co-ops can be more accessible to low-income residents.

While the existing empirical literature examines the history of energy cooperatives and some best practices from around the world, there is not yet a study that examines solar energy financing tools through the lens of energy democracy and in the context of Washington state. While Burke and Stephens examine some financing tools through an energy democracy lens, they do so within a national scope and framework, without being city-specific. Additionally, the costs and barriers to solar are explored in some empirical literature, but gaps exist both in relating these barriers to energy democracy and understanding these costs and barriers within the context of Seattle. This thesis aims to fill these gaps, focusing on costs and barriers to solar as well as opportunities for financial tools to advance goals of energy democracy within the context of Seattle. In order to better understand this in the context of Seattle, the following section explores reports and data related to existing and potential sources of solar energy in the city.

2.4 Literature of Practice

Governments, non-profits, think tanks, and other entities have released reports related to rooftop solar, programs for low-income residents, and pursuing just transitions to a renewable energy market. Other reports provide insight into costs of adopting solar and the prevalence of solar in Seattle. This section introduces the actors involved in policy and decision-making related

to these topics, as well as relevant reports. Current utility programs for low-income residents are also explored in this section.

2.4.1 Solar Financing

As previously mentioned, there are several incentives and tools residents can use to finance solar purchasing and installation. This section focuses on the financial details of the four researched tools: net metering, federal ITCs, neighborhood solar and bulk purchasing, and community solar programs. Public sector organizations, like the City of Seattle, and private sector organizations, such as banks or credit unions, can also provide some financial assistance to homeowners for existing utility bills with programs like LIHEAP and ELIA or loan programs, respectively. Additionally, there are several different ways homeowners can save money or even generate additional income once solar is installed. Depending on the mechanisms for financing and receiving financial benefits for solar energy produced, these systems can support the goals of energy democracy.

2.4.2 Net Metering/Virtual Net Metering in Washington

In Washington state, excess energy generation is credited to a customer's next bill at retail rate, which makes it one of forty-five states with a net metering program.[75] Similarly, virtual net metering allows residents to buy into shares of renewable energy off-site, receiving monetary benefits proportionate to their share of the solar array.[76] Virtual net metering is particularly beneficial for residents who do not own a rooftop because they are renting or because they live in multi-family housing, apartments, or condominiums. An example of this is through the non-profit Emerald Cities Collaborative program for multi-family housing, an organization involved in the interview section of this thesis.

[75] Center of social inclusion and Vote solar and Grid Alternatives, "Low-Income Solar Policy Guide," 2016.
[76] Ibid.

Even with net metering incentives, rooftop solar is not accessible to people of all incomes, in part due to upfront installation costs. Several different non-profit organizations and energy companies give a range of upfront costs for purchase and installation for an average rooftop solar array in Seattle. EnergySage estimates the market average for the purchase and installation of a 5kW system to be approximately $14,800 including a federal solar investment tax credit (ITC), but there is no consensus among organizations or installers.[77] Before the federal ITC discount, the average rooftop solar system size of 5 kilowatts (kW), costs about $17,700, also according to EnergySage.[78] Upfront costs are typically a barrier to low-income homeowners, as discussed in GRID Alternative's *Low-Income Solar Policy Guide*.[79] GRID Alternatives estimates the average cost of purchasing and installing a 3 kW system to be between $7,434 and $14,868 for a 6 kW system.[80] Despite these relatively high upfront costs, trends in solar technology show a decline in cost in recent years, in part due to increasingly efficient solar technology. In fact, the average cost of a solar electric system decreased 50% between 2010 and 2016 in the United States.[81] In addition to these sources, this thesis incorporates a household financial analysis in order to gain a more accurate estimate of rooftop solar in Seattle, using an existing single family residence as a proxy for Seattle houses.

2.4.3 Federal ITCs

Renewed in December 2015, federal solar investment tax credits (ITC) provides a thirty-percent tax credit for residential solar systems, which will gradually decrease over time to ten

[77] Energy Sage, "Top Solar Installers in Seattle, WA." EnergySage. Accessed April 26, 2018. https://www.energysage.com/solar-panels/solar-panel-cost/wa/king-county/seattle/.
[78] Energy Sage, "Virtual Net Metering : What Is It ? How Does It Work ?," 2018, 2–4.
[79] Center of social inclusion and Vote solar and Grid Alternatives, "Low-Income Solar Policy Guide."
[80] Energy Sage, "Virtual Net Metering : What Is It ? How Does It Work ?"
[81] Center of social inclusion and Vote solar and Grid Alternatives, "Low-Income Solar Policy Guide."

percent in 2022.[82] ITCs can help lower upfront costs while incentivizing homeowners to adopt solar earlier rather than later in order to reap the most financial benefits from the tax credit. Due to the variation of quotes and estimates among organizations and installers, a proxy house will represent single family residences in Seattle in the results and discussion sections below.

2.4.4 Community-Oriented Solar Energy

In addition to net metering, which is a state policy, and ITCs, a federal policy, there are several community-based models that can help promote rooftop solar use. Community Purchasing Programs (CPPs), also known as neighborhood bulk purchasing, can help cut costs by bringing neighbors together to invest in solar as a group. As a result, when homeowners pool purchasing power, they are often able to spend 15-20% less than individual purchasing after selecting a provider and weighing financing options.[83] CPPs, as discussed by Burke and Stephens, promote energy democracy by reclaiming existing energy institutions by shifting power from utility companies to the community.[84]

If CPPs or neighborhood bulk purchasing are indicators of a burgeoning grassroots renewable energy movement, solar cooperatives are, in many ways, the even more progressive and energy democracy-promoting backbone of this movement in the United States, Europe, and other nations. Solar co-ops not only allow homeowners to invest and reap benefits as a group, they can also foster social capital and community engagement.

A few cases in the United States stand out for their pursuit of energy democracy and an equitable transition to renewable energy. Solar programs in Massachusetts and Washington, D.C. have been relatively successful and can act as examples for Seattle. These programs, involving

[82] Ibid.
[83] Ibid.
[84] Burke and Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions."

community members, non-profits, government offices, and/or private solar and utility companies, offer publicly available reports than can act as blueprints for groups that want to invest in community shared solar (CSS).

The Massachusetts Communities Report helps inform an understanding of the social, political, and economic conditions of the state as it increases the number of households with solar.[85] The report highlights the benefit of community shared solar as well as potential challenges including variations in zoning and permitting and virtual net metering limitations such as caps on service.[86]

Meanwhile, Washington, D.C. has seen a rise in households with solar arrays, particularly in the Mount Pleasant neighborhood, which is home to the Mt. Pleasant Solar Co-op, a model for other community solar programs around the United States. This rise in rooftop solar in the neighborhood is attributed in large part to Solar United Neighbors, a non-profit organization that has galvanized residents to install rooftop solar through the solar cooperative, receiving net metering benefits.[87] Anya Schoolman, the founder of Solar United Neighbors is among several people interviewed for this thesis.

While other financial incentives and tax credits exist, including but not limited to public-private partnerships, green banks, on-bill recovery and on-bill financing, and solar energy/renewable energy certificates, this thesis does not go in depth in these financing structures. By focusing on net metering; ITCs; and bulk purchasing, solar co-ops, and related community models; a cohesive analysis regarding the current and future conditions of solar in Washington state, and particularly in dense urban areas such as Seattle, can be made.

[85] Massachusetts Communities, "Community Shared Solar,"
[86] Ibid.
[87] Fairchild and Weinrub, *Energy Democracy*. 2017.

2.4.5 Solar Viability and Technology

Opponents of solar and uninformed residents alike often believe that the Pacific Northwest is not viable due to the prevalence of overcast, cloudy, and rainy weather in the region. While the fair weather reputation may hold true, even the "poorest solar resource in the Northwest US exceeds that of Germany-the world's leader in solar energy use" according to Bonneville Environmental Foundation, in part due to long days of uninterrupted sun in the summer.[88] In addition to previously mentioned incentives and programs, recent innovations in solar panel technology also set the stage for solar powered communities in Washington.

Developments in solar technology increase the ability for residents to transition from current energy systems to rooftop solar, either on their own roof or through virtual net metering systems or through a community solar program. Homeowners who live in single or multi-family homes with a sloped roof typically require a south-facing roof in order to maximize the azimuth of the sun to generate solar energy. However, west, east, and north-facing roofs can still support solar panels, to a lesser degree. According to Project Sunroof, 73% of existing buildings in Seattle are solar viable, although it is unknown how many of these are resident-owned homes.[89]

Lower cost, and higher efficiency solar technology will likely help low-income homeowners make the transition to solar.[90] As new solar technology related to energy generation and storage becomes more readily available, homeowners will have even more options, and in many cases, lower priced options, for installing rooftop solar.[91] Additionally, the change in technology and solar adoption is happening at an unprecedented rate, with a recent report from

[88] Bonneville Environmental Foundation and Northwest SEED, "The Northwest Community Solar Guide," *BEF and NWSEED Report*, 2013, 1–49, http://www.nwseed.org/wp-content/uploads/2013/05/NW-Community-Solar-Guide.pdf.
[89] "Project Sunroof - Data Explorer | Seattle." Google Project Sunroof. Accessed April 12, 2018. https://www.google.com/get/sunroof/data-explorer/place/ChIJVTPokywQkFQRmtVEaUZlJRA/.
[90] Center of social inclusion and Vote solar and Grid Alternatives, "Low-Income Solar Policy Guide."
[91] Ibid.

Pricewaterhouse Coopers declaring 97 percent of utility executives across the globe anticipate a "medium to high level of disruption in their main home markets by 2020" mostly due to a rise in renewable energy.[92] While many expect major disruptions in the industry, local organizations and political actors can have major impacts on how the solar market changes in the coming years.[93]

2.4.6 Public Sector Actors and Policy

Several public and private organizations have resources available to help contextualize the current state of solar at both the policy and practice level. In the local and state public sector, these organizations include the Washington State Legislature and the City of Seattle, including its departments Seattle City Light, Office of Sustainability and the Environment, and the Office of Housing. The Washington State Legislature includes important Revised Codes of Washington (RCW), which inform the policies and programs related to renewable energy in the state. RCW 80.60 specifically stimulates net metering, which was a major impetus in promoting community solar programs through Seattle City Light in recent years.[94]

In addition to addressing solar and renewable energy transition, the City of Seattle offers programs for low-income residents who are cost burdened by their energy bills. Seattle City Light offers utility discount programs, which can help ease the financial burden that utilities often pose for low-income homeowners and renters. The Federal Energy Assistance Program (LIHEAP) can help reduce electricity bills for those who are under a certain income level and use electricity, gas, or heating oil as a primary heat source.[95] Another program is the Emergency Low Income Assistance (ELIA), which offers assistance to "customers who have received an 'Urgent' or 'Shut-

[92] Pricewaterhouse Coopers, "Community Solar Share the Sun Rooflessly."
[93] Aronoff, "How to Socialize America's Energy."
[94] Washington State Legislature. Chapter 80.60 RCW: NET METERING OF ELECTRICITY. Accessed April 26, 2018. http://app.leg.wa.gov/rcw/default.aspx?cite=80.60&full=true.
[95] Seattle City Light. "Assistance Programs". Accessed March 2018. http://www.seattle.gov/light/assistance/assistance.asp.

Off' notice on balances of $250 or more."[96] Customers who have participated in either LIHEAP or ELIA can also benefit from Seattle City Light's Project Share, which is funded by customer donations. Through this program, those who qualify can receive up to $500 for assistance in paying their energy bill. Finally, HomeWise is a weatherization program through the City of Seattle, which can help low-income residents receive free home weatherization to make the house more energy efficient.[97] Still, these programs, particularly ELIA, typically only offer short-term financing solutions, unlike installing solar, which has the potential to be a long-term solution to lowering monthly electricity bills through set installments.

The Seattle City Light website provides a robust Community Solar FAQ page as well as other pages and documents related to current projects and how homeowners can install solar. While this thesis does not thoroughly explore issues related to information access, it is important to note that Seattle City Light provides information related to local solar opportunities, such as virtual net metering and community solar projects. The five current community solar projects, each with their own specific monitoring site are located at or near Jefferson Park, The Seattle Aquarium, Phinney Ridge (through the Neighborhood Association), Woodland Park Zoo, and in Capitol Hill through the EcoDistrict partnership with Capitol Hill Housing (CHH).

The Office of Housing also has relevant publicly available reports. In order to gain the most benefits from rooftop solar, it is beneficial for houses to be operating at or near maximum energy efficiency, particularly for homes that use electric-running heat pumps. While solar installation is not currently part of the weatherization process for low-income homeowners through the City's HomeWise Weatherization Program, there is an opportunity for weatherization and solar installation to be part of the same process. In partnership with the national Energy Department's

[96] Ibid.
[97] Ibid.

Weatherization Assistance Program (WAP), Colorado became the first state to include rooftop solar array installation as part of its services.[98]

2.4.7 National Policies and Public Sector Actors

Just as local and state actors have influence over Seattle solar markets, so too do national policies and national public sector actors. While former president Obama's Federal ITCs, some of which built upon former president George W. Bush's programs, helped stimulate solar markets across the country, their fate remains unknown during President Trump's unpredictable administration. Most recently, President Trump approved import tariffs of 30% (to decline in subsequent years) on crystalline silicon photovoltaic (CSPV) cells and modules, which are used to produce solar panels.[99] While some believe this is an important boon for American solar producers, others believe that it will have a major impact on solar-industry jobs, ultimately harming both solar panel producers as well as installers and purchasers.[100] Washington state also has policies in place to protect locally-produced solar panels, with all Washington-produced panels receiving an additional $.05 per kWh in net metering incentives. This incentive gradually declines to $.02 per kWh in 2021.[101] Still, while national policies and public sector actors have important impacts on the solar industry, it is often non-profit organizations that play some of the most crucial roles in the just transition to renewable energy.

2.4.8 Non-profit Sector Actors

In addition to the city government departments mentioned above, several local, regional, and national non-profits are working to increase rooftop solar use, specifically among low-income

[98] U.S. Department of Energy, "Closing the Solar Income Gap : Greater Access , Proven Policies , and Community Engagement."
[99] Joseph Bebon. "Updated: President Trump Approves 30% Solar Tariffs".
[100] Ibid.
[101] Solar Washington, "Solar Incentives, Tax Credits, Net Metering & More" www.solarwa.org/solar_incentives, Accessed May 2018.

homeowners. The non-profit organizations highlighted in this thesis include Spark Northwest and its program Solarize Northwest (Seattle), GRID Alternatives (Oakland), Emerald Cities Collaborative (Washington, D.C., with an office in Seattle), Groundswell (Washington, D.C.), and Solar United Neighbors (Washington, D.C.). Several of these organizations were interviewed for the thesis and the results can be found in the results section below.

Among these major reports is *Solarize Guide Book: A Community Guide to Collective Purchasing of Residential PV Systems* from Spark Northwest, in partnership with the U.S. Department of Energy's SunShot program, which acts as a roadmap for planners and solar advocates who want to increase solar installations in their communities.[102] Using Portland, Oregon as a case study and example city, the report identifies three major market barriers: high upfront cost for residential solar installations, the complexity of the purchasing and installation process, and the challenge of "customer inertia" through projects that can take more than two years to implement.[103]

The report identifies the upfront cost for a 3kW residential solar system decreasing from about $27,000 to $2,000 through tax credits and incentives in certain Solarize sponsored projects.[104] While engaging residents through meetings and workshops is an important part of community shared solar, the complexity of the process "can be an overwhelming task for those not technically inclined" according to the report.[105] Finally, while customer inertia can be a barrier to installation, the solarize program offered competitive prices, incentives, and limited-time offers, which motivated many residents to install solar individually or through shared solar.[106]

[102] U.S. Department of Energy, "Closing the Solar Income Gap : Greater Access , Proven Policies , and Community Engagement."
[103] Ibid.
[104] Ibid.
[105] Ibid. p. 5.
[106] Ibid.

In addition to highlighting barriers, the report also highlights important components of the solar installation process including spreading awareness through education and grassroots campaigns, enrolling residents in the program through online registration, assessing the solar sites, coming to a final decision on contractors, and then the final installation.[107] This process, while often long and tedious is an important path to follow for residents who are interested in community shared solar. Partners are also important in this process including non-profits, technical advisors, project organizers, and a trusted solar industry organization.[108]

The process outlined in the report provides an important snapshot of the community solar process and also discusses financial tools explore in this thesis including federal ITCs. The high upfront cost previously mentioned was lowered to about $2,000 after federal and state tax credits, among other incentives, were applied.[109] Through the solarize program, the 30% ITC was introduced to residents during workshops in order to decrease the information barrier that can discourage residents from adopting solar.[110]

Similarly, the *Northwest Community Solar Guide* from Spark Northwest and the Bonneville Environmental Foundation, provides a comprehensive analysis of community solar projects in the Pacific Northwest.[111] The report also discusses net metering, saying that it is typically preferable for customers to engage in a net metering system rather than a Power Purchase Agreement (PPA), which would involve residents selling electricity directly to the utility instead of receiving retail rate prices.[112]

[107] Ibid.
[108] Ibid.
[109] Ibid.
[110] Ibid.
[111] Bonneville Environmental Foundation and Northwest SEED, "The Northwest Community Solar Guide."
[112] Ibid.

The previously mentioned *Low-Income Solar Policy Guide* from GRID Alternatives highlights successful policies and programs that can help low-income people access rooftop solar.[113] This report also includes case studies from California, Colorado, Massachusetts, New York, and Washington, D.C. The report highlights net metering as a major reason why solar installation on a single-family home rooftop can be successful.[114] In fact, several cities and states including Washington, D.C. and California have offered solar installation for no upfront cost to customers with a $2.50/watt rebate through D.C.'s Solar Advantage Plus Program and a $3.00/watt rebate through California's SASH Program, respectively.[115] One resident who participates in a community SASH Program installation described receiving the benefits of solar as "having [her] own ATM", with a recent electricity bill costing only 53 cents.[116]

Focusing on equity and resiliency, the report also highlights the importance of making programs and incentives work for lower-income communities and communities of color. In one case study, a coalition of non-profits and community organizations offered solar subscribers in a predominantly low-income and African American community in North Minneapolis the option to pay in affordable monthly installments instead of requiring a large amount of upfront capital from members.[117] Because community solar is a relatively new concept, innovation focusing on equity in planning and implementing community solar can help make solar more accessible to people at a variety of income levels.

Also of note are two reports from a statewide coalition of people of color-led organizations, Front and Centered. Both *The Disproportionate Impacts of Climate Change on Communities of*

[113] Center of social inclusion and Vote solar and Grid Alternatives, "Low-Income Solar Policy Guide."
[114] Ibid.
[115] Ibid.
[116] Ibid. p. 35.
[117] Ibid.

Color in Washington State and the *2017 Community Listening Sessions: Solar Power* examine the intersections of race, class, and access to renewable energy. The former report explores the ways in which communities of color and people with lower incomes are often less able to adapt to climate change.[118]

In understanding these conditions, the *2017 Community Listening Sessions: Solar* involved 178 participants in eleven community listening sessions in multiple languages across the state from July to November of 2017.[119] While comments from across the state ranged in opinions of solar, they did indicate a general demand for solar among low-income communities.[120] Additional comments were related to cost and accessibility of solar. One resident expressed concern about costs related to current electricity bills, stating that "[their] electricity bill has gone up three times."[121] Another resident said that solar costs must be lowered in order for them to implement solar, and still others expressed frustration over not being able to attain solar as renters.[122] One community in Seattle perceived that current electricity bills were increasing at a rapid pace "even with a pay structure for low income users."[123] These comments help reveal barriers to solar and also current challenges with the existing energy system, indicating a need for an equitable transition to solar in Washington.

Finally, both a source for theory and literature of practice, *Energy Democracy: Advancing Equity in Clean Energy Solutions* edited by Denise Fairchild, CEO of Emerald Cities Collaborative, and Al Weinrub of Local Clean Energy Alliance (LCEA), the largest clean energy coalition in the Bay Area, provides important anecdotal information related to a national energy

[118] Jacques Colon, *The Disproportionate Impacts of Climate Change on Communities of Color in Washington State.* http://www.thurstonclimateaction.org/wp-content/uploads/2016/07/Climate-Impacts-Communities-of-Color.pdf
[119] Front and Centered, *2017 Community Listening Sessions: Solar*.
[120] Ibid.
[121] Ibid.
[122] Ibid.
[123] Ibid.

democracy agenda.[124] One case study explores the rise of solar in Washington, D.C. with the help of the Mt. Pleasant Solar Co-op, spearheaded by Anya Callahan.[125] These case studies and their related website resources provide context for understanding energy access while also offering strategies explored further in Chapter 5.

[124] Fairchild and Weinrub, *Energy Democracy*.
[125] Ibid.

CHAPTER 3: METHODOLOGY

This chapter presents methods used to answer the primary research questions and sub questions. The research questions for this thesis, also found in the introduction, are as follows:

1. What are the existing costs and barriers to solar, particularly for low and middle-income residents in Seattle?
2. Which solar financing strategies are equitable and in line with goals for energy democracy in Seattle and how can they be improved?

Sub-questions explored in the research include:

1. Where are the gaps in access to rooftop solar, particularly in regard to low-income homeowners?
2. What are the current approaches to closing the access gap to rooftop solar and how are they succeeding or failing?
3. What are the current financial, political, and/or social barriers to installing rooftop solar in Washington compared to other states?
4. What are new opportunities and/or best practices for making the transition to renewable energy, and particularly rooftop solar, more equitable and in pursuit of broader energy democracy goals, particularly at the household level?

Using the transformative framework outlined in the theory and empirical sections, two primary mixed methods were employed in research gathering and analysis. These methods included a financial tool analysis and stakeholder interviews. Two sample households representing low-income and average-income Seattle homes show a cost comparison of solar for a single family residency in Seattle. Analysis of an existing single family home will act as a proxy for Seattle single family homes in order to contribute to the financial tool analysis. Additionally, stakeholder

interviews contextualize the challenges and opportunities that exist for low-income people who want to invest in solar, especially as they relate to energy democracy. Finally, an overarching analysis tying together the financial tools and their ability to advance equity and energy democracy goals is found in the results and discussion sections below.

3.1 Household Solar Cost Analysis

As previously mentioned, the financial barriers that exist for solar adoption often prevent low-income residents from participating in the transition to renewable energy, making the shift inequitable and inaccessible to many. In order to contextualize these problems in Seattle, two example households of four people are used to understand the cost burdens of implementing solar versus the cost burdens of continuing to pay current utilities. The first household represents an average income household in Seattle, based on the Area Median Income (AMI) estimates from the U.S. Department of Housing and Urban Development. As of 2017, the HUD rounded estimate (to the nearest $100) is $90,000 for a Seattle household of four people, according to the Seattle Housing Authority.[126] The second household represents a low-income household, which is represented with a yearly income of 80% of the AMI, the upper limit of low income classification used by the City of Seattle to qualify for low income housing. In the Seattle area, 80% of AMI is $72,000.[127] The upper limit of low-income residents is used for this thesis based on the assumption that residents with lower annual incomes may not be in a position to prioritize solar energy due to other more pressing costs or concerns related to low-income status and financial and/or housing instability.

[126] Seattle Housing Authority. "Income Level - Low Income Public Housing." Accessed May 2018. https://www.seattlehousing.org/housing/sha-housing/eligibility/income-level-low-income-public-housing.
[127] Ibid.

The average household residential electricity bill is about $59.75 per month, according to Seattle City Light public records, among the lowest in the country, in part due to the hydroelectric sources.[128] This data helps determine the percentage of yearly income that goes toward electricity for both the example low-income household and the example average-income household. This information is compared to potential economic costs and savings for the same households using solar as opposed to electricity provided by Seattle City Light.

Table 1 depicts a template that can offer insight into the costs for low-income residents in terms of financial affordability based on existing incentives and the ability to net meter. The data, revealed in Chapter 4, is from solar quotes given by Project Sunroof and Seattle-based solar installers based on a real single family home in Seattle. Table 1 examines the affordability of solar for low and average-income households, showing the upfront costs of purchase and installation with and without the incentive. This cost is then translated into a percentage of yearly income for both sample households. An amortization based on a home equity loan repayment time of 10 years (the average payback period for solar) with a 5% interest rate is used to better compare monthly costs to the current monthly utility costs.

Solar array size (kW)	Cost of purchase and install	Cost of purchase and install	Percentage of yearly income for low-income household		Percentage of yearly income for average-income household	
	without incentives	with incentives	without incentives	with incentives	without incentives	with incentives
3						
4						
5						
6						
Averages						

Table 1: Example table of costs for solar array for a single family home in Seattle.

[128] Seattle City Light. "Households involved in Energy Conservation Programs." Public records request. May 2018.

In order to generate a more accurate cost estimate, an existing single family home in Seattle is used for gathering solar quotes and information on energy use. This single family home is not representative of all single family homes in Seattle, but it does allow for a more accurate cost analysis when used as a proxy. The sample home, located near downtown Seattle in the Central District neighborhood can be seen in plan view in Figure 1.

Figure 1: Example house used for household and financial tool analysis.[129]

As seen in Figure 1, the single family home has a south-facing roof, which is ideal for solar. The home does not have any significant shading from nearby trees, buildings, or other objects. According to a Seattle City Light bill from this address, this house consumes about 3,285 kWh per year. This amount will be compared to potential kWh production according to solar quotes in the results section below.

3.2 Financial Tool Equity Analysis

After comparing the cost of solar purchase and installation on a single family home in Seattle, and the economic impact that it might have on low and average-income households, the financing tools are compared in their ability to advance goals related to equity and energy

[129] Google Maps, "Seattle, WA." Map. April 2018. Web.

democracy. Using information gathered in the literature review, as well as information from stakeholders, the financial tools will be analyzed based on their ability to meet equity and energy democracy criteria. Public control and the ability for the financial tool to resist, reclaim, and restructure existing energy systems are analyzed in this section, as shown in Table 2. Based on interviews with stakeholders as well as information gathered from reports and outlined in the literature review, each financial tool element (including net metering, federal ITCS, neighborhood solar and bulk purchasing, and community solar programs) is analyzed based on its ability to meet criteria for public controlled and the energy democracy goals of resist, reclaim, and restructure.

An existing table from Burke and Stephens provides context for the ways in which these tools will be analyzed, based on interviews with stakeholders, outlined below, and the author's analysis based on interviews and existing literature. An intended outcome will be considered satisfied if at least half of the interviews see the financial tool as helping achieve the intended outcome. As seen in Table 2, Burke and Stephens offer elements that serve the goals of resist, reclaim, and restructure within energy democracy.

Goals for energy democracy	Intended outcomes
Resist the dominant energy agenda	• Fossil fuels remain in the ground. • Expansion of fossil fuel infrastructure and development of extreme forms of energy and extraction stops. • Land grabbing for large-scale renewables ceases. • Fossil fuel subsidies end. • Privatization and marketization of energy sector halts. • Undermining of climate protection stops. • The most dependent on fossil fuel industries protected, especially labor. • Public resources shift away from fossil fuels. • Public legitimacy of the fossil fuel industry is reduced. • New social alliances are created (e.g., unions, environmental groups, municipalities).
Reclaim the energy sector	• Energy corporations democratize and localize. • Social/public control of energy production and consumption normalizes. • Parts of the energy sector that have been privatized or marketized return to public control. • Principles of public interest within and democratic control over publicly-owned energy companies is restored. • New energy companies, ownership models and financial investment systems under social and public control develop.
Restructure the energy sector	• Energy sector moves away from the profit motive. • Energy access and assets are shared broadly and community wealth-building is supported. • Energy systems are governed as a commons. • Community power and capacity to control energy systems strengthen. • Emphasis shifts from growth to wellbeing, sufficiency and environmental quality. • Economic and political power is decentralized and distributed. • Capacity for energy planning increases. • Geopolitics of energy supports global cooperation and peace over competition and conflict. • Solidarity, inclusion and open, democratic participation advances. • Workers, low-income communities and communities of color hold central positions within energy systems. • An understanding of the energy sector as interdependent within the natural environment pervades.

Table 2: Criteria for Resist, Reclaim, and Restructure, according to Burke and Stephens.[130]

Net metering and virtual net metering, federal ITCs, neighborhood solar and bulk purchasing, and community solar programs are evaluated based on the criteria offered by Burke and Stephens. Several community stakeholders in the solar industry and associated non-profits are asked about these tools and their ability to advance the goals of energy democracy. Their responses can be found in the results section, and the subsequent discussion section compares their responses to existing literature.

3.3 Interviews with Stakeholders

Stakeholder interviews supplement information gathered from literature. Several stakeholders from the City of Seattle and non-profits supplement the literature and other publicly-available information. These interviews were conducted in person and over the phone between December 2017 and May 2018. The interviews were open-ended with some pre-written questions

[130] Burke and Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions."

used to guide discussion. Interviews lasted between thirty minutes and two hours. Interviewees signed consent forms per University of Washington Institutional Review Board (IRB) standards, and have consented to have information, including direct quotes, used in this thesis.

The interviewees for this thesis, in order of date interviewed, are: Anya Schoolman, Executive Director and Founder of Solar United Neighbors (Washington, D.C.); Jess Harris, Green Building Program Manager at City of Seattle; Steve Gelb, Director of Emerald Cities Seattle; and Mikhaila Gonzales, Project Manager at Spark Northwest. These interviewees were either strategically selected early in the research process, or suggested by interviewees through "snowball sampling". In addition to the above listed interviewees, solar installers were informally interviewed via email and over the phone in order to provide quotes and estimates related to solar for the Seattle single family house. A more comprehensive list of interviewees, including date interviewed, can be found in Appendix A.

Interviewees also supplement information gathered from existing reports and other documents. In analyzing these reports and asking for elaboration or clarification from interviewees when possible, Table 1 and the financial tool equity analysis are more accurately completed, providing important information for the results section.

3.4 Hypothesis

Understanding the relationship between increasing access to solar for low and middle-income homeowners and advancing energy democracy and equity is a complex process. While there is extensive literature related to solar financing and some literature related to energy democracy and equity in renewable energy, the marriage of the two is not commonly found in academic literature. In attempting to answer the research questions, the literature review informs a few hypotheses.

Regarding the first research question related to barriers to solar for low-income residents, I hypothesize that upfront costs are the greatest barrier to solar, based on several sources from the literature review. However, it is likely that combinations of the financial tools and incentives increase access to solar by lowering the upfront costs related to purchase and installation. I predict that net metering will likely not help increase access to solar for low-income residents because only surplus energy is sold back to the grid in exchange for energy credits, which makes the financial incentive relatively ineffective unless households generate more solar energy than they consume to offset bills during time when solar is not available. I also hypothesize that federal ITCs are a strong strategy for increasing access to solar because they can lower upfront costs by 30%. Similarly, neighborhood solar and bulk purchasing are also likely to be a strong strategy for increasing access to solar due to the security that comes with buying solar alongside neighbors as well as lowered upfront costs. Finally, I hypothesize that community solar program buy-in is a somewhat effective strategy in increasing access to solar with some of its limitations including the lack of existing community solar arrays in Seattle.

With regards to advancing energy democracy, I predict that neighborhood solar and bulk purchasing and community solar programs are the most likely to support goals of resisting, reclaiming, and restructuring. Net metering is likely less supportive of these goals due to its reliance on existing energy and utility companies. Finally, federal ITCs are predicted to be the least in support of the energy democracy goals because while they do help lower upfront costs, they do not change the structure of ownership. As a result, it is predicted that many of the financial tools do not overlap in their ability to decrease barriers while simultaneously advancing the energy democracy agenda. This ultimately leads to the hypothesis that there is a disconnect between tools

and strategies that can best increase access to solar for low and middle-income residents in Seattle and tools and strategies that can best advance goals related to democracy.

The following three sections, results, discussion, and conclusion explore the findings of the research, their impacts on this field of study, and what is to come in studies related to solar access, equity, and energy democracy. The immediately following chapter reveals the results and findings based on the above outlined research methods and previous literature review section.

CHAPTER 4: RESULTS

The purpose of this thesis is to answer two main research questions related to the existing costs and barriers to solar for low and average-income residents in Seattle and analyzing solar financing strategies through the frameworks of equity and energy democracy. This section reveals the findings from a household cost analysis, Seattle City Light public records request, and interviews with solar industry stakeholders. The original hypotheses are revisited following the results shown below.

After interviewing stakeholders, analyzing quotes from Seattle-area solar installers, several findings and themes emerged. This section details the results related to household solar costs, using the example household and average and middle-income salaries. Additionally, findings from the financial tool and equity analysis are explained below. A more robust discussion of these results related to their meaning and significance to Seattle and other cities can be found in the subsequent discussion section.

4.1 Household Solar Costs Results

The following results are based on the proxy for an average Seattle home, a single family home in Seattle, as seen in Figure 1 above in Chapter 3. This house uses approximately 3,285 kWh per year on average, according to the Seattle City Light bill. With the average Seattle household electricity bill of $59.75 per month, or $717 per year, households of different incomes and sizes pay different percentages of their income on utilities.[131] Assuming the low-income household's annual income is $72,000 per year, or $6,000 per month, the upper-limit low-income household (80% AMI), spends about one percent (.009) of its monthly income on electricity. Meanwhile, an average-income family of four, has an income that is the AMI--$90,000 per year, or $7,500 per

[131] Seattle City Light. "Households involved in Energy Conservation Programs." Public records request. May 2018.

month. In this case, the average-income family spends just under one percent of its income on electricity each month. While these numbers are far lower than the 13% of income that over 175,000 low-income families in Washington spend on energy, it can still be a cost burden for some residents. Additionally, the information provided by Seattle City Light is an average electricity bill for households of all sizes because they do not track residential bills by number of residents.[132]

Approximately 2,987 residencies in Seattle have solar arrays, according to data provided by Seattle City Light.[133] While this is still a small percentage of the total number of Seattle residents, it does indicate general interest in rooftop solar. On average, customers who were involved in net metering generated about 21,000 MWh in an average year, which would be enough to power about 6,392 proxy houses.[134] An additional 1,287 households participate in the Community Solar program.[135]

Average production from arrays provides important data points, but a solar analysis based on an individual household is more relevant for understanding solar production at the household level. Based on solar quotes from several different installers and Google Project Sunroof, Table 3 below shows potential costs of solar with and without incentives for the proxy house. Table 3 also shows what percentage of monthly income the cost would be for low and average-income households in Seattle based on an amortization calculation. Quotes were offered for solar arrays between 3 and 6 kW and then an average per kW was used to estimate costs for each solar array size. Additionally, the cost of purchase and install with incentives was calculated using the 30% federal ITC rebate. An additional incentive in net metering is offered to residents who use solar

[132] Ibid.
[133] Ibid.
[134] Ibid.
[135] Ibid.

panels manufactured in Washington, however, this is not reflected in the upfront cost of purchase and installation.

The amortization estimates for the different sized solar arrays with and without incentives were calculated using a home equity loan amortization calculator.[136] The calculation used a 5% interest rate and a 10 year payback period, which is consistent with average payback periods for solar in the Seattle area. By amortizing the initial solar costs, rather than paying one upfront sum, homeowners can more accurately compare costs between the monthly loan amount and monthly utility bill to make an informed decision regarding solar purchase and installation. On the following page, Table 3 shows the results of amortizing the upfront costs for a 3, 4, 5, and 6 kW array as they compare to the monthly income of low and average income homeowners.

[136] Mortgage Calculator. "Amortization Schedule Calculator," Amortization-calc.com. Accessed June 06, 2018. http://www.amortization-calc.com/.

Solar array size	Middle income			Low income		
	without incentives	with incentives		without incentives	with incentives	
3kW	$90,000.00	$90,000.00		$72,000.00	$72,000.00	**annual income**
	$10,226.50	$7,170.80		$10,226.50	$7,170.80	**system cost**
	$108.00	$76.00		$108.00	$76.00	**monthly home equity payment (from calculator)**
	12	12		12	12	**months in the year**
	$7,500.00	$7,500.00		$6,000.00	$6,000.00	**monthly income**
	1.44%	1.01%		1.80%	1.27%	**percentage of monthly income for home equity payment**
4 kW	$90,000.00	$90,000.00		$72,000.00	$72,000.00	**annual income**
	$13,635.33	$9,561.07		$13,635.33	$9,561.07	**system cost**
	$145.00	$101.00		$145.00	$101.00	**monthly home equity payment (from calculator)**
	12	12		12	12	**months in the year**
	$7,500.00	$7,500.00		$6,000.00	$6,000.00	**monthly income**
	1.93%	1.35%		2.42%	1.68%	**percentage of monthly income for home equity payment**
5 kW	$90,000.00	$90,000.00		$72,000.00	$72,000.00	**annual income**
	$17,044.17	$11,951.34		$17,044.17	$11,951.34	**system cost**
	$181.00	$127.00		$181.00	$127.00	**monthly home equity payment (from calculator)**
	12	12		12	12	**months in the year**
	$7,500.00	$7,500.00		$6,000.00	$6,000.00	**monthly income**
	2.41%	1.69%		3.02%	2.12%	**percentage of monthly income for home equity payment**
6 kW	$90,000.00	$90,000.00		$72,000.00	$72,000.00	**annual income**
	$20,453.00	$14,341.61		$20,453.00	$14,341.61	**system cost**
	$217.00	$152.00		$217.00	$152.00	**monthly home equity payment (from calculator)**
	12	12		12	12	**months in the year**
	$7,500.00	$7,500.00		$6,000.00	$6,000.00	**monthly income**
	2.89%	2.03%		3.62%	2.53%	**percentage of monthly income for home equity payment**
Average	$90,000.00	$90,000.00		$72,000.00	$72,000.00	**annual income**
	$15,339.75	$10,756.21		$15,339.75	$10,756.21	**system cost**
	$162.75	$114.00		$162.75	$114.00	**monthly home equity payment (from calculator)**
	12	12		12	12	**months in the year**
	$7,500.00	$7,500.00		$6,000.00	$6,000.00	**monthly income**
	2.17%	1.52%		2.71%	1.90%	**percentage of monthly income for home equity payment**

Table 3: Solar costs estimates for rooftop solar arrays in Seattle, Washington

As seen in Table 3, the costs for purchase and installation for a solar array between 3 and 6kW without incentive ranges between about $10,200 and $20,400 with an average cost of $15,300, rounded to the nearest hundred dollars. With incentives, these solar arrays would cost between about $7,100 and $14,300 with an average cost of about $10,800. Purchase and installation without incentives is, on average, about 2.17% of a monthly income for a middle-income household of four people that earns $90,000 annually. With incentives, purchase and installation is on average 1.52% of yearly income for middle-income households. Comparatively, the cost of purchase and installation for a 3 to 6kW solar array is on average 2.71% of a low-income household's yearly income of $72,000 without incentives and about 1.9% on average with incentives. The significance of these findings is further explored in Chapter 5.

4.2 Financial Tool Analysis Results

Interviews with stakeholders in the public and non-profit sectors provided important insight into the barriers and opportunities of solar as they relate to cost and equity. While over ten people in the solar industry were contacted for interviews, only four were available for in depth interviews and discussions: Anya Schoolman, Executive Director of Solar United Neighbors (SUN); Jess Harris, Green Building Program Manager at City of Seattle; Steve Gelb, Seattle Local Director at Emerald Cities Collaborative; and Mikhaila Gonzales, Project Manager at Spark Northwest. In addition to these interviews, a conversation among approximately twenty solar industry employees across Washington state in a meeting regarding community solar and increasing access to solar for low-income residents took place on May 11, 2018 and adds to the research for this thesis. Participants from this meeting are cited as anonymous employees in the solar industry.

The interviewees listed the following as major barriers to solar among low and average-income residents: lack of transparent information related to solar and solar policy; long and

complicated solar installation processes; existing laws, regulations, and policies; a lack of efficient technology; and problems related to inequity and political and financial power. Additionally, interviewees discussed the benefits and challenges of net metering, the federal ITC, community/bulk purchasing models, and community solar programs. Finally, they responded to questions about energy democracy and how different financial tools can or cannot advance the ideas of resist, reclaim, and restructure. The following sections provide an in-depth discussion of themes and responses that emerged from the interviews.

4.3.1 Perceived Barriers to Solar

It is well documented that those with greater income and capital have greater access and opportunities to solar, with Seattle being no exception. As indicated in "The Green Divide" from Northwest SEED (now Spark Northwest), the median income for homeowners in King County that installed solar in 2015 was approximately $90,000.[137] Several barriers to solar purchase and installation exist, particularly among lower economic groups. These barriers can be grouped into the following categories: legal and regulatory, installation process-based, political, and technological. In understanding the barriers to solar, policymakers, planners, and even individual residents can advocate for changes to reduce or eliminate these barriers.

One major barrier discussed by multiple people interviewed is the difficulty of understanding solar legislation and regulations, which is a legal and regulatory barrier. While understanding legislation may not seem directly relevant to purchasing and installing solar, the complexity of legislation can deter residents who are interested in investing in solar. For this reason, understanding legal and regulatory barriers is paramount to advancing energy democracy and reducing obstacles to accessing solar energy.

[137] Spark Northwest. "Access Solar." Accessed May 07, 2018. https://sparknorthwest.org/projects/solar/access-solar/.

4.3.2 Legal and Regulatory Barriers to Solar

Anya Schoolman, Executive Director of SUN, explains that a major barrier to solar is the lack of transparency in solar legislation. Schoolman says that "the whole [solar energy industry] is incredibly opaque", saying that those who have the ability to create legislation and ask for citizen input do not end up facilitating input from residents. As a result, language in energy policy and regulation is difficult to understand for the average resident.[138]

A lack of transparency in solar energy policy, as well as inaccessible language, can prevent residents from initiating changes that can increase access to solar for low and average-income residents. In Washington, D.C., where SUN is headquartered, residents involved in solar organizations worked to pass four major bills in order to make solar more attainable and affordable for residents, according to Schoolman.[139] However, people involved in the solar industry and legal profession donated their time to help initiate these changes, which is a form of social and political capital that is not available to all residents.[140] Similarly, at the city and state level in Seattle, a lack of transparency in policy can be a barrier for those looking to purchase and install solar, according to Mikhaila Gonzales of Spark Northwest. Gonzales says that because there is no transparency for state initiative comments, with regards to how they are or are not addressed during the comment period, it is difficult to know the impact that residents' comments have on changing legislation.[141] Related to Schoolman's comments, Gonzales mentioned that financing tools for solar are critical, but the use of them is often inaccessible and opaque.[142] The implications of this barrier is further discussed in the discussion section below.

[138] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[139] Ibid.
[140] Ibid.
[141] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[142] Ibid.

In addition to not being accessible or transparent, existing laws and regulations can be barriers to adopting solar whether the desired solar source is on a resident's rooftop or part of a multi-family housing or community solar project. Nearly all of those interviewed say that some existing laws or regulations were barriers to adopting solar. This barrier can be evaluated on the individual household level as well as the multi-family or community solar program level.

At the household level, Schoolman says that fixed-charge bills or minimum utility bills can be a barrier to adopting solar. In this case, residents are charged a certain amount of money each month even if the solar that they produce offsets their use by 100% or more.[143] In addition to minimum bills, some utilities set net metering caps, which limits the amount of credits that a resident can use to offset their utility bills. In this case, net metering caps, as determined by the utility company, can be unnecessarily low, in part because utilities do not want to manage net metering, particularly if residents would otherwise have the opportunity to fully offset their energy bill through energy that they produce from rooftop solar.[144]

At the multi-family building scale, numerous regulations make it difficult for developers, landlords, and affiliated organizations to implement rooftop solar. Participants in the community solar meeting discussed challenges related to permitting, particularly that some state-level incentives for neighborhood solar cannot be applied until electrical permits are applied.[145] Under federal regulation, a for-profit LLC must sponsor rooftop solar on multi-family housing properties.[146] This can be a costly process, particularly when mostly non-profit entities are involved in building operation and management, as is the case in one particular partnership in Seattle, a collaboration with Capitol Hill Housing (CHH) and Emerald Cities Collaborative (ECC).

[143] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[144] Ibid.
[145] "Community Solar Meeting." Interview by author. May 11, 2018.
[146] "Interview with Steve Gelb." Interview by author. April 9, 2018.

In a partnership between Capitol Hill Housing and Emerald Cities Collaborative, under the purview of the Capitol Hill EcoDistrict initiative, the two non-profit organizations are in the process of installing solar on a low-income property owned by CHH.[147] Under federal rule, non-profit organizations are not allowed to sponsor solar. As a result, CHH and ECC created a limited liability corporation (LLC) in order to legally sponsor the project. Legal costs for setting up and operating LLCs can be cost prohibitive for organizations that would otherwise be willing to fund solar for multi-family and/or low-income housing developments. As a result, this federal regulation is a major barrier for increasing access to solar for low-income residents. Steve Gelb, of ECC, says that much of the planning process around this particular property involved making policies and systems fulfill roles and requirements that they were not originally intended to fill. More broadly, the existing legislature does not specifically address low-income housing in solar initiatives, which increases the disconnect between the housing industry and the solar industry.[148]

The CHH property in question also has to involve 10 participants in order to use state community solar credits.[149] While ECC and CHH did fulfill this requirement, it does bring into question the logistics for attaining state community solar credits in a building with residents who may not have the means or capacity to be involved in such a project in a meaningful way. This barrier, as it relates to social capital, is further explored in the discussion section.

Just as multi-family buildings face legal and regulatory barriers to solar, so too do households working at the neighborhood level. Schoolman cites the legal and regulatory approach as being difficult, with decision-making on the community scale working at a slow pace with regards to neighborhood solar.[150] In a few instances, groups of neighbors that otherwise planned

[147] Ibid.
[148] Ibid.
[149] Ibid.
[150] "Interview with Anya Schoolman." Interview by author. December 20, 2017.

to start solar co-operatives ended up pushing for rooftop solar in groups, as unofficial co-operatives. In some cases, these acted as *de facto* co-operatives, while others were co-operatives in name only, choosing not to undergo the complicated processes of forming and maintaining a true co-op.[151] However, even when residents are able to form groups to obtain rooftop solar, more barriers exist throughout the process.

4.3.3 Installation Barriers to Solar

Residents who are able to overcome the legal and regulatory barriers, either as individual homeowners or as a group with or without outside expertise, still face barriers on the path to solar installation. Citing the difficult legal and regulatory process, among other reasons, Schoolman says that many residents "burnout" before neighborhood solar projects get off the ground. In some cases, a community solar project will be implemented, but Schoolman says that, among community groups involved with SUN, only forty percent of people who begin the process of involvement with a given neighborhood solar project will actually end up installing solar.[152]

4.3.4 Political Barriers to Solar

While many of the legal and regulatory barriers can still be overcome, some political barriers at the city, state, and federal level, stand in the way of residents accessing solar. At the city level, changing mayoral priorities as well as changing popular opinion and priorities within Seattle can be a barrier to solar access. Jess Harris, of the City of Seattle, says that while Seattle has a reputation of being an environmentally-focused city, addressing climate change is not a major political priority at the moment, as the issue has been eclipsed by housing affordability (not including green energy access) and transportation.[153]

[151] Ibid.
[152] Ibid.
[153] "Interview with Jess Harris." Interview by author. February 8, 2018.

Political incentives also play a major role in the implementation of solar at a variety of scales. Schoolman says that, nationwide, many utilities implement net metering caps, which can dissuade residents from installing solar. According to Schoolman, a main reason for the existence of these net metering caps is because utility companies don't have strong incentives to make solar more accessible to residents. Paired with the difficulty of implementing and managing net metering programs, this can be a reason that utility companies are not among the leaders pushing for residential solar.[154]

At the federal level, building owners and property managers of HUD properties and Section 8 housing do not have an incentive to retrofit existing buildings with solar because the federal government pays the utility bills, according to Gonzales.[155] Without a financial incentive to install solar, property owners are not likely to take initiative in this realm, even if residents have a general demand for renewable energy.[156] Also at the federal and state level, politically powerful actors can have major influence over energy policies. Connecting the inequities at the household level back to the political structures that are at play in federal and state energy policy, Schoolman says that powerful actors such as the Koch brothers and the Heartland Institute are in the business of designing energy bills that can be replicated in many different states and regions that throttle rooftop solar, to the detriment of residents and organizations that would otherwise implement residential solar.[157]

Several of the interviewees also cite general economic inequities as a major barrier to solar. Gonzales describes the process of implementing solar as capital and technically intensive. Citing the "Green Divide" figure of the median income of residents who installed solar in 2015 in King

[154] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[155] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[156] Ibid.
[157] "Interview with Anya Schoolman." Interview by author. December 20, 2017.

County as $90,000, Gonzales mentions that wealth and housing stability are currently necessary for residents who want to install solar. Those who are unable to plan for and deal with uncertainties, related to housing stability and other life circumstances, are unlikely to be in a position of implementing solar.[158] This sentiment is echoed by Gelb, who mentions that many renters who would like to participate in single or multi-family solar programs are typically not in the same building long term, which is a barrier to solar access.[159]

Ultimately, race and class stratification that is prevalent in American society is also a major barrier to solar, as resources and social and political power are often distributed across race and class lines. Because people of color and low-income people do not necessarily have the same wealth and class standing as white people, they are often less likely to be able to use the existing tools to install solar.[160] Furthermore, a non-profit industrial complex, which incentivizes the continuation of non-profits, sometimes at the expense of the people that it serves, can be a barrier to solar for low-income residents.[161] To this point, Gonzales says that understanding who is able to wield financial tools and incentives is often more important than the tools themselves, as the way that they are issued and dispersed is not equitable.[162] The complex relationships between race, class, wealth, and power as they relate to solar access is explored more thoroughly in the discussion section.

4.3.5 Technological Barriers to Solar

While some residents may be able to overcome legal, regulatory, and political barriers to solar, there are still some technological barriers that exist. Harris says that it can be difficult to

[158] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[159] "Interview with Steve Gelb." Interview by author. April 9, 2018.
[160] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[161] Ibid.
[162] Ibid.

control how much energy is put back into the grid, which supports the previously mentioned notion that utilities implement net metering caps as a way to avoid managing the net metering system.[163] Similarly, Harris says that cities can have difficulty with net metering infrastructure. As mentioned in the literature review, net metering requires a meter that can work "backwards", monitoring the amount of energy that is produced by the rooftop and then put back into the grid. While Seattle does offer net metering, not all houses are equipped with the right infrastructure for solar net metering.

Just as some houses do not have net metering infrastructure set up, many older stock houses have large energy demand. While previously mentioned programs such as LIHEAP and ELIA can help homeowners with energy bills, it does not always make sense to install solar if the house has not been retrofitted for energy efficiency.[164] While other technological barriers may exist, net metering technology and energy efficiency were the main technological barriers discussed by interviewees.

4.4 Net Metering Financial Tool Results

As a financial tool, there are several benefits to net metering, which allows residents with solar panels to receive energy credits for the solar energy that they produce. Schoolman says that if you are able to fully net meter, it makes sense financially and "pencils out" to install solar.[165] Schoolman says that usually within a year, residents can offset their energy consumption if they are able to get retail price for net metering.[166] This is supported by several of the solar quotes offered in the previous section. One anonymous solar installer estimated that the proxy house would generate slightly more than 100% of its energy demand, indicating that excess energy could

[163] "Interview with Jess Harris." Interview by author. February 8, 2018.
[164] Ibid.
[165] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[166] Ibid.

count toward net metering credits.[167] In multi-family housing units, such as the Capitol Hill Housing and Emerald Cities Collaborative project in Capitol Hill, the proposed solar array will have net metering. However, according to Gelb, surplus money from net metering will go to a community fund for resident services rather than the individual residents themselves.[168]

4.4.1 Net Metering and Equity/Energy Democracy

As a component of advancing energy democracy goals, net metering has benefits and challenges, according to the interviewees. Several comments suggested that net metering can help advance goals of resist, reclaim, and restructure, which can be found in Figure 2 in Chapter 3. Schoolman's comments related to net metering and the opportunity for residents to fully offset their use from the power that they generate supports a few of the criteria for the goal of reclaiming the energy sector including normalizing social/public control of energy production, returning parts of the energy sector that have been privatized or marketized to public control, and creating new ownership models for energy.[169] With regards to Rawls' Second Principal and other equity measures, net metering does not fully achieve these goals. In the CHH/ECC project, net metering does not generate money for residents directly, and, because the residents in this building are qualified low-income, Rawls, Beatley, Lucy, and others mentioned in the theory section of the literature review may not find the mechanism of net metering lacking as a tool for equity. Further explanation of these results, and their implication for Seattle residents, can be found in the discussion section below.

4.5 Federal ITC Financial Tool Results

[167] "Interview with Anonymous Solar Installer." Interview by author.
[168] "Interview with Steve Gelb." Interview by author. April 9, 2018.
[169] Ibid.

Federal ITCs also offer several challenges and benefits as a financial tool for increasing access to solar among low and average-income residents. As previously mentioned, the federal ITC offers a 30 percent discount on solar panel purchase costs, which lowers the upfront costs for residents who want to install solar. Additionally, sponsoring LLCs can help organizations purchase solar for multi-family housing. In the case of the ECC/CHH development, the LLC gets tax credits that allow the solar to be paid for in eight years, after which the building owner owns the solar.[170] While this can make solar more affordable for multi-family housing, the legal and regulatory barriers to creating a sponsoring LLC can still make it difficult for low-income multi-family housing to install solar, particularly if the housing is otherwise managed by a non-profit organization, in this case, Capitol Hill Housing.[171]

Gonzales also spoke to the benefits and challenges of federal ITCs as a financial tool. Gonzales says that while a 30 percent incentive is helpful, some residents choose to forgo the ITC application process because it is complicated.[172] Although the ITC lowers upfront costs, it is not necessarily an accessible tool.

4.5.1 Federal ITCs and Equity/Energy Democracy

With regards to equity and energy democracy, federal ITCs have a few strengths and weaknesses according to the interview responses. Because they are federal incentives, ITCs shift resources away from fossil fuels, which is a criterion for the resist arm of energy democracy.[173] Beyond this goal, federal ITCs do little to advance energy democracy, as the incentive is helpful,

[170] "Interview with Steve Gelb." Interview by author. April 9, 2018.
[171] Ibid.
[172] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[173] Ibid.

but not necessarily great enough from the perspective of some residents to justify the process that they must undergo in order to receive the financial benefits.[174]

4.6 Neighborhood Solar and Bulk Purchasing Financial Tool Results

As a financing tool, neighborhood solar and neighborhood bulk purchasing of solar panels allows residents to join together for discount rates and co-operative decision-making. Structurally, community solar can be set up in a variety of different ways from formal co-operatives and group decision making among single family homeowners to top-down solar installation for multi-family buildings. Schoolman says that due to the challenging legal and regulatory approaches to solar, residents often cooperate and engage in decision making and bulk purchase as a group, but ultimately enter individual contracts for each home for the sake of simplicity.[175]

4.6.1 Neighborhood Solar and Bulk Purchasing and Equity/Energy Democracy

As a strategy for equity and energy democracy, neighborhood solar and neighborhood bulk purchasing have potential according to the stakeholders interviewed. Both Schoolman and Gonzales say that strong community solar initiatives typically have an anchor community group on non-profit, which can build upon existing community networks.[176] [177] In the case of the CHH project, in conjunction with the Capitol Hill EcoDistrict certification, anchor communities are beneficial to starting and sustaining equitable community solar, according to Gonzales.[178] Schoolman's SUN projects also require a local community partner, which can help involve more residents in the cooperatives.[179]

[174] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[175] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[176] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[177] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[178] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[179] "Interview with Anya Schoolman." Interview by author. December 20, 2017.

Building social capital and strengthening community ties, neighbors can meet and rely on one another during the planning and implementation process.[180] Gonzales says that this creates opportunities for community organizing and bringing neighbors together, which helps advance energy democracy goals.[181] Under the resist branch of energy democracy, these community ties created or strengthened by community solar and related co-ops promote the outcome of creating new social alliances. Additionally, neighborhood solar can help achieve the outcome of social/public control of energy production and returning parts of the energy sector to public control under the reclaim branch. Finally, neighborhood solar helps strengthen community power, and sharing community energy access and assets, which are desired outcomes under the restructure branch of energy democracy, according to Burke and Stephens.[182]

While neighborhood solar has many advantages, Gonzales also emphasizes that bulk purchasing and organizing often builds wealth and capacity on top of existing wealth and capacity, which suggests that lower-income residents may not have the same opportunities to engage in these systems and structures due to a lack of resources.[183] This is in contrast to Rawls' Second Principal, in that it is an advantage to those who already have wealth, resources, and capacity. This concept will be further explored in the discussion section.

At the multi-family scale, Gelb says that using state community solar credits requires a minimum of 10 participants, which requires building owners to engage residents in the contract.[184] While this does engage residents more than a traditional utility system might, it does not go so far

[180] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[181] Ibid.
[182] Ibid.
[183] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018
[184] "Interview with Steve Gelb." Interview by author. April 9, 2018.

to change the governing system of energy in the multi-family buildings, falling short of Burke and Stephen's restructuring goal of governing energy systems as a commons.[185]

4.7 Community Solar Programs Financial Tool Results

Seattle-run community solar programs were only minimally discussed during the interviews with Seattle stakeholders, perhaps in part because they are not found widely across Seattle. Additionally, each solar array can only support a certain amount of shares, purchased by residents, either homeowners or renters, in Seattle. To date, Seattle has five community solar arrays, and two which are nearly completed, shown on the map on the following page, in Figure 2.

[185] Ibid.

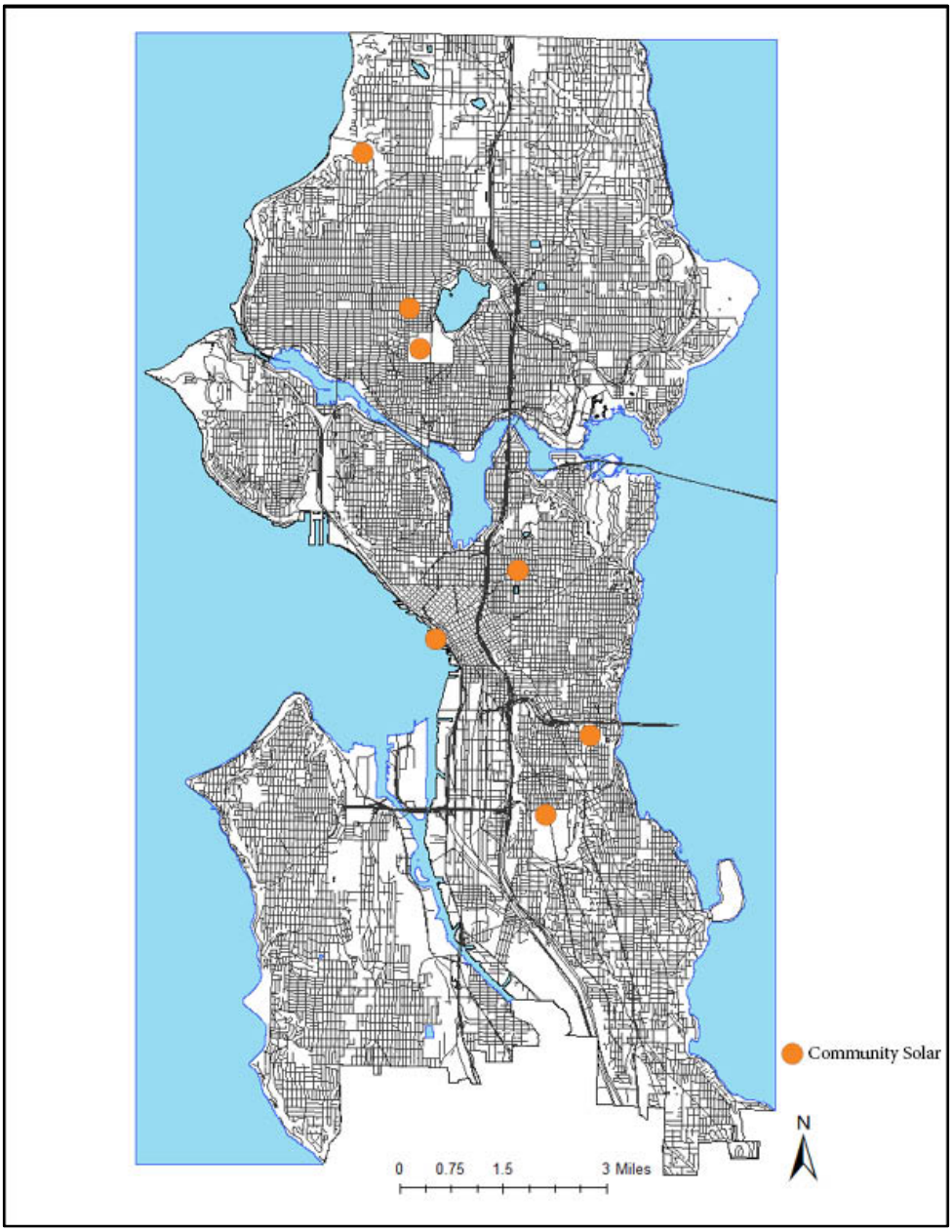

Figure 2: Map of Community Solar in Seattle, created by the author.

As a financial tool, community solar programs offer residents the opportunity to invest in solar even if they do not have a solar viable roof. One advantage of the community solar program is that residents in Seattle can choose how much solar they want to invest in based on the number of shares they want to purchase. Through the community solar share program in Seattle, the cost

is $150 for a solar unit, and to date, all solar units have been purchased by Seattle residents.[186] After purchasing these shares, residents receive credit to their energy bills proportionate to the number of shares they have purchased, based on the productivity of the solar array. Community solar programs can also have the advantage of helping with grid distribution, if they are not connected to a centralized grid, which is preferable to a concentrated grid, according to Schoolman.[187] Participants in the community solar session also say that more small scale solar systems that are accessible to renters are coming online across the state.[188]

4.7.1 Community Solar Programs and Equity/Energy Democracy

As a tool for equity and energy democracy, community solar programs do advance some desired outcomes. Under the resist branch of energy democracy, community solar programs can help shift public resources away from fossil fuels and toward renewable energy, and also create new social alliances, just as community solar does for neighborhoods. Community solar programs can also normalize social and public control of energy production and consumption, which is a desired outcome under the reclaim branch, according to Burke and Stephens. Finally, the availability of community solar program arrays throughout the city help advance the goals for restructuring, increasing the capacity for energy planning.[189]

4.8 Potential Opportunities for Solar Access

In addition to discussing the barriers to solar and the strengths and weaknesses of different solar financing tools in their ability to increase access to solar and advance energy democracy goals, the stakeholders interviewed also offered their ideas related to the future of solar in Seattle.

[186] Seattle City Light "Community Solar FAQs." Accessed May 09, 2018. http://www.seattle.gov/light/solarenergy/commsolarfaq.asp.
[187] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[188] "Community Solar Meeting." Interview by author. May 11, 2018.
[189] Ibid.

Promising opportunities suggested by the stakeholders fall into the categories of new technology, changes to laws and regulations, programmatic solutions, and power restructuring.

In the realm of new and emerging solar technology, Harris says that better efficiency and integrated rooftop materials can help decrease barriers.[190] Gelb also recommends looking at new technologies, including community solar farms, which could be larger-scale grids that are still distributed rather than concentrated.[191] The ways in which these technologies may advance energy democracy and equity, and decrease barriers to solar, is discussed in detail in the discussion section.

Laws and regulations can also be improved, according to all of those interviewed. The stakeholders interviewed specifically recommended on-bill financing, carve outs for low-income residents in community program solar regulation, new building code provisions, and taxes and initiatives that may be able to generate revenue for solar including the proposed Initiative 1631 and the so-called Seattle "head tax", formally known as the Progressive Tax on Business. Relatedly, programmatic solutions were also discussed. Collaborative programs that engage the housing industry and the solar industry were discussed by interviewed stakeholders. Participants in the community solar meeting also recommend engaging community organizations earlier in the design process. Relatedly, solar industry employees at the meeting recommend forming a better understanding of how communities of color and immigrant communities have interacted with utility companies in the past and how they prefer to do so in the future in order to foster trust and social capital.[192] Additionally, Gonzales and others suggest land trust engagement as a potential solution.[193] Finally, power restructuring, related to existing inequities, was listed as a possible

[190] "Interview with Jess Harris." Interview by author. February 8, 2018.
[191] "Interview with Steve Gelb." Interview by author. April 9, 2018.
[192] "Community Solar Meeting." Interview by author. May 11, 2018.
[193] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.

solution. These strategies and potential solutions are explored further in the discussion section below.

4.9 Hypothesis Results

The results of the interviews as well as the household cost analysis are generally supportive of the original hypothesis. In the methods section, it was hypothesized that upfront costs are a major barrier to implementing solar, which has been confirmed by the interviewees. However, many other barriers exist as the interviewees also mentioned a lack of transparent solar regulation, complicated installation processes, existing laws, political and financial power imbalances, and a dearth of efficient technology as major barriers to solar.

The hypothesis stated that net metering and community solar programs did not help increase access to solar as much as the other two mentioned tools, federal ITCs and community purchasing models. This hypothesis is not affirmed as the interviewees did not agree on the equitable benefits of net metering. Additionally, the City of Seattle's community solar program was rarely discussed in the interviews with Seattle stakeholders, which, combined with the small number of community solar programs in Seattle, indicates that they do not have a large impact on increasing access to solar as they are currently implemented and distributed. Federal ITCs were overestimated in their ability to increase access to solar and mitigate inequities related to solar access, as some interviewees mentioned the difficulty in actually receiving the credits and the small impact that the ITCs have on lower-income families. Finally, neighborhood solar and bulk purchasing was generally verified as a tool for increasing access to solar, although some social and structural inequalities are not fully addressed in this model.

Focusing on energy democracy, none of the tools achieved a majority of Burke and Stephen's criteria for the energy democracy goals of resist, reclaim, and restructure. However,

each of the financing tools satisfied at least one or more of the criteria for each branch of energy democracy. As summary table of the energy democracy outcomes is below. Outcomes achieved are highlighted in bold, with the tool(s) that help advance each outcome in parenthesis next to the outcome, where net metering is represented as "NM", federal Investment Tax Credits are represented as "ITCs", neighborhood solar and bulk purchasing is represented as "NS", and community solar programs are represented as "CSP".

Resist the dominant energy agenda	• **Fossil fuels remain in the ground.** (NM, ITCs, NS, CSP) • Expansion of fossil fuel infrastructure and development of extreme forms of energy and extraction stops. • Land grabbing for large-scale renewables ceases. • Fossil fuel subsidies end. • Privatization and marketization of energy sector halts. • Undermining of climate protection stops. • The most dependent on fossil fuel industries protected, especially labor. • **Public resources shift away from fossil fuels.** (NM, ITCs, NS, CSP) • Public legitimacy of the fossil fuel industry is reduced. • **New social alliances are created (e.g., unions, environmental groups, municipalities)** (NS, CSP)
Reclaim the energy sector	• **Energy corporations democratize and localize.** (CSP) • **Social/public control of energy production and consumption normalizes.** (NM, NS) • **Parts of the energy sector that have been privatized or marketized return to public control.** (NM) • Principals of public interest within and democratic control over publicly-owned energy companies is restored. • **New energy companies, ownership models and financial systems under social and public control develop.** (NM, NS)
Restructure the energy sector	• Energy sector moves away from the profit motive. • **Energy access and assets are shared broadly and community wealth-building is supported.** (NS, CSP) • **Energy systems are governed as a commons.** (NS) • **Community power and capacity to control energy systems strengthen.** (NS, MG) • Emphasis shifts from growth to wellbeing, sufficiency and environmental quality. • Economic and political power is decentralized and distributed. • Capacity for energy planning increases. • Geopolitics of energy supports global cooperation and peace over competition and conflict. • **Solidarity, inclusion and open, democratic participation advances.** (NS) • Workers, low-income communities and communities of color hold central positions within energy systems. • An understanding of the energy sector as interdependent within the natural environment pervades.

Table 4: Energy democracy goals (suggested by Burke and Stephens) advanced by financial tools. NM = net metering, ITCs =federal investment tax credits, NS = neighborhood solar, CSP = community solar programs.

As shown in Table 4, three out of the ten resist goals, four out of five reclaim goals, and four out of eleven restructure goals may become more achievable by the four financial tools. The implications of these findings, as well as a more in depth connection between the household analysis and the financial tools are discussed in the following discussion section.

Regarding barriers to solar, the interviews and conversation with solar industry employees offered several lessons and ideas for opportunities in increasing access to solar for low and average-income residents. These opportunities and potential solutions can be categorized as legal and regulatory, programmatic, and technological.

Acknowledging the legal and regulatory barriers to solar, the interviewees offer a few options as potential solutions or strategies to increasing access to solar. These strategies and opportunities help reduce barriers at the planning, installation, and/or metering phases. One proposal is on-bill financing, which would allow residents to pay for installed solar on their utility bill, consolidating the amount of payment systems that residents might use in obtaining solar.[194]

Other strategies related to permitting and installation were also discussed. In most cases, residents do not need building permits in Seattle to install rooftop solar, which is an important strategy in reducing barriers to rooftop solar for homeowners. In March of 2016, Seattle passed a building code requiring new homes to be solar ready and set aside space for solar if the home is not shaded and meets other solar qualifications, under the Residential Building Code, Appendix U.[195] Due to the recent passage of the code, it remains to be seen if this new requirement will significantly increase access to solar in addition to increasing access to solar viable roof space.

[194] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[195] "Interview with Jess Harris." Interview by author. February 8, 2018.

As many residents expressed concern over cost, in both listening sessions and reports provided by organizations such as Spark Northwest, the interviewed stakeholders offer a few financial-related options for increasing access to solar. A major proposed initiative is I-1631, which, as of this writing, does not have a formal name for the ballot in the upcoming election. The initiative, drafted by the Alliance for Jobs and Clean Energy and in partnership with several local organizations, advocates for 100% clean energy, with some funding going to clean energy initiatives such as solar.[196] Some interviewed stakeholders say that this initiative could be essential to increasing access to solar for low-income residents.

Finally, as discussed in the literature review and reiterated by multiple interviewed stakeholders, a carve out for community solar for low-income residents could be a promising strategy. Currently, Colorado has an Act that requires 5% of all community solar to be allocated to low-income residents, provided there is demand among low-income residents.[197] By proposing a similar act in Seattle or statewide, the city could see an increase in low-income solar subscribers particularly because all shares for current community solar programs have been claimed and there is not currently available data related to income of those who have purchased one or more shares.

Programmatic solutions were also recommended in the interview process. These strategies generally center around partnerships between community organizations and public or private entities. Interviewed stakeholders recommend partnering with aid organizations such as Habitat for Humanity to put solar on new developments that are designed for low-income and/or transitional residents.[198] The Green Up program through Seattle City Light and the LIHEAP aid program could also incorporate a stronger partnership between housing, affordable utilities, and

[196] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[197] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[198] Ibid.

renewable energy.[199] Another potential partnership could be between community land trusts and Seattle City Light, which would also expand upon social capital benefits offered by neighborhood solar.[200]

Technological advancements on the horizon may also play a role in increasing access to solar for low and average-income residents. Community solar farms, which are distributed and often more affordable and productive than individual rooftop solar when divided among neighbors, could be an effective financing tool that exists in a somewhat gray area between neighborhood solar and community solar programs.[201] Interviewed stakeholders also look forward to more efficient and integrated rooftop solar materials, which could drastically decrease cost and increase production of rooftop solar, increasing the accessibility of rooftop solar for lower income homeowners.[202] Finally, if electric cars continue to increase in popularity, some believe that rooftop solar could become more popular as it would lower the cost of charging electric vehicles and could eventually be integrated with more efficient home battery storage systems.[203]

Understanding the costs and barriers, categorized as legal and regulatory, installation-based, and financial can help provide insight into potential strategies for increasing access to solar energy. These costs, as well as the implications of the results related to the financial tools is explored in the following chapter as they relate to ideas discussed in the literature review in the context of Seattle.

[199] Interview with Steve Gelb." Interview by author. April 9, 2018.
[200] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.
[201] Ibid.
[202] "Interview with Jess Harris." Interview by author. February 8, 2018.
[203] Ibid.

CHAPTER 5: DISCUSSION

The results reveal several insights into the costs of rooftop solar as well as the benefits and challenges of the four researched financial tools: net metering, federal ITCs, neighborhood solar, and community solar programs as they relate to financing, social equity, and energy democracy. This section discusses the results from the previous chapter and suggest how they relate to the literature researched and broader implications. According to those interviewed, major barriers to solar can be summed up in the categories of legal and regulatory, installation process-based, political, and technological in addition to cost-prohibitive upfront costs. Household solar, while still expensive, has an average cost of about $10,300 with incentives for the proxy house, which is 14% of a low-income resident's monthly income and 12% of an average-income resident's income in Seattle. This is significantly higher than current average utility bills, which are about $60 and only 1% of low and average-income residents' annual income. Finally, the four financial tools support equity and energy democracy goals to varying degrees, and their relationship to these goals as well as the implications of these relationships is explained in this chapter.

5.1 Household Solar Costs Discussion

Currently, low and average-income residents spend about 1% of their income on utilities, in part due to low cost electricity from hydroelectric dams. In contrast, the upfront costs of solar, with incentives, would make up 1.9% of a low-income household's income and about 1.52% of an average-income household's income. The average payback time for solar ranges between 8 and 10 years according to local solar installation companies interviewed. Residents who can afford to pay the upfront costs of solar will begin to receive full benefits of solar after this time, particularly if net metering is installed and if the array uses Washington produced solar panels, which offer an additional $.05 per kWh in net metering under the state production incentive. While low-income

homeowners may be able to receive federal and state assistance from LIHEAP and ELIA, these programs are not formally connected to solar programs, adding to the complexity of solar financing that continues to be barrier to solar installation, according to the results.

The high upfront costs of solar can still be a major barrier to low and average-income residents who want to install solar. However, these costs are comparable to average utility costs for residents who are able to amortize the cost over a multi-year period. If residents are able to pay for solar over a multi-year period using a home equity loan then the difference in cost between an average monthly utility bill and a monthly solar loan payment is only about one percent or less, as shown in Table 2 in Chapter 4.

Multiple interviewed subjects cited cost as a major barrier and the household solar financing results show that solar is significantly more costly than paying for utilities through Seattle City Light if residents must pay the full upfront cost in one installment. Still, many homeowners are able to amortize the cost of solar and receive additional financial benefits through net metering and the Washington state renewable energy incentives, making household solar installation a smart economical decision for residents who can afford the incentivized upfront costs and/or pay through a multi-year home equity loan system.[204]

5.2 Financial Tool Analysis Discussion

The results revealed several insights into the costs of rooftop solar as well as the benefits and challenges of the four researched financial tools: net metering, federal ITCs, neighborhood solar, and community solar programs as they relate to financing, equity, and energy democracy. By looking at barriers to solar first, and then the alignment between the financing tools and energy

[204] Washington State Legislature RCW 82.16.165 "Annual production incentive certification" Accessed: June 2018.

democracy, one can draw conclusions about these financing tools as components of increasing access to solar and progressing toward energy democracy and a more equitable energy system.

The literature review explored several barriers to solar. Many of these barriers were related to the upfront cost of solar, which prevented market entry.[205] Legal barriers, particularly related to community solar were also discussed in the literature review as challenges for implementing solar.[206] The interview responses are in line with the literature review, with interviewees listing cost and regulatory and legal challenges as barriers to implementing solar. In understanding these barriers, the strengths and weaknesses of financing tools as they relate to cost and equity can be discussed in greater detail.

5.2.1 Net Metering Discussion

As a financing tool, net metering can help residents get credits toward their utility bill based on the energy that their rooftop solar array produces. As a compensation mechanism, net metering has been found to be among the best suited for residential energy needs according to literature reviewed. However, some studies suggest that while net metering has benefits over other compensation mechanisms, the benefit to residents can be insufficient compared to upfront costs.[207] The interviews varied in their view of the financial benefits of net metering compared to the literature. While some people interviewed saw net metering as an important tool for increasing access to solar due to its financial incentives, others say that a more radical approach to offering financial benefits for solar produced is required for a restructuring that supports ideas of energy democracy.

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[205] Gordon Walker, "What Are the Barriers and Incentives for Community-Owned Means of Energy Production and Use?"
[206] Wiseman and Bronin, "Community-Scale Renewable Energy."
[207] Yamamoto, Y. (2012). Pricing electricity from residential photovoltaic systems: A comparison of feed-in tariffs, net metering, and net purchase and sale. *Solar Energy, 86*(9), 2697.

Revisiting Rawls, as discussed in the theoretical literature review section of Chapter 2, net metering is not in line with the Second Principal in that, as a financing mechanism, it is only an advantage for those who are able to afford the upfront costs and overcome other barriers to implementation and it does not provide additional benefits for the most disadvantaged residents. A financing mechanism more in line with Rawls would strategically offer benefits for those most disadvantaged, in this case low-income residents, rather than acting as a one-size-fits-all tool. Once solar is installed and residents begin receiving the benefits of net metering, all people benefit equally and to date there is no additional benefit for low-income residents with solar. An exception to this is the Emerald Cities Collaborative and Capitol Hill Housing project, which is designed specifically for low-income residents at the CHH property. The net metering benefits will likely go to a community fund, but questions remain regarding who makes decisions on how this money will be spent. While this project is just one example of offering additional advantages to those who are least advantaged, it could potentially serve as inspiration for developers and non-profits that wish to partner together, with residents, to implement solar in low-income housing.

Each financing tool is different in its ability to promote energy democracy, as seen in Table 2, a chart from Burke and Stephens in the literature review. Table 4, above, shows ways in which net metering (indicated by "NM") is line with these goals, according to data gathered from the interviews. While there was not a true consensus among people interviewed, the advanced energy democracy outcomes represent ideas that were expressed by at least fifty percent of the interviews.

According to Burke and Stephens, net metering supports the goal of reclaim, within the energy democracy framework.[208] In suggesting that net metering is in line with three of the five criteria for the reclaim branch of Burke and Stephens' energy democracy table, Schoolman and

[208] Burke and Stephens, "Energy Democracy: Goals and Policy Instruments for Sociotechnical Transitions."

others interviewed have similar views to Burke and Stephens, among other energy democracy-focused scholars. While net metering does not help achieve goals related to resisting the dominant energy agenda and restructuring the energy sector, it is relatively agreed upon that it is a financially beneficial tool that does at least advance the goal of reclaiming the energy sector. Furthermore, it is unrealistic to expect any one financial tool to achieve most or all of the intended outcomes for energy democracy, as outlined by Burke and Stephens. As a result, net metering shows promise as a financial tool that can increase access to solar for low and average-income residents, providing the opportunity to offset upfront costs over the payback period. By incorporating net metering into more low-income multi-family housing developments and decreasing the barriers to net metering for low-income single-family residents who already have rooftop solar or are in the process of implementing rooftop solar, the financial tool could become an even more important strategy in increasing access to solar and advancing energy democracy.

5.2.2 Federal ITC Discussion

Like net metering, federal ITCs are offered to all residents who install solar, without considering income or wealth. Federal ITCs offer a 30% rebate for all who install solar, but, as Gonzales says, some residents do not end up completing the application process for receiving this federal benefit. Additionally, Gonzales and others mention that while 30% is helpful, it may not necessarily be the tipping point for a low-income resident considering solar.[209] Of all of the financial tools analyzed, federal ITCs do the least for advancing energy democracy. Revising the theoretical literature, federal ITCs do not support the Rawlsian principles regarding increasing access to the most disadvantaged as a 30% rebate is too low for lower-income residents to take advantage of in order to implement rooftop solar. As direct incentives, federal ITCs can help

[209] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.

relieve the financial burden only of those who have already installed solar, and in Washington, completed the necessary permitting process. Aside from funneling public money toward solar energy, federal ITCs do little to advance the goals of energy democracy.

Burke and Stephens do not examine federal ITCs as a potential financing tool for advancing the goals of energy democracy. However, the interviews conducted indicate that almost none of the intended outcomes of energy democracy would be advanced by federal ITCs. Although federal ITCs fall short of these goals, there is potential for this tool to increase access to solar due to lowered upfront costs. Still, it is unclear whether savings from federal ITCs alone would encourage residents to install solar who not otherwise had the incentive not been in place.

5.2.3 Neighborhood Solar and Bulk Purchasing Discussion

Neighborhood solar and bulk purchasing can help reduce upfront costs as several installers offer discounts to residents who purchase solar as a group.[210] As financing tools, bulk purchasing and neighborhood solar are beneficial to low-income populations because of their ability to reduce upfront costs, about 15-20% compared to those who do not purchase solar with neighbors.[211] Neighborhood solar and bulk purchasing can also decrease barriers to information and political barriers that exist due to the community organizing involved in the neighborhood process. However, Gonzales and other say that it can be difficult for communities to organize around installing solar when they are concerned about housing stability and other necessities.[212]

Among the financing tools, neighborhood solar and bulk purchasing are the most effective in advancing goals related to energy democracy. Neighborhood solar and bulk purchasing, more than the other financial tools discussed, advance goals in the resist, reclaim, and restructure

[210] "Interview with Anya Schoolman." Interview by author. December 20, 2017.
[211] Center of social inclusion and Vote solar and Grid Alternatives, "Low-Income Solar Policy Guide."
[212] "Interview with Mikhaila Gonzales." Interview by the author. May 2, 2018.

branches of energy democracy. Unlike the other tools, neighborhood solar and bulk purchasing place a large emphasis on community building and the democracy side of energy democracy. In their ability to connect neighbors throughout the planning, purchasing, and installation processes, neighborhood solar and neighborhood bulk purchasing are particularly strong in the reclaim and restructure components of energy democracy. Additionally, community solar continues to be implemented at the multi-family housing scale, as is seen in the ECC/CHH project in Seattle.

Still, Gonzales and others suggest that communities may require a certain amount of social, political, and economic capital in order to develop a community solar program.[213] Because not every community has the capacity to go through the necessary processes of community solar and neighborhood bulk purchasing, more work must be done in order to increase access to all residents in Seattle. One promising strategy, as suggested by multiple people interviewed, is to incorporate anchor community organizations, which are organizations that already have a strong connection to the community, during the planning and purchasing processes. To this end, anchor communities can help the most vulnerable and disenfranchised populations, filling gaps in the planning process as funded institutions with capacity for planning community solar projects. The ECC/CHH project is one example of different stakeholders collaborating to bring solar to a multi-family building, and it seems plausible that other community organizations will follow the lead of organizations around the country in helping spur community solar growth in their neighborhoods.

5.2.4 Community Solar Program Discussion

As a financial tool, community solar programs show promise in Seattle for decreasing barriers to solar for residents of all incomes. Community solar programs in Seattle are connected to solar arrays that are divided into shares, which cost $150 per share through Seattle City Light.[214]

[213] Ibid.
[214] "Community Solar." Seattle City Light. Accessed May 2018.

Residents who purchase one or more shares receive energy credits based on the proportion of shares that they have purchased. The more productive the solar array, the more credit residents will receive based on the number of shares that they own. Depending on the amount of energy produced, these solar arrays can offer a range of savings to residents who purchase one or more shares. Currently, residents receive credits for their portion of electricity generated, which is $.70 per kWh under the Washington State Incentive as well as $.09 per kWh through net metering credit.

City operated community solar programs are few in number in Seattle, with only seven in operation across the city.[215] Perhaps as a result, they were among the least discussed by those interviewed. Still, it is possible to analyze the ability of community solar to advance energy democracy based on responses provided in the interview.

Community solar programs only advance six outcomes of energy democracy in the Burke and Stephens framework. However, what community solar programs lack in energy democracy principles, they arguably make up for in accessibility. Community solar accessible to all residents of Seattle, whether they are renters or homeowners.[216] As heard in community listening sessions, many low-income residents do not seek out solar because there is a lack of information and opportunities for renters.[217] Unlike a fixed rooftop solar array, a share or multiple shares of community solar can travel with the Seattle City Light customers as they move around the city.[218] While shares of community solar do not allow residents to generate their own energy separate from Seattle City Light, it does support sharing of community assets, especially for those who still find

[215] Ibid.
[216] "Community Solar." Seattle City Light. Accessed May 2018.
[217] Front and Centered, *2017 Community Listening Sessions: Solar*.
[218] "Community Solar." Seattle City Light. Accessed May 2018.

the upfront costs of solar to be cost prohibitive.[219] Additionally, the distribution of community solar is also a strength in that it is a sign of Seattle City Light localizing and distributing its energy sources, which can make them more resilient to natural disasters and encourage local job growth. Currently, Seattle City Light gets most of its energy from dams outside of the city limits and more distributed community solar arrays within the city can help bring energy production to a more local scale.

5.4 Lessons and Opportunities

Just as no single financing tool fully advances energy democracy or fully removes barriers to solar for low and average-income residents, none of the solutions described in Chapter 4, including on-bill financing, more money for renewable energy generated by new taxes, and carve outs for low-income residents for community solar would achieve these goals on their own. As all interviewed stakeholders discussed, it takes a variety of tools and financing mechanisms to help make solar more equitable for all residents. The suggestions outlined above in Chapter 4 could, in concert with one another, help reduce barriers to solar and advance energy democracy, though future research would be required to better understand the degree to which they are successful in these goals.

5.5 Implications of the Results

The findings from this research show that there is generally still a gap in affordability and opportunity for solar for low and average-income residents in Seattle. In addition to cost, there are numerous barriers to solar adoption in Seattle that are legal and regulatory, installation process-based, political, and/or technological in nature. Finally, the interview results show that while the four researched financial tools may advance energy democracy goals in a few ways, these tools do

[219] Ibid.

not satisfy all or even a majority of energy democracy goals. Another important question to ask is whether or not advancing energy democracy goals means a tool is necessarily equitable or in line with ideas of equity put forth by Rawls and others.

Even with current incentives, the upfront costs of purchase and installation of solar make up about 1 to 2 percent of low and average-income residents' yearly income, respectively. This is not significantly higher than existing utility rates, which make up about 1% of low and average-income residents' yearly incomes, but it is worth reiterating that these low rates are only achieved through an amortized home equity loan, which requires a certain degree of knowledge and awareness of solar financing that many homeowners may not have. Fewer than 3,000 households in Seattle have installed solar to date, as referenced in cost concerns during the listening sessions, and this could be due to a lack of transparent information and access to financing systems that allow residents to amortize cost and invest in solar energy as a confident and informed consumer.[220] There is a need for upfront costs to be reduced in order for more low and average-income residents to be able to access solar energy as well as a need for more transparent language and accessibility to the financing tools that already exist. While community solar programs offer low and average-income residents an opportunity to invest in solar at a lower cost, all shares for these solar arrays have been claimed, indicating that demand may be greater than the available supply of shares. Again, the problem of information and accessibility remains as not all Seattle residents are aware of the community solar program or whether or not it is a financially smart investment.

This thesis operates on the assumption that residents in Seattle need access to renewable energy for their own well-being and the well-being of future generations, as emphasized in Rawls'

[220] Front and Centered, *2017 Community Listening Sessions: Solar*.

Second Principle. Under this assumption, there is a disconnect between the legal and regulatory barriers that exist and laws and regulations that would support a general goal for increased access to solar for residents of all incomes. These barriers are also related to installation barriers, which underscore the complicated process of bidding and permitting that residents must undergo in order to install solar. Technologically, solar installation and operation has improved in recent years, but its complexity and opacity remain barriers to installation for many. In addition to these visible barriers, it is an inequitable society, with power imbalances between residents, utility companies, and legislators, that is a major barrier for low-income residents, particularly those who are understandably more preoccupied with housing stability and other challenges that low-income residents face.

While energy democracy is a promising framework for ushering in a renewable energy transition that satisfies equity goals related to the triple bottom line, the research revealed that the four tools researched do not advance a majority of the energy democracy outcomes. There is a disconnect between the financing tools in their ability to decrease barriers to solar and their ability to advance energy democracy. While federal ITCs, net metering, neighborhood solar and bulk purchasing, and community solar programs can help lower the cost of solar for renters and homeowners alike, they are lacking in their ability to advance energy democracy outcomes.

From the outset of this research, two central concerns guided the focus of solar to include low-income residents: that early adopters of technology tend to be upper-income residents and that low and average-income residents do not have the ability to choose their energy sources or participate in energy democracy advancing systems due, in part, to the high cost of solar. This thesis confirmed that while solar adopters in King County have an average income that reflects

average income of all residents in Seattle, major barriers to solar still exist for low and average-income residents.

These findings suggest that low-income residents may continue to lack access to solar if current economic and political environmental trends in Seattle continue. While the financial tools analyzed do not fully advance energy democracy, they do support its outcomes in several ways, with ten of the twenty-five intended outcomes from Burke and Stephens satisfied by at least one of the four analyzed financial tools. The interviews indicated that while the tools are not perfect in decreasing barriers to solar or advancing goals of energy democracy, they each play a role in ushering in a new era of a society powered by renewable energy.

Net metering can help residents more quickly reap financial benefits from the solar that they produce, by distributing excess energy back to the grid, powering other buildings that do not have rooftop solar arrays, which is an important component of increasing overall renewable energy produced. However, questions about its ability to be an equitable tool remain as only surplus energy produced offers incentives for residents involved in net metering. The Washington state incentives however, offer greater incentives for homeowners with solar arrays, and are worth exploring in future research for their potential to increase equity in solar production at the household scale.

Federal ITCs, while sometimes overly complicated to implement, do help stimulate reduce the upfront cost of solar for all residents by 30%. By acting as a one-size-fits all federal incentive, ITCs do not support Rawls' theory that the most disadvantaged residents should receive the most benefit. Perhaps a better model for the federal ITC would be proportionate to income, providing lower-income residents with a larger rebate in order to make rooftop solar more affordable.

Neighborhood solar and bulk purchasing, the strongest financial tool in advancing energy democracy, can help lower upfront costs while also building democratic community networks that can help with community resilience. Neighbors who invest in solar together may find the overall process less daunting, as indicated in multiple interviews with stakeholders. Future research into the relationship between social capital and energy democracy can help answer questions about the long-term success of neighborhood solar and bulk purchasing. Despite these strengths, however, the neighborhood and bulk purchasing models are only successful if residents are able to access these community networks and spend the time and capital to implement rooftop solar. These barriers are likely exacerbated for residents who face housing instability, are not able to meet basic needs, and/or have less social capital in their communities.

Finally, community solar programs offer the lowest cost option for solar while also advancing some energy democracy goals regarding energy localization. Community solar programs increase the overall energy provided by solar, however, they are still operated by utility companies or city governments and do not offer ownership to residents. As a result, it is difficult to meet energy democracy goals, particularly in the reclaim section, through community solar programs. Perhaps a more radical ownership system, which allows residents to receive more financial benefits and make decisions about the community solar program, in addition to a significant carve out for low-income residents in these projects, would lead to more equitable outcomes.

It is unrealistic to expect any one of these tools, or even a combination of tools, to undo systemic power imbalances that exist in Seattle and other major cities in the United States. While many Seattle residents struggle with housing stability and income inequality, solar financing tools alone cannot correct these inequities. Still, each financing tool is able to reduce some barriers by

lowering upfront costs and/or utility costs once installed. Additionally, each financing tool plays a small role in advancing energy democracy, which is an important framework for equity as societies transition from fossil fuels to renewable energy. However, homeownership remains a prerequisite for all financing tools explored except for community solar programs, which is a major barrier to true energy democracy. In a more equitable society, property ownership, the ability to understand opaque regulations and legal jargon, and the availability of wealth and capital would not be required to participate in a renewable, solar-focused energy system that is democratic and affordable. Ultimately, city, state, and federal powers would do well to increase access to solar by strengthening these financing tools in an effort to reduce cost, which is perhaps the greatest barrier to solar for low and average-income households in Seattle.

CHAPTER 6: CONCLUSION

This study aimed to explore the barriers to solar in an effort to understand how to increase access to solar for low (80% area median income) and average-income households in Seattle, Washington. Methods for research included a financial household analysis, which involved obtaining solar quotes from solar installers and Google Project Sunroof for a proxy house with a south-facing roof located in the Central District of Seattle. Other primary research included a financial tool analysis of net metering, federal Investment Tax Credits, neighborhood solar and bulk purchasing, and community solar programs as they help achieve desired outcomes of energy democracy. The financial tool analysis also involved interviews with four stakeholders in the solar industry and a discussion among solar industry stakeholders across Washington state about increasing access to solar for low-income residents. These interviews also offered new insight into the costs and barriers to solar energy in the Seattle area. Supported by theoretical, empirical, and practical literature found in the literature review, the findings of this research helped answer research questions related to barriers to solar, effectiveness of financial tools in advancing energy democracy, and future opportunities for increasing access to solar.

6.1 Research Limitations

It is impossible for research on any subject to be wholly comprehensive, this thesis being no exception. While the research related to the four financial tools aimed to be comprehensive, some limitations exist. Ten people in the solar industry in Washington state and Washington, D.C. were contacted for this thesis, but only four were available for in depth interviews. The small interview pool is a limitation, as it does not necessarily represent the breadth of opinions and ideas in the solar industry. Perhaps the biggest limitation to the research is that low and average-income residents who wish to invest in solar were not interviewed. Originally, a few non-profit

organizations had the intention of introducing residents for further interviews, but these introductions did not come to fruition in time to be incorporated into the thesis.

This thesis also does not explore options for solar for residents with incomes lower than 80% area median income (AMI), which means that it does not include some of the lower income and most vulnerable residents who would benefit from solar energy. As housing stability is a prerequisite for solar, these populations are not fully addressed in the research due to the assumption that, in the current bullish housing market of Seattle, residents near, at, or below poverty level are unfortunately not in a position of thinking about or obtaining solar. It is important to acknowledge that households earning 80% AMI are financially better off than many homeowners and renters in Seattle and people below this income level must be involved in energy democracy strategies if the city is to move toward a truly just and equitable society.

Also related to the household analysis, the sample house structure acts as a proxy for a single family home in order to get more accurate solar quotes and estimates. As a proxy, this house cannot not truly representative of all Seattle homes, though it does offer reasonable estimates. The house, shown in Figure 1 above, has a south facing roof, which is not a characteristic shared by all Seattle homes. Additionally, the square footage of the roof and the amount of shading from buildings, trees, or other obstructions varies across single family homes in Seattle.

Finally, the structure of this thesis did not fully allow more radical notions of energy democracy and restructuring to be fully considered. This outcome is a result of prioritizing the financial tool analysis within current existing capitalist systems, energy structures, and existing tools rather than being open to alternative economic structures and political systems that might better advance energy democracy. These limitations provide the basis for important opportunities for future research.

6.2 Opportunities for Future Research

This thesis focuses on the population of Seattle, Washington, a city located in the Pacific Northwest region of the United States. As a result, the findings live within current city, state, and federal conditions. Future studies could geographically expand this research and/or examine the use of the four financial tools in another state or country as they relate to current and potential projects and existing regulations.

Temporally, this thesis is bound to the changing conditions of a country responding to an unpredictable and tumultuous presidency in 2018. As previously mentioned, President Trump has already imposed tariffs on imported solar panels and the administration is generally hostile toward the renewable energy. It would be beneficial to conduct this research under future presidential administrations, as federal ITCs will likely have decreased by then according to the current schedule, and new solar technology may decrease upfront costs. Locally, a changing city council, mayor, or state legislature could also stimulate or stifle the solar industry in the coming years.

Finally, future research could expand the number or types of financing tools explored. This thesis examines net metering, federal ITCs, neighborhood bulk purchasing, and community solar programs as they relate to energy democracy. Other tools listed in the literature review and suggested by the interviewed stakeholders could be explored using similar analysis as it is likely that additional tools could help fill gaps in desired energy democracy outcomes.

6.3 Concluding Thoughts

An equitable transition to renewable energy requires a variety of financing mechanisms and the advancement of energy democracy principles. The research outlined in this thesis helps fill research gaps in the fields of energy democracy and solar access, particularly in Seattle, Washington. Net metering, federal ITCs, neighborhood solar and bulk purchasing, and community

solar programs are four important financing tools, but they do not exist in a vacuum separate from one another or other solar financing tools. While these tools lower costs for solar and help further energy democracy goals, additional strategies are needed to overcome existing barriers that are legal and regulatory, process-based, political, or technological in nature. As it stands, these barriers and a generally high upfront cost of solar compared to average utility bills can make it difficult for low and average-income residents in Seattle to access solar.

Some potential solutions and opportunities are legal and regulatory in nature, including on-bill financing and community solar carve outs set aside for low-income residents. Programmatic solutions including a greater connection between community anchor institutions, low-income developers, and solar installers and non-profit organizations may also play future roles in stimulating access to solar for low-income residents in multi-family buildings. Finally, technological innovations such as integrated rooftop materials and better battery storage systems could drastically cut costs for residential solar. Under government, private, or non-profit initiatives, these tools could supplement the existing tools for solar, helping to make solar more accessible to low-income and average-income populations while ushering in an equitable and democratic transition to renewable energy.

This research discusses potential tools and strategies that can be used in increasing access to solar and advancing goals of energy democracy. Government agencies, non-profit organizations, and private sector solar companies can use the results provided here to inform future strategies and policies related to solar energy access for residents in Seattle and beyond. As costs related to renewable energy technology is expected to decrease as individuals increasingly reject fossil fuels and the damages that they cause and as solar technology advances, it is important to champion strategies for increased access to solar in a way that is equitable and beneficial to all

residents. The road to energy democracy in Seattle has many barriers along the way. It is important to examine the barriers that currently exist not just for low and average-income households explored here, but also for residents who are surviving off of even lower incomes. Wealth inequality in Seattle and the United States is a major barrier to achieving an equitable society, but if the transition to renewable energy focuses on access, equity, and bringing low-income stakeholders to the table in a way that supports energy democracy and autonomy, it is likely that new energy systems that resist, reclaim, and restructure existing systems can help alleviate many current problems and provide new opportunities to residents of all income levels.

APPENDIX

Appendix A

Date	Interviewee	Organization	Location
Wednesday, December 20, 2017	Anya Schoolman	Solar United Neighbors	Washington, D.C.
Thursday, February 8, 2018	Jess Harris	City of Seattle	Seattle, Washington
Monday, April 9, 2018	Steve Gelb	Emerald Cities Collaborative	Seattle, Washington
Wednesday, May 2, 2018	Mikhaila Gonzales	Spark Northwest	Seattle, Washington
Friday, May 11, 2018	Anonymous Solar Industry Employees	N/A	Seattle, Washington
Continuous	Anonymous Solar Installers	N/A	Seattle, Washington

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