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Blocking Out the Sun: Restricting Rooftop Solar in Atlanta, Georgia

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by

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ABSTRACT

This study examines the uneven geographies of residential rooftop solar energy adoption across the City of Atlanta. Rooftop solar has the potential to reduce the racial wealth gap, advance economic independence for low-income households, and decrease utility bills. However, research in cities nationwide has consistently shown a marked discrepancy in rooftop solar adoption between white and minority neighborhoods. In Atlanta, analysis of solar permit applications and demographic data shows that 64% of solar installation permits are in majority-white census tracts, though the majority of permits have been located in majority-Black neighborhoods over the last two years. While rapidly increasing adoption rates might indicate decreased racial disparities in Atlanta's energy market, indicators show that these permits are mostly located in rapidly gentrifying neighborhoods, confirming that access to solar power remains elusive for many of the communities who could benefit most from its potential.

INDEX WORDS: Energy justice, Urban geography, Renewable energy, Environmental justice, Uneven development, Rooftop solar

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1 INTRODUCTION

Energy is a basic human need; it is what drives economies and sustains civilizations. However, energy production and use are also the biggest contributor to global climate change, responsible for a majority of U.S. greenhouse gas emissions[1]. In an effort to reduce harmful greenhouse gasses, such as carbon dioxide and methane, governments and companies alike are embarking on the transition to renewable sources for energy production. This move presents an opportunity to transform economies and lives, as energy possesses a unique combination of physical, environmental, and social dynamics. Due to uneven geographies of infrastructure, cost and access barriers, and disproportionate negative externalities, these systems produce and reproduce disparities that place certain populations at higher economic, social, and physical risk.

Renewables, such as rooftop solar, provide an opportunity to produce clean energy and lessen undue strain on underserved households. While the median household income for those with rooftop solar has decreased over the past few years, significant financial barriers to solar adoption for low- and middle-class income households still exist and have created a significant gap in solar adoption (Barbose 2018). Beyond that, even greater racial disparities exist in solar adoption. Research in cities across the country has consistently showcased a marked discrepancy in rooftop solar adoption between white and minority neighborhoods (Reames 2020; Darghouth et al. 2022; Goldstein et al. 2022). Black and Latino households are also more likely to be renters than white and Asian households (Ibid.). Renting correlates with lower solar adoption, due to inequitable incentives and the general lack of authority to make physical changes to the property, and in Black renter households, it is more common to have higher total energy costs and a

[1] 67% of U.S. greenhouse gas emissions come from transportation, electricity production, and commercial and residential consumption (EPA 2022).

greater percentage of income that goes toward energy bills (Goldstein et al. 2022). There is also a significant lack of information distribution and awareness that contribute to reduced solar adoption (Reames 2020). There are a few campaigns and programs available to incentivize and subsidize adoption that are not sufficiently circulated in low-income communities, but stark disparities still exist. It is critical that these households are recognized and intentionally included in energy policies that aid the transition to clean and renewable energy.

These issues are especially acute in Atlanta where 28% of households in the metro area are considered to have a high energy burden (Drehobl 2020). According to the Department of Energy, energy burden is the percentage of household income spent on energy costs. A high burden is considered having to spend more than 6% of a household's monthly income on energy. Nearly 600,000 households in the metro Atlanta area are under financial stress to maintain safe temperatures within their residence, an unsurprising number for the city ranked fourth in the nation for median energy burden (CEPL 2018). In Black neighborhoods on the south and westside of Atlanta proper, the average energy burden is twice as high as the citywide rate (Luke 2021). Low-income and Black households, in Atlanta and nationwide, are disproportionately negatively impacted by high energy costs and rooftop solar provides a potential relief to this burden.

Not only is there an economic and racial disparity within solar adoption, but there is a 92% gap between potential and achievable solar power production and storage in Georgia (Brown et al. 2021). Google's Project Sunroof[2] estimates that 1,500,000 rooftops in Georgia, 76% of the state's total rooftop space, has the potential for viable photovoltaics. This would equate to 26.8 million metric tons of carbon dioxide saved or 5.7 million cars taken off the road

[2] https://sunroof.withgoogle.com/data-explorer/place/ChIJV4FfHcU28YgR5xBP7BC8hGY/

for a year (Google Project Sunroof 2021). There is substantial natural and technical potential for rooftop solar in Georgia, however political and economic barriers restrict this possibility. Fossil fuel interests, special-interest groups, and policy makers have fought solar expansion or have focused on utility solar and tax credits to the wealthy (Brown et al. 2021).

In 2019, the Georgia Public Service Commission (PSC), the regulatory body for Georgia electric, gas, and telecommunications utilities, passed a motion to create Georgia Power's Renewable & Nonrenewable Tariff (RNR) 'Monthly Net Metering' program. This behind-the meter solar program requires Georgia Power to purchase excess energy generated by a customer's solar panels at the retail rate, the rate at which Georgia Power would typically pay for utility electricity, thereby providing an additional financial benefit to customers. Previously, the company used instantaneous netting and credited customers at the annual Solar Avoided Cost Rate per kilowatt hour (kWh). The "avoided cost" is the rate at which the Company pays power generators, which is about 25% of the retail value (Creative Solar USA 2020).

The PSC limited the program to 5,000 participants or 32 MW of additional energy capacity, whichever occurred first. As of July 2021, the participant cap was reached and Georgia Power stopped accepting applications for the program. This limit is colloquially referred to as the "solar cap." Given that residential solar expansion tends to depend on financial subsidies like this program, the solar cap has the potential to suppress the adoption of residential solar across the state. In 2019, only 64 houses per 100,000 in the Atlanta metro area had rooftop solar (Cape Analytics 2019). Since then, the number has barely increased. There is no existing financial incentive for solar panel purchase in the state of Georgia, so customers must depend on eligibility for federal tax credits or private grants. Customers who cannot participate in Georgia Power's program and still decide to install solar panels are enrolled in the RNR instantaneous

netting program and are credited at the aforementioned avoided cost rate of $0.03 per kilowatt-hour. This provides the greatest advantage to Georgia Power, as the utility company is able to maintain control over the market.

At odds with the solar restriction, the City of Atlanta has announced its goal to reach 100% clean energy by 2035 (Clean Energy Atlanta 2019). The city has made little headway toward achieving this goal, but has announced a few potential programs in partnership with Georgia Power. The success of these initiatives, such as the Home Energy Efficiency Assistance Program (HEEAP), which gives customers the opportunity to contribute funds to help low-income residents make energy upgrades, rests upon the philanthropic whims of the wealthy instead of real investment from Georgia Power or the city of Atlanta to reduce the gap in energy efficiency and expand renewable energy access. In many states across the country, low-income solar programs are financed through government incentives, utility funds, and charitable grants and donations (Reames 2020). And absent significant financial incentives, Georgia Power's monopoly status further impedes the already incremental progress of renewable energy growth. The power company favors other generation sources, such as natural gas and utility-scale solar (Brown et al. 2021), hindering the growth of rooftop solar.

It is not in the best interest of Georgia Power to promote customer generated energy because it is a threat to their profit margins. The current structure of regulated public utilities incentivizes the burning of fossil fuels and construction of infrastructure to turn a profit, leaving customers at yet another disadvantage. However, nonprofits, clean-energy groups, and some local jurisdictions around the state are working hard to advocate for rooftop solar to provide environmental and economic benefits to consumers (Partnership for Southern Equity 2021; *Solarize Savannah, Ga* 2022; CESA et al 2019). The transition to clean energy in Atlanta and

across the state is an opportunity for restorative justice and to reduce the economic and social disparities that exist across racial and income groups.

The solar cap's failure to address the energy inequities faced by Atlanta's most vulnerable communities is representative of an expansive, systemic infrastructure failure – along with an opportunity for the city to reimagine the delivery of solar to those communities through a justice-centered framework. Currently, the authority designated to the Georgia Public Service Commission discounts racial disparities within access and affordability (Luke 2021) and instead prioritizes financial gain for Georgia Power by ignoring the needs of low-income and Black households for cheaper, cleaner energy options. Presented as a safeguard for customers, the reality is that the PSC actively protects corporate profit and minimizes competition. Given these conditions, without a change in trajectory, Atlanta will not meet its 2035 goal of 100% clean energy. The city will continue to contribute tons of carbon dioxide into the atmosphere, while thousands of residents carry on struggling to pay their monthly utility bills.

This research seeks to investigate the potential of residential rooftop solar for rebalancing an already inequitable electricity market. In Chapter 2, I provide a case study that outlines the history and current state of the energy market in Atlanta through research on the city government, the Georgia Public Service Commission, and Georgia Power. Chapter 3 supplies a theoretical rationalization for the importance of this research by exploring gaps in energy geography literature, along with the importance of energy justice and democratization in the clean energy transition. I end the chapter with a discussion on the incorporation of critical geography in my work and the role Geographic Information Systems can play in supporting qualitative research. To display the effectiveness of this combination, Chapter 4 describes the reasoning for my chosen methods and an explanation of how this analysis operated. Chapter 5 is

an analysis of rooftop solar in Atlanta, related specifically to its geography, the historical and current contexts for patterns of its adoption, and the consequences of these developments. Chapter 6 concludes my research with a discussion of the findings in Chapter 5 in relation to Chapters 2 and 3, while considering a possible future for rooftop solar and studies like this one.

2 CASE STUDY: BUYING POWER IN ATLANTA

Electricity regulation and access in Georgia has long been contested, despite the ongoing favor the state's regulatory body has shown Georgia's utility monopoly, Georgia Power. Since the early 1900s, electricity consumers in the South have "voiced their displeasure at (and sometimes approval of) the fuel sources and corporate organizations behind the energy that powered everyday life" (Cater 2019, 187) with many groups of Georgians regularly protesting the expansion and effects of electric utilities. High additional fees, unwanted power plant projects, and more have led individuals and groups across all political ideologies to challenge Georgia Power's "monopolistic grip" on its customers and the state (Ibid.).

Today, Georgia is ranked 46th in the nation for total household electricity costs as a percentage of income and 43rd in overall affordability, a ranking decided by bills as a % of income, cost of household expenditures, cost per kWh, and annual expenditures (Citizens Utility Board 2021). An unfriendly state for energy customers, Georgia regulators, policymakers, and the state's electric utility have created an energy landscape that places profit over ethics and efficiency. Seemingly working against each other, the City of Atlanta, Georgia Power, and the Public Service Commission maintain competing priorities for a race to the bottom. In the past few years, the City of Atlanta, a momentary climate leader, has intentionally allowed its sustainability plans to fall away as the pursuit of corporate interests continues to take precedence (Lutz 2022). Simultaneously, the Public Service Commission and Georgia Power have worked in tandem to increase electricity costs for Georgia ratepayers through poor business decisions and the intentional stifling of consumer-first projects.

2.1 The City of Atlanta

Atlanta currently ranks in the bottom five for cities in the U.S. with climate plans, due to inconsistencies between the goals the city has set and its clear lack of a plan for execution (Kane et al 2022). While the city received high praise nationally upon publishing the Clean Energy Atlanta plan in 2019, only a mere three years later, the implementation efforts have fallen short.

Prior to the plan, Mayor Kasim Reed had ambitious goals in 2015, creating the Commercial Buildings Energy Efficiency Ordinance and making Atlanta the first city in the southeast to pass this kind of benchmarking policy (Shutters 2015), while also passing a plan to install solar on all municipal buildings. In 2019, the city was even recognized by the U.S. Department of Energy for reaching its goal a year early to reduce energy and water use by 20% (Department of Energy n.d.). Since then, the Office of Sustainability and Resilience has been gutted. Mayor Kiesha Lance Bottoms made little effort to maintain the momentum of her predecessor. The office became part of the Office of Equity, Diversity, and Inclusion and fell to political scandal. Almost a year in, many employees had resigned, and eventually the department head, Amol Naik, a corporate attorney with little sustainability experience, followed (Lutz 2022). Though the newest administration under Mayor Andre Dickens has now appointed the previous Democratic candidate for Public Service Commission and former Just Equity Director for the Partnership for Southern Equity, Chandra Farley, as Chief Sustainability Officer, there is still a long way to go for the city to get back on track to reach its original goals.

The City of Atlanta is aware of the energy burden that many households in the city face every month. Georgia Tech, American Council for an Energy Efficiency Economy, Atlanta Regional Commission, and even the Mayor's Office of Resilience have all put out research and literature on the high rates of energy costs and where burdened populations are located

throughout the city (CEPL 2018, ACEEE 2020, Digirolamo 2021, Mayor's Office of Resilience 2018). Despite the city ranking fourth in the nation for median energy burden (CEPL 2018), the City of Atlanta has done little to remedy these difficulties for residents. Two programs that Atlanta recommends for its residents who need bill assistance include the Low Income Energy Assistance Program (LIHEAP) and the Home Energy Efficiency Assistance Program (HEEAP). The former being a federally funded program and the latter funded by ratepayers who choose to add a donation to their monthly bill to Georgia Power. Neither program includes effort or financing contributed by the city to its citizens but depends on the federal government or wealthy residents to fund temporary remedies to costly bills. Little has been done to find solutions for the root cause of the issue at hand, high energy costs due to natural gas and coal volatility, inefficient housing, and low wages.

2.2 Public Service Commission and Georgia Power

Georgia's Public Service Commission was established in 1879 as the Railroad Commission of Georgia to help regulate train service and operations. In 1922, the state legislature changed the Commission's name to better reflect its growing jurisdiction, which included regulating energy utilities, telecommunications, and gas. Today, the five elected Commissioners enjoy the "exclusive power to decide what are fair and reasonable rates for service" (Georgia Public Service Commission 2022), a power they wield primarily to protect corporate interests and the Commission's own corrupt practices.

This corruption is evidenced in two major court cases targeting the Commission in 2022 alone. The first case, against Georgia's Secretary of State Brad Raffensperger (*Rose v. Raffensperger*), held that the structure of PSC elections dilutes the state's Black vote by selecting district members through a statewide vote, rather than the region where Commissioners' seats

reside. Upon appeal, the United States Supreme Court vacated the lower court's ruling, arguing that the principle cited was misapplied and ruling that elections would not be held for the Georgia Public Service Commission in November. This decision by the U.S. Supreme Court was handed down on the same day that a state judge overruled a residency challenge to Patty Durand, a Democrat running for the District 2 seat. PSC seats are held as a statewide election, but Georgia law requires that candidates live in their district 12 months prior to each election. Durand's opponent, incumbent Commissioner Tim Echols, participated in a coordinated effort to draw Durand's residence out of District 2, removing her as a competitor for the seat. Text messages between two of the sitting Commissioners, Tim Echols and Tricia Pridemore, showed how the two colluded to redraw the district maps in an attempt to erase Durand's eligibility (Kann 2022). Durand will be on the ballot, however, there will be no election held for the Public Service Commission this November.

While the Public Service Commission's fight to further cement their power and control over Georgians has attracted public and media scrutiny, equally onerous is its failure to regulate and hold utility companies accountable, specifically Georgia Power, the state's primary energy utility. The Commission has voted to allow Georgia Power to offload much of the bloated cost of its nuclear power plant, Plant Vogtle, largely onto its customers, the price tag for which has now exceeded $30 billion, more than double its original budget. In response, the plant's co-owners – the two power co-operatives Oglethorpe Power Corporation and Municipal Electric Authority of Georgia (MEAG) – have sued Georgia Power and seek to halt all future payments for the project and take a smaller share of ownership as a result. In the lawsuit, Oglethorpe stated "Georgia Power is a for-profit company that can pass the growing costs of Plant Vogtle on to shareholders," (Jones 2022), something Oglethorpe and MEAG cannot do as not-for-profit co-

operatives. However, Georgia Power is not passing the cost onto shareholders: at the end of 2021, the Public Service Commission unanimously voted to pass $2.1 billion of the plant's costs onto customers instead, adding an additional $3.78/month fixed fee onto residential energy bills, one of many such fixed fees charged by Georgia Power (Williams 2021). This additional cost comes on top of the estimated $3.5 billion customers have already paid for Plant Vogtle through a Nuclear Construction Cost Recovery Fee (Watson and Jacob 2021).

It is not surprising that the Commission consistently votes in Georgia Power's favor and forgoes its stated mission to serve ratepayers and ensure reasonably priced electric services. Every commissioner, elected or appointed, has received significant campaign donations from individuals and entities associated with regulated companies like Georgia Power and their parent corporation, the Southern Company (Tait 2018). The two most outspoken and prominent PSC members, Commissioner Lauren "Bubba" McDonald has received over $400,000 from influential donors since 2014, while commissioner Tim Echols has received over $300,000 since being elected in 2017 (Georgia PSC Accountability Project 2022; Georgia Government Transparency and Campaign Finance Commission).

2.3 Passage of the "Solar Cap"

The PSC has demonstrated a capacity for negligence and prioritization of corporate interests even in instances where Georgia Power's direction is absent. In 2019, the PSC voted to approve a motion to create Georgia Power's Renewable & Nonrenewable Tariff (RNR) 'Monthly Net Metering' program, requiring the company to purchase excess solar power generated by those with rooftop solar who feed unused energy into the grid. If that motion was all the Commission approved, renewable advocates and Georgia's solar market would have notched a significant victory: net metering provides the biggest benefits for homeowners with

increased savings on utility bills and shorter payback periods on the upfront solar costs (Lane 2022). According to Allison Kvien, the Southeast Regulatory Director at Vote Solar, “monthly netting empowers families to lower their monthly bills and contribute to a cleaner, more resilient energy grid through rooftop solar” (SEIA 2022). What’s more, this motion established that Georgia Power would compensate customers at a retail rate, equaling about 12 cents per kilowatt-hour (kWh), a significant improvement from the previous rate of roughly 3 cents per kWh.

However, what appeared to be a rare consumer-first initiative from the PSC came with a catch: only the first 5,000 customers to sign up could participate, a meager number compared to the 2.6 million customers Georgia Power serves. But according to all available evidence, this number was proposed by the Public Service Commission, not Georgia Power. Inexplicably, this limit – known colloquially as the “solar cap” – has slashed the already limited financial incentives for Georgia homeowners interested in installing rooftop solar as a way of limiting carbon emissions and moving towards local and national clean energy goals. But as of summer 2021, residents who install rooftop solar on their homes are not able to participate in the net metering program due to it having already reached the 5,000 customer capacity. Residents who install rooftop solar moving forward are only eligible for the previously mentioned 3 cents per kWh rate, meaning a notably lower and slower rate of return on investment that makes residential rooftop solar a less financially viable investment for most households.

As state regulators work to curb the implementation of clean energy alternatives, the City of Atlanta has done little to push back or make headway toward its goals to increase renewables and reach net zero by 2035. The maintenance of Georgia Power’s monopoly status in the city plays a large role in these stunted endeavors by further impeding the already incremental

progress of renewable energy growth. The city is dependent on the infrastructure and planning of Georgia Power to transition to clean energy and as of now, the company has little incentive or desire to make changes, then it is to be expected that the transition will continue to stagnate.

2.4 Mishandling of Georgia Power

Both in the lack of accountability for Georgia Power's mishandling of their nuclear plant and the coordinated restriction of net metering benefits for customers, the PSC has played into the hands of the state's utility monopoly, adding to profits for the company and losses for the customers. This year, the Commission is meeting to vote on Georgia Power's Integrated Resource Plan (IRP), a collection of planning documents for goals, operations, and utility resource needs that is voted on every three years. In this plan, the company is seeking to increase customer bills an additional 12% over the next three years, starting at over $14 in 2023 (Dunlap 2022b). Citing the same reasons for increasing bills by $6 in the last IRP, the company states the money is necessary for grid modernization and customer service (Van Brimmer 2022). These additional fixed fees are why Georgia Power customers face electricity bills higher than the national average, despite paying less than the nationwide average per kWh of electricity alone (EnergySage 2022). It has been a long-time talking point for Georgia Power and the Commission that residents here pay some of the lowest costs in the country. In 2016, a Georgia Power spokesman stated that "the company's base electric rates have been frozen since 2016 and will not be adjusted until 2020 at the earliest" (Pirani 2018). The end of the frozen rates has arrived. Customers are now beginning to see prices rapidly increase, both through the direct cost of electricity and from the expansion of fixed fees for environmental cleanups, budget mismanagement, and Georgia Power's drive to create as much profit for shareholders as possible.

Some of the decisions and votes for sections of the company's Integrated Resource Plan have already been made. Instead of making the decision to transition into cheaper, cleaner sources of energy that will benefit the state economy, environment, and individual customers, Georgia Power has doubled down on fossil fuel production – despite publicly claiming goals for greener energy production (Georgia Power 2022) – with the Public Service Commission's explicit approval. Citing the worry of unpredictable costs for solar, the PSC voted to add 2,300 MW of renewable energy over the next three years. The "renewable" is natural gas, a misleading name for the CO2 emitting power source. Georgia Power's decision to expand natural gas dependency comes at a time when prices have nearly quintupled and is only bound to push prices higher. The total cost of electricity in Georgia already ranks the 8th highest in the nation (McCann 2022), even with the lower rates customers have grown accustomed to. As costs rise and volatility increases, it is poor and working-class households who disproportionately face the burden of an already high and now growing percentage of their monthly income that is to be spent on keeping the lights on.

Additionally, the PSC has just voted this year to reject the expansion of the rooftop solar program and keep the "solar cap" in place. In a 3-2 vote, supported by Commissioners Tim Echols and Bubba McDonald, the effort to expand the cap to 75,000 customers was denied. As a result, instead of saving on their utility bills while transitioning to cleaner sources of energy, Georgians continued to face rapidly increasing energy costs in a year of record-breaking inflation. Commissioner Tricia Pridemore, who voted against the net-metering program expansion, stated that the commission needs more time to study the problems of solar instability (Dunlap 2022a). However, extra time was not needed to investigate the instability of natural gas, despite the skyrocketing prices and volatility of the gas market (SELC 2022).

The IRP is a roadmap for Georgia's energy future and Georgia Power is looking to make it an expensive one, asking the Commission to increase monthly bills by almost $15 per month (SELC 2022). An attorney from the Southern Environmental Law Center (SELC) stated that this "will be the first of several big hits for customers – next year customers will likely see steep bill increases due to sky-high gas prices" (Ibid) and added costs from Plant Vogtle's explosive budget. Local groups in Atlanta such as the SELC and Partnership for Southern Equity (PSE) continue to advocate for expanding the net metering program and reducing Georgia Power's natural gas and coal use. Joel Alvarado, the VP of Strategy and Engagement at PSE, pronounced the fight must continue and they are turning their "attention to the Georgia Power rate case where we will combat rising electric bills and reliance on our monopoly utility" (SELC 2022). Nonprofits, clean-energy groups, and others in the city know that renewable, accessible energy would provide much needed economic benefits to consumers, specifically to low-income and Black neighborhoods that are disproportionately negatively impacted by high energy costs. However, these changes would not be in the best interest of Georgia Power's bottom line. Customer-generated energy means less revenue and profit for utilities, whose structure is built on the basis of vertical integration – a monopoly control of the generation, transmission, and distribution of electricity. This type of control is no longer necessary. The grid itself and customer interface may be all that's left to require more centralized control. Currently, there is a market distortion created by Georgia Power and Public Service Commission that essentially subsidizes fossil fuels and discourages rooftop solar.

In all of this, we see the role of the Public Service Commission and the dominance that Georgia Power has been granted over its customers. Georgia Power has been government-sponsored since the 1970s and possesses an exclusive domain over providing electricity in the

state. Power relations, politics, and money are at the root of this issue. Georgia Power makes billions in operating revenue every year. In the 2020 fiscal year, the company registered a net income of $1.575 trillion (U.S. Securities and Exchange Commission 2021). This comes from authorizations by the PSC for shut offs during the COVID-19 economic crisis, rate hikes and fees for the pandemic and environmental disasters, and the offloading of ballooning costs for Plant Vogtle (Georgia Conservation Voters 2021). The current structure of regulated public utilities incentivizes the burning of fossil fuels and construction of infrastructure to turn a profit, leaving the customer at yet another disadvantage. To protect profits and maintain control over customers, Georgia Power has continued to discount solar as a viable option for individuals and has furthered dependence on fossil fuel consumption. Reducing the detrimental control of the PSC and Georgia Power over customers is the first step to ending an energy system that disproportionately burdens low-income communities and people of color. While only one piece of a much larger set of policy reforms, expanding the net metering program in Georgia provides an additional opportunity to rebalance the inequitable electricity market that we see in the uneven geographies of energy burdens in the city and where solar production is located.

3 LITERATURE REVIEW

Energy has long been an essential component of the human experience. Civilizations throughout time have depended on energy, from the burning of wood to hydropower to the combustion of fossil fuels and, more recently, nuclear fission and solar conversion through photovoltaic (PV) panels. As the global population and economy continue to grow, so does the demand for energy. Additionally, there is a growing demand for clean energy that further complicates the dynamics of energy's physical, social, and economic relations. The vast, complex energy-social-environmental relationship is in need of in-depth study, and geographers have shown that it will take more than a technical and economic understanding of energy to ensure justice and equity (Calvert 2015). Geography brings a critical lens to the impacts of energy production, resource distribution, and the spatial patterns of consumption, while also addressing the power dynamics, political motivations, and social consequences of such practices.

In this chapter, I focus on the importance of geography to energy research and the complexity of space as a social construction. Energy justice and energy democracy literature further bolster these entangled issues by addressing the centralized control of energy, environmental abuses, and other inequities that result from modern energy systems. Additionally, I incorporate literature on critical geography and critical GIS and its usage in the mapmaking process for this research, as well as inclusionary and exclusionary practices within geospatial work. In working within this literature, I found gaps that fail to address the strong connections between rooftop solar adoption, housing, and the processes of gentrification.

3.1 Energy Geographies

Energy geography is a distinct subfield that has emerged at the nexus of environmental, social, and economic concerns. The figure below, taken from Calvert (2015), shows the overlap of geography's physical, social, human-environment, and GIScience domains that all contribute to a better understanding of energy issues.

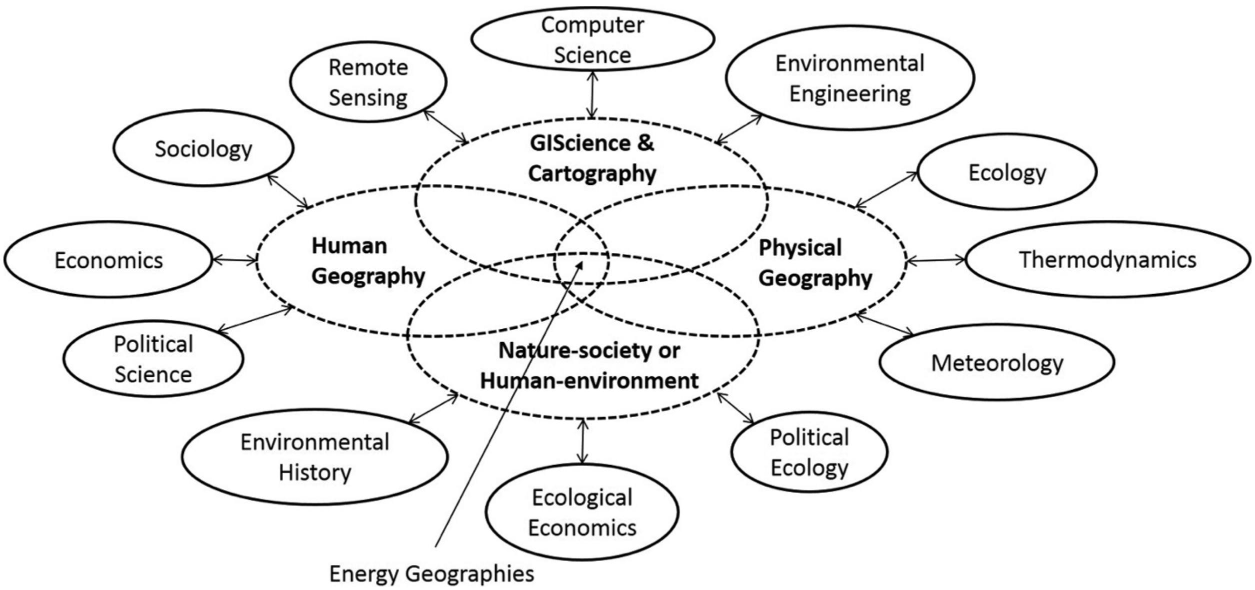

Figure 1: Overlapping fields (and subfields) of geography that advance relevant and necessary perspectives to the understanding of energy geographies (Calvert 2015).

Analysis of climate change, the global energy budget, and energy resources have in some ways moved away from the field of geography into more mathematically intensive fields, such as climatology, applied modeling, and geochemistry (Solomon et al. 2004; Smil 2006; Cleveland et al 2000). For the purpose of this thesis, I look to the contributions made by human geographers, and those adjacent to the field, for a more holistic explanation of the role of energy. Explorations of social science's potential reach include energy policy (McCauley et al 2013), energy justice (Huber 2015; Sovacool 2016; Jenkins 2016), energy poverty (González-Eguino 2015), branches of economic geography (Knight, E 2012), energy activism (Fuller et al 2016), and more. These

few selections exemplify the breadth of possibility for the application of a geographic lens in the ever-expanding energy sector.

Some energy geographers (Pasqualetti 2011; Baka et al. 2020; Huber 2015) have already worked to produce a framework through which to "map the geographies of a low-carbon energy system and so guide choices among different potential energy futures" (Bridge et al. 2013: 331). As societies make the transition to new forms of energy, it is critical that the socio-spatial relationships involved with energy and the disparities they (re)produce be integrated into energy studies. Sovacool (2014) highlights the undervaluation of social science and a lack of interdisciplinary collaboration across energy technology and policy work. Energy is not a domain that should be left exclusively to scientists, engineers, and other technical experts. The inherent social and spatial dynamics of energy necessitate the work of social scientists, beyond that of these other technical experts. Technocratic trends within energy have neglected areas of study as varied as ethics, communication, geography and scale, politics, energy governance, and more (Sovacool 2014). This lack of critical social science involvement has created a gap between the technical domain of energy and the subsequent social and cultural impacts of current infrastructure and future renewable transitions.

Furthermore, understanding the dynamics of energy and climate change is impossible without geography (Knight 2010). The environmental, social, and political resources used in energy production, distribution, and consumption span socio-environmental interactions across spatio-temporal scales. The scale of a geographic approach must provide an analysis of both the local hyper-specific issue and the larger systemic factors that play a role in the social and environmental production of energy. Today's energy system is spatially extensive as many resources are extracted far off and shipped halfway across the globe to be consumed elsewhere.

Scales of energy governance range from the global movement of resources and capital to policies and climate issues at the state and local level (Zimmerer 2011). Framing the different scales of energy as local-to-global, and vice versa, helps define relations from the production and use of energy at a local level all the way to the organization of global economies.

In an increasingly globalized world, the transfer of hydrocarbons, coal, and other sources of energy are highly spatialized. As governments around the world make the transition to new low-carbon energy systems, new spatial understandings and imaginaries will be required (Huber 2015). Renewables may be an opportunity to gain independence and control over energy production and distribution (Barone 2021), but at the industrial scale, it is difficult to determine if this is realistic. Solar farms, wind turbines, hydropower, and biomass creation will each involve substantial land use, highlighting the fact that decarbonizing the energy grid is not an inherently equitable process. Accumulation of land by the state would further reproduce the current landscapes of dispossession by consolidating power and continuing the ongoing privatization of land and energy. What's more, the land use required to facilitate certain climate mitigation projects in some ways hinder their implementation (Vinayak et al 2020). In the American West, the utilization of rural land use for wind farms has implicated the conflict between the 'American pastoral imaginary' and social and economic values (Phadke 2011). Comparably, large scale solar installation projects in India are confronting the issue of land dispossession from vulnerable communities whose livelihoods depend on land cultivation (Yenneti et al. 2016).

An alternative to this kind of extensive and authoritarian land use is to increase rooftop solar adoption. Denholm and Margolis (2008) illustrate that power density – the rate of energy production per unit of area – is highest with flat and tilted rooftop solar versus ground based

solar photovoltaics. Thus, in terms of land-use efficiency and energy efficiency, rooftop solar provides an opportunity for reduced land consumption and increased consumer independence. Self-sufficiency for energy production, whether partial or total, minimizes the dependency of individuals on what is currently a highly regulated and privatized energy system.

3.2 Energy Democracy and Energy Justice

The concept of moving away from centralized corporations and privatization in favor of public-ownership is increasingly referred to as 'energy democracy' (van Veelen & van der Horst 2018). Energy democracy (ED) is seen not only as both an end goal, but also a process. As an end goal to aspire to, ED outlines the path toward equitable access, reduced environmental destruction (Weinrub & Giancatarino 2015), and decentralized and socially controlled energy systems (Chavez and Dove 2015). As a process, it is a framework for policy and social action to achieve these end goals (Burke and Stephens 2017). This effort to democratize energy systems is in contrast to both the function of top-down state regulation and neoliberal market fetishism. Current energy systems are highly regulated and subsidized by the government, protecting corporate profit and reducing competition (Hess 2011). Governments globally spend half a trillion dollars every year subsidizing fossil fuel use alone (IISD 2020). Moreover, oil and gas companies hold immense political influence and power, making the phasing out of fossil fuel subsidies and support unlikely at the rate necessary to limit global temperature rise. Facilitating the transition to renewables through this normative hegemonic approach may reproduce "specific regimes of accumulation" (Furnaro 2019: 969) and continue the centralization and consolidation of energy governance.

A socio-technical approach to energy cannot be the only perspective taken when so much of the current (and future) production, transmission, and consumption processes are entrenched

in political and interscalar relationships of power. Smith and Stirling (2010) highlight the need for a multilevel perspective that "cuts across policy sectors, involving multiple governing agencies, institutions, and policy networks" (8). Researchers are continuing to integrate the role of politics into energy transitions as emerging work moves to include the geopolitics of renewables (Vakulchuk and Scholten 2020; Bazilian et al. 2020) and incorporate economic themes into sustainability (McCarthy 2015). Much of the previous research that *has* included political economy and governance focuses on the global or national scale (Chang and Berdiev 2011; Matutinović 2009; Florini and Sovacool 2011; Gunningham 2011). While understanding these scales of power is important, both alone and in how they shape smaller scales of production and consumption, a more localized approach is necessary as renewables are projected to reduce dependency on foreign imports.

Energy democracy focuses on the rebuilding of governing systems, innovation, and experimentation, as part of "a shift to more local or regional-based systems and decentralized technologies and management structures" (Burke and Stephens 2017: 36). This approach advances community-based control and provides the opportunity for reduced dependency on utilities and the continuous extraction of a limited, harmful resource. Furthermore, local control of energy policy and financial resources created from the energy network would present new economic opportunities for poor communities by reshaping the role and identity of energy producers, along with where funding and profits primarily circulate (van der Schoor et al. 2016). Local and decentralized systems may constitute 'true' energy democracy to some, but others argue that public utilities have the opportunity for democratization through empowering legitimate participation in energy systems and ensuring racial minorities and low-income groups have equal access (Chavez and Dove 2015). This places corporate action at the center of the path

toward energy democracy. While utility companies may play a role in the sociotechnical transition to renewables, others say intended outcomes can only be reached through the resistance and decentralization of existing regimes (Turnheim and Geels 2012). These differences display the scale of issue here; this may not be something that can be solved through small scale efforts, but instead requires massive public ownership and a restructuring of the role utilities play in the market (Huber 2022).

Energy democracy is a diverse movement, area of study, and framework within the broader field of energy justice. Energy justice (EJ) is defined as “as a global energy system that fairly distributes both the benefits and burdens of energy services, and one that contributes to more representative and inclusive energy decision making” (Sovacool et al. 2017: 677). This relatively new academic term draws heavily from the core tenets of environmental justice in framing contemporary energy problems as justice concerns (LaBelle 2017). In total, energy justice encapsulates unequal distributions within environmental risks, laws, and regulations along racial, ethnic, and economic demographics (Burns 2014), while focusing on the negative externalities that result from energy production, infrastructure, structural dynamics, and energy disparities.

Jenkins et al. (2016), pulling from the work of John Rawls[3] and others, posit three types of justice: distributive, procedural, and recognition. *Distributive* justice takes on different meanings across disciplines, but in geography it is understood that social inequalities are also spatial inequalities. It concerns the uneven distribution of environmental benefits and hazards, as well as their respective responsibilities (Walker 2009). There is a significant amount of research on the distribution of environmental ills, from the concentration of coal plants in African

[3] Political and ethics philosopher who developed the theory of “justice as fairness.” See *A Theory of Justice*.

American communities (Keating & Davis 2002) to the impact of oil drilling on indigenous land and water supplies (Orta-Martínez et al. 2010). *Procedural* justice is about bringing everyone into the decision-making process and taking heed of all contributions (McCauley et al. 2013). Public participation in decision making and policy is critical in ensuring equitable engagement with the people who will face the effects of said decisions. *Recognition* justice, the third tenet, requires the acknowledgement of "the diversity of the participants and experiences in affected communities" (Schlosberg 2004: 517). Following this recognition is the acknowledgement that these communities should therefore not be subjected to the abuses of fuel poverty, pollution, and other forms of energy injustice.

Not all scholars adopt these three tenets as the working framework for energy justice. Fuller and McCauley (2016) alternatively develop two realms of study: production and consumption; and distribution and procedure. The former captures the questions of energy infrastructure siting, subsequent pollution, and access to affordable energy, i.e., energy poverty (González-Eguino 2015), while the latter relates to the structures in which these issues can be addressed, similar to the definitions above. "Distribution" refers to both availability of access and allocation of responsibility for the costs and benefits of energy, while procedural dictates equal participation and consideration for all consumers. LaBelle (2017), on the other hand, divides energy justice into two interpretations: universal and particular energy justice. Universal energy justice is defined as a "global energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial energy decision-making" (Sovacool et al. 2015: 436). Universal approaches may lead to generalized implementation of energy systems assessed by some to be superlatively democratic or just, but these strategies can interfere with local customs and traditions (Jack-Scott 2020). Particular energy justice moves

away from this Western way of thinking, to a more “particularistic analysis of energy transitions" (Broto et al 2018: 645). This approach incorporates the nuance of local experience and understanding of access to energy resources and utilities (LaBelle 2017). This feeds into *recognition justice*, as it gives voice to those who are living within the uneven distribution of energy access and systems.

As there is not one universally accepted definition of energy justice, the framework can be employed flexibly to tackle large scale issues of production, representation, and distribution. Along with energy democracy, it seeks to highlight and solve the existing inequities in the energy system while preventing new ones from originating. These ideas intersect at the need to examine political power, community solidarity, and the ethical and social aspects of energy. The pursuit of increased community participation and agency in energy is part and parcel of the goal of maintaining and establishing just and fair energy systems. In this sense, energy democracy is necessary for answering the demands of energy justice. Acknowledging the interconnection of energy and social issues creates the opportunity for a more comprehensive and equitable energy transition.

This framework extends to the long standing connections between energy and housing. Energy vulnerability is most significant in the Deep South (Bryan 2020) and is an issue born out of intense segregation, inadequate housing standards, and uneven electricity distribution. Energy codes in the southeast are rarely updated, causing affordable housing to be built at lower, inefficient standards, leaving many households energy insecure. Energy insecurity is the “inability to adequately meet household energy needs" (Jessel et al. 2019: 2). Lower-income households tend to live in poor quality housing, possess inefficient appliances, and face affordability challenges in paying their utility bills. In 2015, 31% of U.S. households reported

some version of energy insecurity, and nearly 20% reported "reducing or forgoing necessities such as food and medicine to pay an energy bill" (US EIA 2015). Energy insecurity can occur at two scales: chronic and acute. Chronic energy insecurity is a long-term, persistent inability to meet household energy needs. Factors such as income, race, and gender can determine accessibility to resources and sufficient energy (Jessel et al. 2019). Acute energy insecurity is a short-term inability to access adequate energy “from infrastructural, maintenance, environmental, or other external sources” (Jessel et al. 2019). This is typically due to natural disasters, shutoffs, or corporate failures. These two forms of insecurities are distinct but can be experienced simultaneously.

Those engaged in energy justice work must incorporate their efforts into the work of energy geographers to produce a more ethics-centered understanding of energy systems in a field that is otherwise dominated by engineers and economists who focus solely on technical efficiency and market pricing (Sovacool 2016).

3.3 Critical Geography and GIS

Geographic scholarship has evolved over time as a field devoted to the study of earth’s places, features, and the relationships between people and their environment. Geography provides a way of making sense of the world and contributes a framework for communicating this knowledge. Though there were applications early on in the 20th century, it wasn’t until the 1970s and 80s until radical geography, or better known today as critical geography, was formally introduced and recognized as a branch of scholarship. Critical geography developed out of the idea that there “is no such thing as objective, value-free and politically neutral science” (Peet 1997, 1). Peet goes on to define radical geography as a practice that “strips away diversions, exposes existing explanations to criticism, provides alternative explanations which trace the

relationship between ‘social problems’ at the surface and deep societal causes, and encourages people to engage in their own theory construction” (Ibid.). Critical geography is meant to work as an agent of change and operates as an objection to positivist epistemologies that are reductive in the name of objectivity and remove context and positionality from knowledge production.

Throughout this evolution in human geography, new definitions and conceptions of space were incorporated into the practice. In his decisive book, *Social Justice and the City*, David Harvey (1973) characterizes three interpretations of space: absolute, relative, and relational. Absolute space is considered fixed and removed from any external relations, independent of its surroundings, while relative space is defined by the relationship between objects and only exists because of how objects relate to each other (Harvey 2006). By contrast, relational space states that an “object can be said to exist only insofar as it contains and represents within itself relationships to other objects” (Ibid.); that space only exists because of the processes that create it. Ultimately, there is no one correct definition for space. One or all can be true simultaneously, and it is humans who apply meaning to space and the practices that create it. While some researchers may disagree on the place for more abstract understandings of space within geography and alternatively, the incorporation of quantitative research into parts of the field, the combination of critical geography and quantitative research have vast opportunities when applied correctly.

Given critical geography’s focus on understanding and challenging structures of oppression, it is important for geographers to recognize that there is political power in counting and statistical representation (Lawson 1994; Carter 2009), but the current positivist approach within conventional quantitative geographic analysis can oversimplify and generalize otherwise very complex social phenomena. Examining spatial and statistical data through GIS, Census

data, and more can be decidedly powerful in producing knowledge about social and economic disparities, but often abstains from inclusion of the larger social and political context that reality operates within. Quantitative methodologies have been co-opted and used to further separate the fields, working to reproduce positivist epistemologies and reductionist practices of knowledge production (Wyly 2009). Research has shown that this practice can provide an overemphasis on the technique over the subject which "has led to the production of simplistic and flawed race research" (Carter 2009; Wright & Ellis 2006). The goal of quantitative methods is to analyze mathematical and statistical data, but this data does not materialize out of nothing. How data is collected, who is counted, who is excluded, the researcher who gathers and examines said data, and more all impact the outcome of quantitative research and yet there is a reluctance to incorporate critical scholarship and analysis to the process.

One breach of this polarity can be found in critical GIS, which is defined as the "theoretical and empirical consideration" of "how GIS has been used to reinforce or challenge social injustices" (Thatcher et al. 2016). Much of geospatial work has confined itself to the limited definition of space as points in the Cartesian plane and has forgone space as a social construction, as touched on previously in this section. Within energy research, discussions of space have become integral in the growing field of energy geography but are limited to more surface level understandings of space (Bridge 2018). GIS has primarily been used for locating sites for energy production and best pathways for transmission, be it fracking or solar. However, with the incorporation of more critical approaches, there is a great opportunity for the use of GIS in understanding the depths of spatial and societal inequality, inside and out of the energy market.

4 METHODOLOGY

In order to understand the social and spatial dimensions of rooftop solar adoption in Atlanta, this research was originally conceived as a mixed methods study focusing on the geographic distribution of rooftop solar and the political and power relationships among relevant actors that shaped it. The initial proposal for this thesis included a research plan based heavily on qualitative data gained through interviews and archival and document analysis. I set out to fill a gap in the literature that appeared to lack an in-depth analysis of not only the influence of institutions like Georgia Power and the Public Service Commission on Atlanta's energy market, but the greater racial and socio-economic factors that bar some and enable others greater access to participation in this component of the clean energy transition. These objectives motivated my original research questions, as follows:

RQ1: What is the geography of solar adoption across Atlanta and what socio-spatial factors help to explain this distribution?

RQ2: What existing relationships among the City of Atlanta, the Public Service Commission, Georgia Power, and others shape the possibilities for rooftop solar expansion in Atlanta?

RQ3: What policies and regulations have reinforced uneven access to energy in Atlanta and what is being done to create a more equitable energy system?

After receiving approval from the Institutional Review Board to perform interviews, I created questions and an outline of who I would interview, how, and why. I set out to investigate the role of public officials and ask questions about the processes and reasoning behind certain actions and policies, as well as their thoughts on the public response. For community groups and private individuals, I had planned to address certain policies, but my questions were primarily focused

on whether or not they possessed knowledge of these decisions, the role of the PSC, and about impacts they've faced in light of these circumstances

Additionally, I conducted secondary research through existing policy, academic texts, and journalistic articles to gather information about the historical, economic, and political changes that have formed the modern electricity market from which Georgia Power has emerged, as well as to determine the factors that define the relationship between the customers, the corporation, and the state. I attended or viewed several Public Service Commission hearings, few of which were open to the public. I also read through hearing transcripts, campaign donations, and legislation put forward by the commission or on its behalf. Additionally, I followed press coverage, blog posts, and social media to gauge public opinion on the City of Atlanta's sustainability efforts, Georgia Power, and decisions made by the Public Service Commission.

After failing to secure interviews with Public Service Commissioners, local community group leadership and members, candidates running for elected positions, Georgia Power representatives, and other relevant actors in the Atlanta energy sphere, this initial research goal proved unattainable for the timeline that I had. I made the decision to pivot my research to a more GIS-based analysis of secondary data on solar adoption across the city. I maintained the premise of my first two questions from the original project, but instead of making the political and legislative action the centerpiece of my study, I used it as supplementary qualitative knowledge that informed the strategy for, and interpretation of, my GIS analysis. This understanding of how restricted rooftop solar has become in Georgia and the resulting impacts of uneven access, based off the previous intentions of this research and the literature on socio-spatial inequity, informed my decision to move into a more in-depth focus on the spatial patterns of solar adoption and its possible correlation with the movement of capital across Atlanta and the

changing demographics of neighborhoods in which solar is increasingly located. These ideas and changes led me to ask the following updated research questions:

RQ1: What is the geography of solar adoption across Atlanta and what socio-spatial factors help to explain this distribution?

RQ2: How are the uneven geographies of solar shaped by housing market and demographic change in Atlanta?

RQ3: What existing relationships among the City of Atlanta, the Public Service Commission, Georgia Power, and others shape the possibilities for rooftop solar expansion in Atlanta?

4.1 Data

This project combines City of Atlanta data on solar installation permits, publicly available Fulton and DeKalb County housing data, and demographic data from the U.S. Census Bureau to create a full picture of rooftop solar in Atlanta.

4.1.1 Solar Data

Permit data accessed through the City of Atlanta[4] was used to locate addresses for homes with rooftop solar. This data included date of permit approval, status, address, permit name, and descriptions of the PV system types. Dates and addresses were the primary data points taken from this source, though names on the permits were used to cross reference for address and ownership accuracy. I began with 438 permits through the city website, which includes data from just one in 2017 when the first permit was issued up to March of 2022. These permit files had to be cleaned and filtered for duplicates, false permits, and systems that were registered but had yet to be issued to the homeowner. My final dataset from the city permits list came out to 400 total

4 https://aca-prod.accela.com/ATLANTA_GA/Cap/CapHome.aspx?module=Building&TabName=Building

residential installations and does not include any new permits that have been issued since the time of selection.

Date	Record Number	Record Type	Address	Description	Permit Name	Zoning/Prope	Parcel numbe	Year bui	Owne	Current Total Value	Notes on Ownership Change	Ownership
4/17/2017	PV-201800001	Solar PV Single	1337 FAIRVIEW R	INSTALLATION OF SOLAR PAN	LASSITER - SOLAR PANELS - XPF		15 241 01 13	1925	Y			
2/13/2018	PV-201800002	Solar PV Single	823 HARTFORD F	INSTALL 5.32KW SOLAR PANE	VACHON SOLAR I	R4/ R3- Resid	14 01050002	1929	Y	$ 136,700.00	Went to Wells Fargo in 200	Y
6/12/2018	PV-201800007	Residential - Sc	1389 PLAZA AVE	INSTALL A 3.360KW SOLAR A	MOORE - SOLAR	R4/ R3- Resid	14 01380002	1963	Y	$ 148,000.00	Sold to My Discount Home	L
6/12/2018	PV-201800005	Residential - Sc	627 ORMEWOOD	INSTALL A 3.245KW SOLAR A	PALESCH - SOLAR	R5/ R3- Resid	14 00220007	1924	Y	$ 611,600.00	Only sold between people	O
6/12/2018	PV-201800006	Residential - Sc	1205 MANSFIELD	INSTALL A 5.6KW SOLAR ARR	QUICK - SOLAR PV - XPRS		15 240 03 00	1993	Y	$ 536,900.00		
6/29/2018	PV-201800014	Residential - Sc	1408 NORTH MC	SOLAR PANEL INSTALL	SMITH-SOLAR-XF	R4/ R3- Resid	17 00020006	2009	Y	$ 1,340,400.00	Went to American Home M	L
6/29/2018	PV-201800015	Residential - Sc	60 LAKEVIEW DR	SOLAR PANEL INSTALL	GROSSMAN-SOLAR-XPRS		15 205 01 04	1916	Y	$ 714,700.00		
7/5/2018	PV-201800016	Residential - Sc	554 WINTON TER	INSTALL A 5.9KW SOLAR PAN	MENTER RESIDEI	R5/ R3- Resid	14 00470003	1920	Y	$ 567,300.00	Only sold between people	O
7/20/2018	PV-201800019	Residential - Sc	402 LAKESHORE	INSTALLING A 4.76 KW SOLA	CYR-PV-XPRS		15 238 05 10	1940	Y	$ 769,600.00		
8/13/2018	PV-201800027	Residential - Sc	746 LEXINGTON	INSTALL 3.245KW SOLAR ARF	POVERTOD - SOL	R4A/ H3- Hist	14 01060012	1921	Y	$ 176,600.00	Went to American Propert	O
8/13/2018	PV-201800026	Residential - Sc	220 BEREAN AVE	INSTALL 3.45KW SOLAR ARR	DUFFY - SOLAR P	HCR5/R3- Res	14 00200004	1990	Y	$ 372,000.00	Only sold between people	O
8/13/2018	PV-201800025	Residential - Sc	2211 VIRGINIA P	INSTALLING A 3.54KW SOLAF	MATTHEWS - SOI	R4/ R3- Resid	17 01020013	2017	Y	$ 1,095,200.00	Only sold between people	O
8/13/2018	PV-201800023	Residential - Sc	1724 BARNESDAI	INSTALLING A 7.08KW SOLAF	GASSMAN - SOL	R3/ R3- Resid	17 01040001	1950	Y	$ 803,900.00	Only sale listed is to currer	O
8/13/2018	PV-201800022	Residential - Sc	21 MADDOX DR I	INSTALL A 7.08KW SOLAR AR	BROWN - SOLAR	R4/ R3- Resid	17 01050005	1920	Y	$ 1,185,000.00	Sold in 2010 for $730,000	O
8/13/2018	PV-201800024	Residential - Sc	23 WYMAN ST N	INSTALLING A 6.785KW SOLA	AYERS - SOLAR PV - XPRS		15 207 01 03	2017	Y	$ 670,300.00		
8/13/2018	PV-201800021	Residential - Sc	1418 METROPOL	INSTALL A 4.72KW SOLAR AR	LITTLE - SOLAR PV - XPRS		15 177 02 06	2004	Y	$ 584,700.00		
9/12/2018	PV-201800034	Residential - Sc	450 BILL KENNED	INSTALL A 4.72KW SOLAR AR	NORVELLE - SOL	PDMU/R3- Re	14 00120006	2006	Y	$ 528,500.00	Sold in 2006 to buyers and	L
9/12/2018	PV-201800032	Residential - Sc	137 FLAT SHOALS	INSTALL A 9.44KW SOLAR AR	GARRETT - SOLAI	R5/ R3- Resid	14 00130009	2007	Y	$ 617,800.00	Sold from LLC to owners in	L
9/12/2018	PV-201800029	Residential - Sc	1476 NORTH HIG	INSTALLING A 9.44KW SOLAF	VILLOUTREIX - SC	R4/ R3- Resid	17 00020003	1925	Y	$ 1,494,100.00	Sold to Taylor Custom Hon	L
9/12/2018	PV-201800031	Residential - Sc	3117 PEACHTREE	INSTALL A 10.03KW SOLAR A	ABSHIRE - SOLAR	R4/ R3- Resid	17 00460011	1940	Y	$ 716,000.00	Only sale listed is in 2012 t	O

Figure 2: A snapshot of the spreadsheet used to collect information on the homes with solar. The letters in the ownership column on the far right end represent owner occupied (O), LLC or corporate owners (L), bank owned (B), and a combination of bank and corporate ownership.

Additionally, I located homes that had installed rooftop solar before permits were required by the city through published state data from SolarView[5], a solar asset management platform. After filtering through commercial and residential solar located throughout the state, I narrowed down 56 additional homes with residential solar in the city limits of Atlanta. Combining permit data with SolarView, I came up with 456 total homes with rooftop solar in the City of Atlanta. Once the files were cleaned, I geocoded the permit addresses through ArcGIS Pro, by taking the postal address and attaching rooftop latitude and longitude location coordinates. For the SolarView data, only longitude and latitude were provided, meaning I had to reverse the process and search the coordinates to locate addresses for later analysis beyond just spatial visualization and patterns.

[5] https://zenodo.org/record/1477581#.Y02zgXbMKUm

4.1.2 Tax Assessor Data

Using these addresses, I then went through the Fulton and DeKalb County Tax Assessor websites to search each address to determine a variety of characteristics for the properties in question: ownership change, status, home value, unit type, sale history, year built, and land and building value trends. The majority of addresses located in Fulton County had data with the Board of Assessors, but DeKalb County data was significantly less accessible. Beyond current ownership, home and sale value, and year built, housing data in DeKalb County is held behind a paywall and was inaccessible for this research. For citywide analysis, this did not prove to be an issue as value, ownership, and location were still available and made up the primary data necessary for analysis. However, because the sales and ownership histories for DeKalb County properties were generally unavailable, these properties have been excluded from certain analyses later in the thesis. In those cases where missing data led to properties being excluded, it is noted by footnote. Having all of the address data for the homes not only allowed me to create an image of their location in absolute space, one part of the beginning of my first research question, but also provided the basis of my housing analysis for change and redistribution across the city.

4.1.3 Census Data

Once I had all the point locations for homes with rooftop solar, I collected demographic data from the American Community Survey (2015-2019 ACS 5-year estimates) to classify addresses across income, race, renter and homeownership rates, and poverty levels. This data was accessed through the Atlanta Regional Commission's open data portal[6], which does perform some pre-processing and cleaning of the data before publishing. For change of race over time, I used ACS 5-year estimates from 2006-2010 and 2015-2019. Race, income, and housing tenure were the

[6] https://opendata.atlantaregional.com/

central datasets used for this research, as the literature names these as some of the primary factors in determining solar access disparities (Sunter et al 2019; Reames 2021; Darghouth et al. 2022). Data on energy burden and annual energy costs were gathered from the Department of Energy's Low-Income Affordability Data (LEAD) tool[7]. Energy burden is a tangible effect of all these overlapping social and demographic characteristics and was used to provide another layer of analysis for who and why rooftop solar has greater benefit potential for certain households.

4.2 Approaching the Analysis

Altogether, in this project I combined demographic information and housing data to create a more in-depth comparative analysis of trends over time, as well as a variety of descriptive statistics related to rooftop solar adoption in the city. In geography and other social sciences, a dualism between qualitative and quantitative research exists that commonly pits the efficacy of the methods against one another (Lawson 1994). In reality, "true geography is a natural meeting point for the quantitative and qualitative" (Procheş 2016). I set out to use these two methods in tandem and focused on combining written description and experience with Geographic Information Systems and descriptive statistics to serve as a critical midpoint.

The method of locating and interpreting data in this project turned out to be a very messy process. Compiling data sources from the U.S. Census Bureau, different federal departments, the city, and more required careful attention to detail. While I worked almost entirely with secondary data, no matter how careful I was in collection and selection or how in depth the primary data collection may have been, it must be acknowledged there will always be a level of abstraction and generalization to this work. While creating overlays, like those shown in Figure 3 on the next page, allowed me to quantify some of the phenomena I sought to capture, a process that has

[7] https://www.energy.gov/eere/slsc/maps/lead-tool

potential to bring about real tangible political power (Lawson 1995), the complexity of the "real world" is still abstracted and simplified through the basic principles of map making. It is impossible to create an "objective" map, as maps are only symbolic interpretations of place and space and are influenced by these processes and a map maker's implicit bias, among other factors (Harley 1990; Harvey 2006; Crampton 2001; Crampton 2010). I experimented with data classification, styling decisions, and data deconstruction both within the numbers and through ancillary text and descriptive analysis, to be as critical as possible both in my maps and analysis.

I chose an analytical approach that focused on 'grounded visualization,' a term coined by Knigge and Cope (2006) to combine the similarities of grounded theory and visualization. This method emphasizes exploration, consideration of general patterns and particular instances, and encourages the usage of multiple perspectives for knowledge building (Ibid.). I created numerous maps to display spatial patterns and variables relevant to my research questions, including date of permits, current ownership status, previous ownership status, last date sold, housing tenure, energy burdens, and annual energy costs. This exploratory visualization process was iterative and recursive, a point also addressed by Knigge and Cope (2006), and was not only helpful for distinguishing connections in the data that would have been difficult to make without the added spatial component, but also created space for new theorization and identifying further questions about the data and analysis.

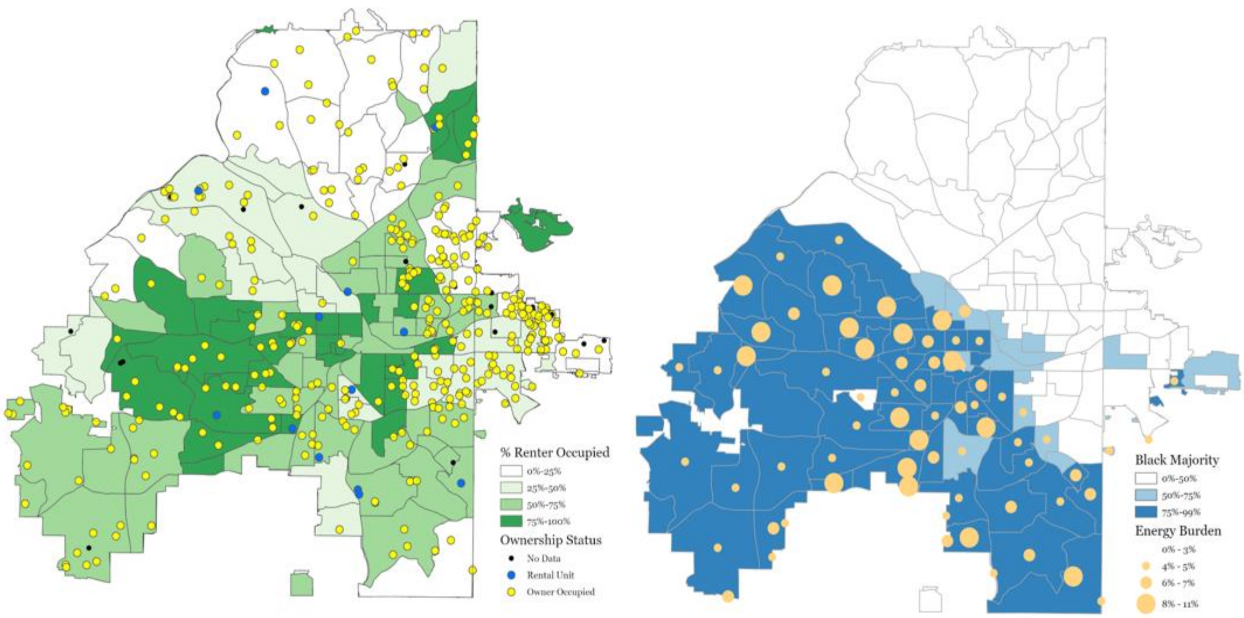

Figure 3: On the left, the map shows percentages of renters by census tract compared with solar homes that are owner occupied or rentals. There are very few rental units with rooftop solar, but this map does show the clustering of solar homes in areas with lower.

To verify ownership status for the map above and other analysis, I cross-checked the name on each solar permit with the owner of its listed housing unit. Because an individual or company can own a home and not live in it, I made sure the name and address on file for the listed owner of each home matched the actual site address to ensure it was an owner-occupied unit.

Because of the history of access to home ownership and how energy burden differs across demographics, something I elaborate on later in the analysis chapter, these maps above are just two examples of the many variables I chose as points of analysis in the effort to answer my first two research questions. To understand the role of socio-spatial factors and social redistribution in the city and its relation to patterns of solar installations, I also looked at where higher rates of homeownership exist, who owns certain types of homes, when the owners purchased their home, when solar was installed, and more. I selected these variables because they were accessible and

trackable across time, allowing me to create a timeline while also displaying patterns of movement throughout different parts of the city.

Synthesizing this data created a more detailed picture of trends in adoption across ownership status, value, and building trends. Sales data, in combination with other information, such as building and land value change, allowed me to make assumptions about neighborhood change in relation to house flips, rebuilds, sharp sale price increases, and more. For example, I located a home with solar at 2069 Beecher Rd SW on Atlanta’s westside. The house was sold in 2014 for $7,600 to an LLC. In 2016 it sold for $45,000 to an individual, and then sold again one year later to the current owner for $225,000. Using this information, I deduced that the home was likely flipped between 2016 and 2017. I then went to look at the home through Google Street View to confirm my speculations by comparing the status of the home during these years.

Figure 4: Comparing the home before it was sold in 2015 to 2019, after the home was flipped and solar panels were added.

I did this for a number of the homes that had an evident pattern of flipping in their sales history to further break down the data to the level of each individual home. Though I looked at all solar homes across the city, the majority of home flips like the one above are located in predominantly low-income and Black neighborhoods. Disaggregating the data further like this

helped to make additional connections between income, race, home value, ownership status, and rooftop solar, along with the spatial and temporal patterns seen later in the paper.

Throughout this research, I sought to incorporate parts of critical geography that commit to "emancipatory politics, progressive social change and, of course, systematic map critique" (Delon 2020, 1). A lot of mapping in the energy field, as it has begun to integrate spatiality, has confined itself to a very literal and limited understanding of space (Bridge 2018). In my data collection, research, and analysis, I aimed to incorporate the reality that space is a social production and not just limited to the points on my maps. The geography of solar in Atlanta is not just in the physical location of each housing unit with PV installation; it is also the social structures of differences and shared understandings that create the space in which rooftop solar access is attained and obstructed.

I utilize the idea that maps operate as a "communication device" (Crampton 2001), displaying only one selection of reality. My maps here are not just an assembly of data displayed in geographic space but provide a narrative for the story of these different places. With this project, I aimed to chronicle the story of how Atlanta's rooftop solar market has come to be and the factors that were integral in shaping it to what it is today, as well as to show how solar is playing its own role in shaping the city, a phenomenon already well documented through the use of other green infrastructure development (Black and Richards 2020; Rice et al 2020; Immergluck and Balan 2018). Contradictions exist, shown in a number of these studies, wherein cohorts of increasingly middle- and upper-class households coalesce in areas that were previously low-income, in close proximity to public transportation, and have higher non-white populations in search for the benefits of high-density, mixed use, and lower-carbon living (Rice et al 2020). However, the result is not a lower carbon footprint; in fact, it is just the opposite.

Through this process, vast neighborhood change in population demographics and housing value occurs, but the carbon footprints of the neighborhood only increase. While rooftop solar may often not be considered as a type of green infrastructure in many of these studies on green gentrification, I propose it is an issue that requires more attention by scholars interested in the intersection of energy justice and housing. This thesis highlights how these trends are happening in Atlanta, and ultimately suggest that rooftop solar provides another possible method of tracking gentrification and neighborhood change.

5 AN ANALYSIS OF ATLANTA'S ROOFTOP SOLAR

Rooftop solar in Atlanta has expanded rapidly over the past few years, despite an adverse political and economic environment. Residential solar has spread across the city through hundreds of new installations, many of which have occurred in just the past two years. However, the geography of solar distribution in Atlanta remains uneven, collecting in wealthier and whiter areas on the east and north side. I situate these patterns not only within the systemic issues tethered to solar access, but also within the larger political, economic, and social context of the city.

As mentioned previously in the discussion of Georgia's 'solar cap', government tax credits and state utility regulations play a key role by shaping the financial incentives for solar adoption. Since the participation cap has been reached for Georgia's net-metering program, there is no longer a substantial financial incentive for consumers that would encourage solar expansion in the state. The city of Atlanta has similarly done very little to help reduce the gap in energy efficiency and bolster renewable access. This chapter is split into multiple sections to provide deeper insight into the role income, race, and homeownership all play in shaping access to rooftop solar, and how solar installation plays a key role in helping to reshape the social and spatial organization of the city. Context and evaluation of the unique characteristics of Atlanta will be discussed later in this chapter, as they relate to local trends that provide a unique insight into the circumstances that have created trends in the city that on paper appear to differ from those at the national level.

5.1 Solar in Atlanta

While Atlanta's solar market has grown exponentially over the past five years, almost all other major cities in the U.S. outpace it, leaving it in the bottom five of the top 50 cities with

solar (Olano 2022; Cape Analytics 2019). However, the city has gone from just 56 residential installations in 2017 to 456 by early 2022, 800% increase in the past five years.

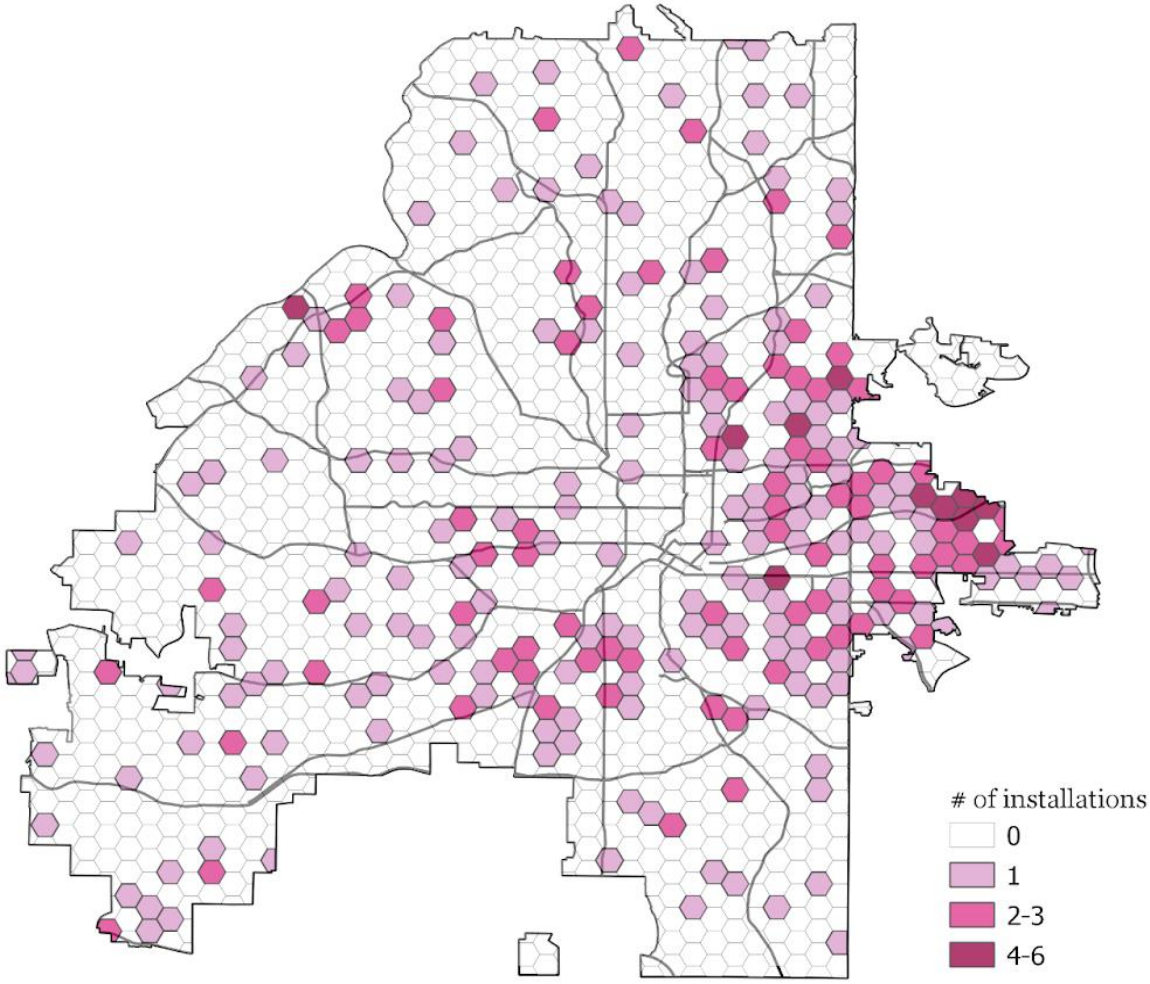

Figure 5: Aggregate map of rooftop solar in Atlanta.

As shown in Figure 5 above, the geography of solar adoption remains uneven in the city, collecting on the east and north side in neighborhoods like Lake Claire, Kirkwood, and Candler Park, as well as the northeastern section in Virginia-Highland, Morningside, and Ansley Park. The vast majority of these units with solar are single family homes and are currently owner occupied.

Rooftop solar adoption in the city has also seen distinct spatio-temporal change over the past decade. Before 2021, the city had 209 solar installations dating back to the earliest listed installation in 2009.

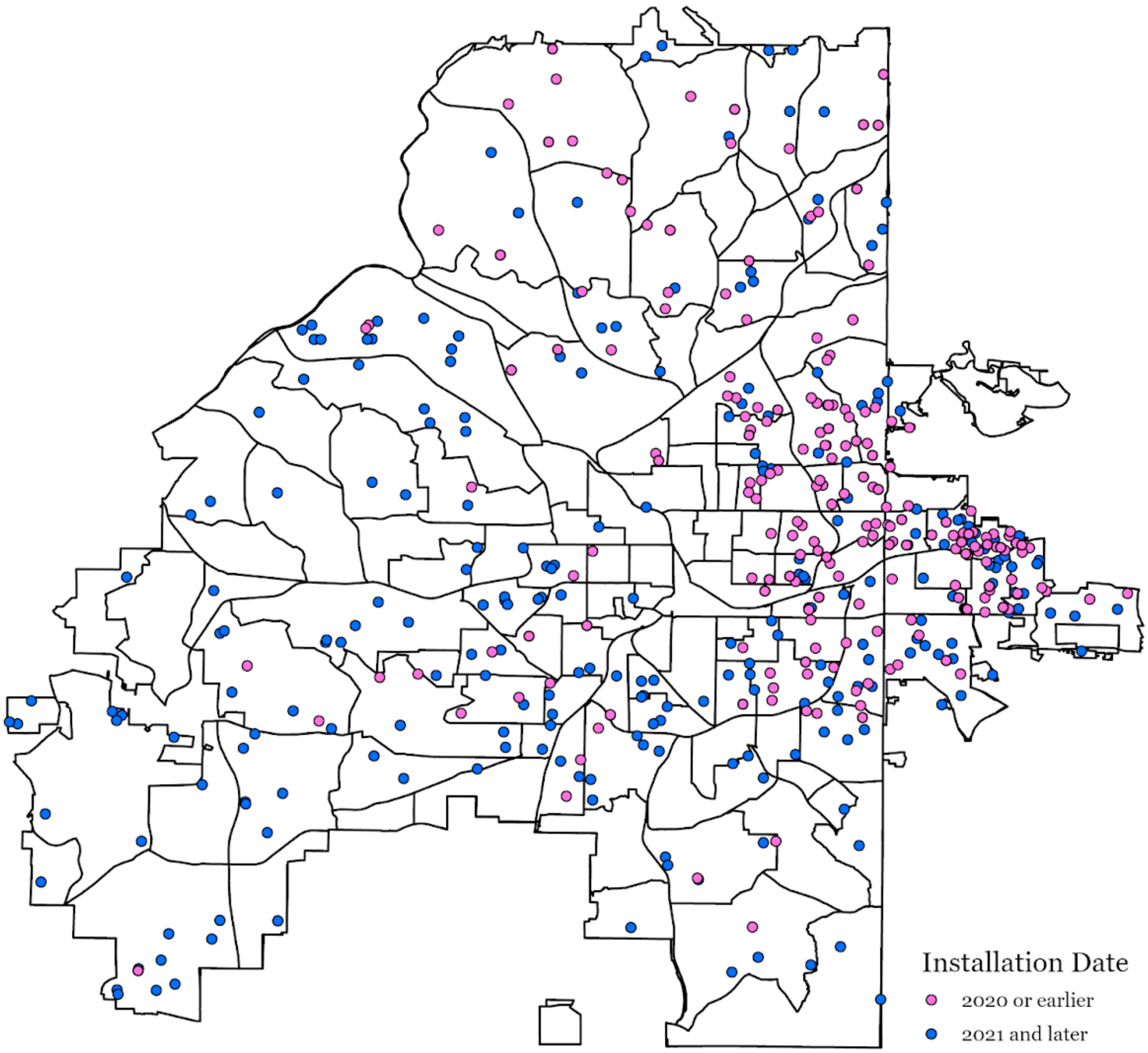

Figure 6*: Map of solar installations before and after 2021.*

Since 2021, the total has more than doubled, with 247 new installations in a 15-month time period. The majority of these new permits are located on the west and south sides of Atlanta, different from the patterns of adoption seen prior to 2020. Many of these neighborhoods differ from national trends in that they are lower-income and majority-minority. However, overall the demographics of solar in Atlanta maintains similar trends to those found at the

national level of wealthier, whiter adoptees, while also differing in spatial layout due to the unique context and the current movement of people and capital within the city. Income, race, and homeownership status all impact the adoption of residential rooftop solar both in and out of the city. In the following section, I explore the ways in which these factors play out in the data collected from permits and other sources explained previously.

5.2 Key Factors Shaping Solar's Uneven Geography in Atlanta

5.2.1 Income

Much of the research concerning rooftop solar disparities focuses on the large income gap between households with solar and U.S. households in general. Though that disparity is decreasing as solar costs continue to decline and alternative financing options become available, it remains substantial. In 2021, homes with solar in the U.S. had a median household income (HHI) of $113,000, compared to the median income of $64,000 for all U.S. households (Berkeley Lab 2022). Only 14% of households with rooftop solar have annual incomes less than $50,000 (Ibid.). In Atlanta, based on the median value of homes with solar, it is likely that this percentage is even smaller. In 2020, the median home value for a home with rooftop solar in the city was $675,000. A 30-year mortgage on a $675k home would require a HHI of around $185,000 (Capital Bank 2022), more than triple Atlanta's current median HHI.

The distribution of solar in Atlanta differs from national trends, where wealthier neighborhoods have higher adoption rates, in that a large percentage of the city's solar is located in low-and moderate-income neighborhoods. Before 2021, there were 209 registered residential rooftop solar installations in the city of Atlanta, 74% of which were in census tracts with average household incomes exceeding the city's median of $64,179. Since then, the number of permits in

tracts with median HHI below the citywide median has increased dramatically, now comprising 43% of all rooftop solar installations in the city.

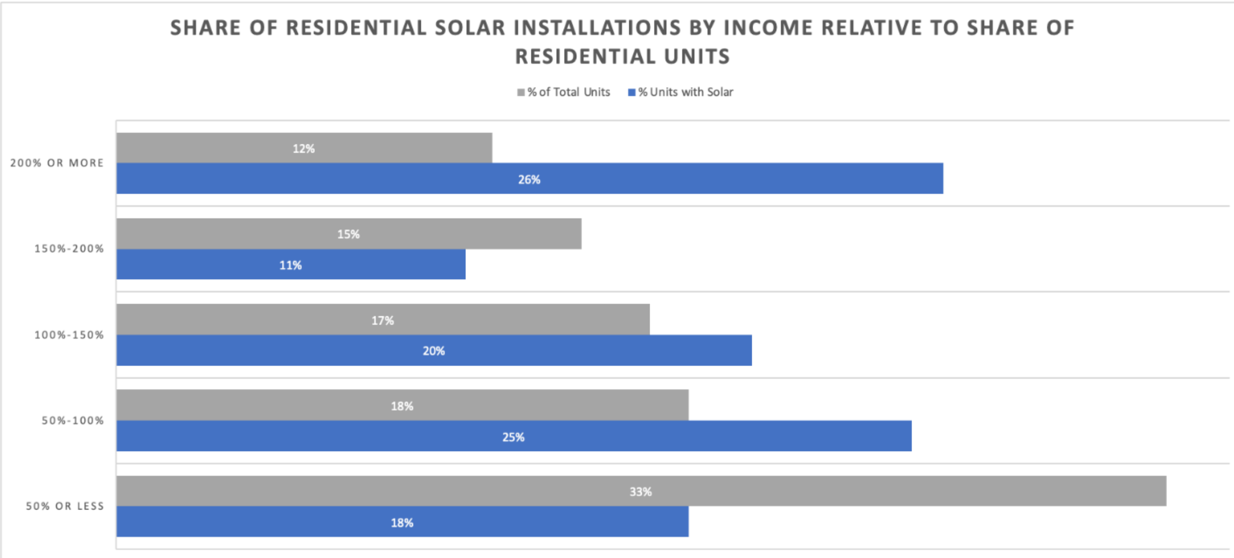

Figure 7: Share of residential solar installations by income relative to share of residential units.

18% of the city's total rooftop solar is located in census tracts where most residents make less than 50% of the city's median HHI, about $32,000 or less. In Georgia, after federal tax credits are applied, the average cost of a 6-kWh rooftop solar system is $10,700 (Neumeister 2022), an outrageous number for a household making near-poverty wages. While under-representations in this category may well be expected, the proportion to overall adoption rates is still unrealistically high. A total of 83 homes with rooftop solar fall within these census tracts, a number of which are selling for $400,000 to $700,000, well above the median housing value and cost accessibility for legacy residents in the area. However, the majority of homes are significantly under the overall median for homes with solar. Additionally, another 25% of all units with solar are in census tracts with incomes of 50%-100% of the city's median HHI, though those tracts contain only 18% of the city's total housing units. This overrepresentation is compelling when compared to national trends that show reduced access and adoption rates of

solar in middle- to lower-income tracts. The home values of these units with solar are well under both the overall city home value median and the median for homes with solar.

Similar to nationwide trends of higher income households maintaining the highest rates of solar (Barbose et al 2020), the highest-income tracts of Atlanta have a stark overrepresentation of homes with solar. Solar units represent more than double the share of Atlanta's housing located in tracts making 200% or more above the median HHI. In a state where financial incentives such as subsidies, rebates, and favorable net metering policies are far and few between, it is conceivable that over a quarter of all solar in the city is located in census tracts making $125,000-$170,000 a year. Higher income households are able to make the financial decision to purchase expensive solar panels or have the credit score necessary for financing.

Income plays a large role in acquiring rooftop solar. Through Georgia Power, there is no solar rebate available in the state, nor is there any opportunity left for new customers to participate in net metering, both two key financial incentives that would aid in expanding solar to lower-income households. There is currently a 30% federal tax credit available through the new Inflation Reduction Act, however this still leaves thousands of dollars in upfront costs with slow payoffs, not something a majority of households can afford to take on.

5.2.2 Race

As the transition to renewable and clean energy sources continues to gain traction with governments, businesses, and individuals alike, studies are emerging with troublesome findings: marked racial disparities exist in rooftop solar deployment (Kwan 2012; Reames 2021). Even when correcting for income and homeownership status, the inequalities nationwide are distinct with 61% less solar installation in majority Black census tracts (Sunter et al 2019). In Atlanta, despite having a much larger Black population than the national average, over 35% higher, the

statistics aren't much different. Majority Black census tracts in the city have 54% fewer permits than non-majority Black census tracts.

In mapping the locations of rooftop solar installation, I found stark spatial patterns across geographies. The current overrepresentation of solar in low-income areas mentioned earlier correlates with the sudden expansion of solar permits into Black neighborhoods over the past year and a half. Within the city boundaries, 64% of all permits are within majority white or no majority census tracts. Before 2021, that number was 83%, with only 36 permits located in majority Black neighborhoods.

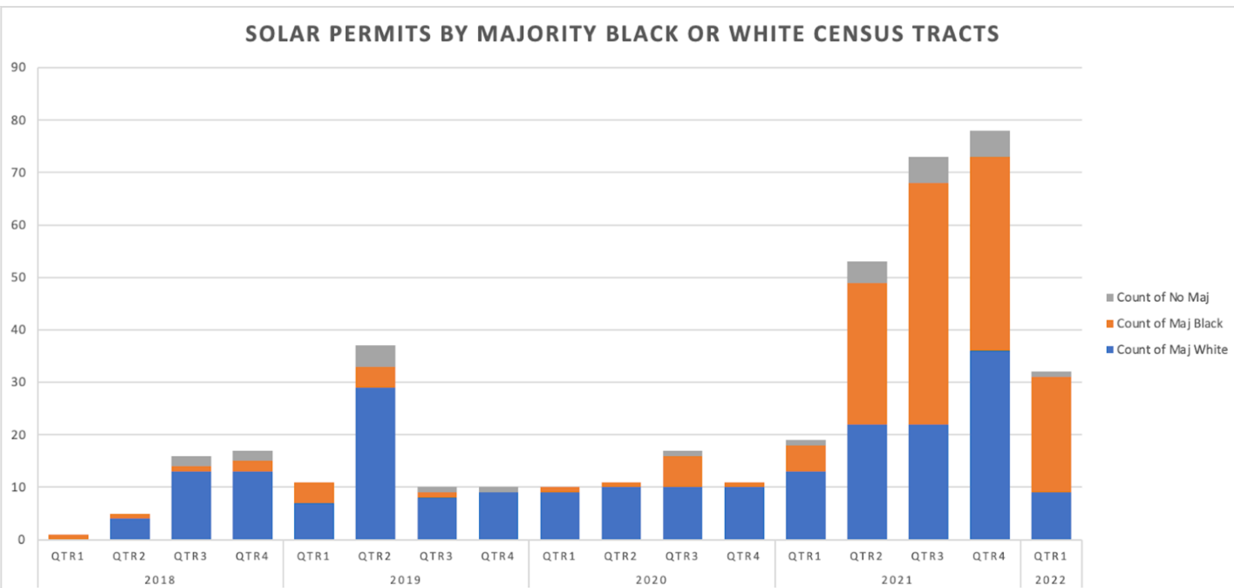

Figure 8*: Solar permits by majority Black or white census tracts.*

Beginning in 2021, there was a sudden shift in which of all newly added permits, those located in majority Black neighborhoods surpassed those located in majority white neighborhoods. Of the 244 solar permits added in 2021 and 2022, 53% were in majority Black neighborhoods. Many of these installations are located in historically Black neighborhoods such as Pittsburgh, Mozley Park, and Rockdale, which all have over 90% Black populations. This sudden change in trend seen in Atlanta is a distinct difference to national trends of significantly

lower adoption rates among Black households, and suggests that Atlanta *may* be making progress in closing the racial gap in residential rooftop solar adoption. As I will discuss later on, there is an evident temporal shift that correlates with other changes occurring in the city that will inform the possible reasons for this abrupt development.

5.2.3 Homeownership

Homeownership, a status heavily impacted by both income and race, is likely the foremost leading indicator of solar adoption in the United States. In part due to the design of government incentives and tax credits, homeowners face fewer barriers and more reasons to purchase rooftop solar. Renewable and energy efficiency tax credits and rebates for climate forward upgrades are primarily targeted toward those who are able to make structural changes to their units and properties, i.e., homeowners. Owning the roof you live under provides much more flexibility for how and where you source your electricity from. As such, renters are left out from many of these possible benefits due to a lack of agency over their unit modifications and structures.

In the United States, homeownership is the principal method for building wealth. However, ownership is not accessible to everyone, nor does wealth accrue equitably across owners. The gap between Black and white homeowners is the highest it's been in 100 years (Lalljee 2022), with a nearly 30% difference in homeownership rates between white and Black Americans (Snowden and Evangelou 2022). Black homeownership saw a steady increase since the passage of the Fair Housing Act in 1968, which prohibited discrimination on the basis of race, sex, disability, and more, but those gains were diminished after the Great Recession. Black homebuyers had been disproportionately "targeted for predatory and subprime lending, even

when they qualified for traditional mortgages" (Sarra and Wade 2020: 4). This has left the rate of Black homeownership today lower than it was in the 1960s (*Reducing* 2019).

In Atlanta, the Black homeownership rate currently sits at 49%, 27 points lower than white homeownership rates (2020 U.S. Census). Disparities in homeownership only exacerbate the differences in rooftop solar adoption, as 96% of homes with solar in Atlanta are owner occupied[8]. With how incentives and tax credits work, this leaves out solar as an option for the 55% of the city's population who are renters. Two totally different realities exist for renters and homeowners in the city. In 2019, nearly half of all renters faced housing affordability challenges, with nearly 24% considered severely cost-burdened, defined as those who pay more than 30% of their income on housing, compared to one-fifth of homeowners in the city facing affordability challenges (Pendered 2020). In many cases, renters make up those who would stand to benefit the most from energy savings. Across the U.S., the median income of renters in 2019 was $42,500, less than half of the income of homeowners. As it stands, landlords do not have reasons beyond their own altruistic environmentalism to purchase solar panels for their tenants, as solar PV only financially benefits those purchasing and consuming the electricity.

It is also important to note that homeownership also typically correlates with (and requires) greater wealth and higher credit scores, both of which are also needed to access rooftop solar. This is increasingly difficult for Black and Hispanic households who face greater obstacles to building generational wealth, part of which is due to the fact that home values in Black neighborhoods are significantly undervalued (Raymond et al 2015; Raymond 2017; Perry et al 2018; Akbar et al. 2019). Undervaluation hinders Black homeowners not only from increased

[8] 19 homes are owned by LLCs or individuals who rent the property out. 21 of the 456 total homes have no owner listed but are included in this total. The total percentage when excluding the homes with no ownership info from the denominator is still 96%

purchasing power, but also restricts the ability to finance improvements and renovations. This perpetuates a cycle of self-reinforcing mechanisms that exacerbate wealth inequality and subsequently permeates into the disparities of elective upgrades such as rooftop solar.

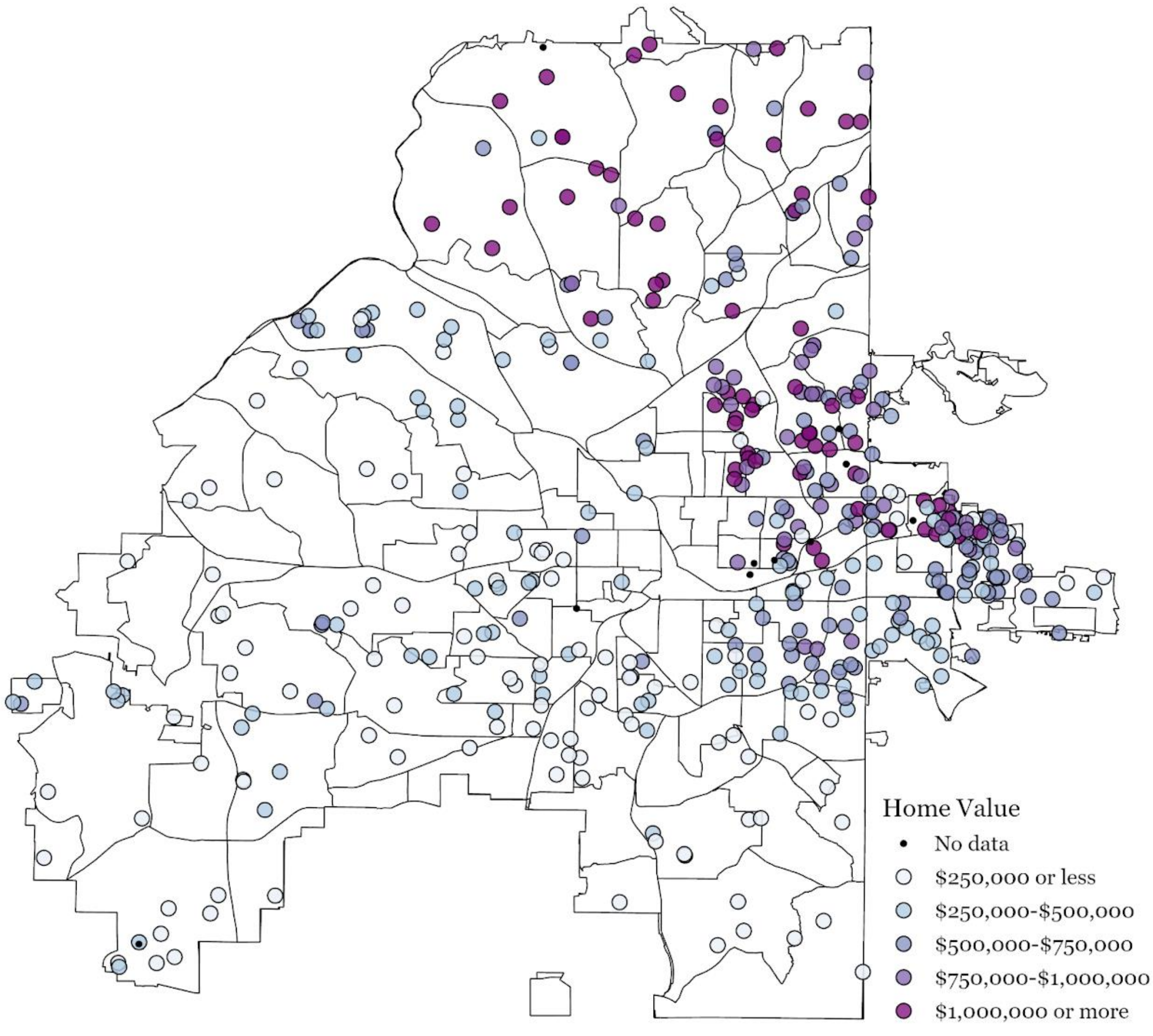

Figure 9: 2021 home value for each home with rooftop solar.

According to a study by The Brookings Institute, Black neighborhoods in Atlanta have the widest gap in home value between Black-majority and Black-minority neighborhoods among their studied cities (Perry et al. 2021). Houses in majority Black neighborhoods in Atlanta are "priced on average 23% lower than similar structures in white neighborhoods" (Stafford 2021).

Even when holding for income, home quality, and the severity of the housing crisis, race still plays a role in home valuation (Raymond 2017; Markley et al 2020). Additionally, this is complicated by the fact that while these homes are generally underassessed in numerous ways, Black homeowners might alternatively see rapid assessment increases that bring it closer to its actual value, resulting in massive new tax obligations. This means even less expendable income that could otherwise be spent on solar. As a result, even when this alternative is at least partially true, the same end result can be reinforced.

5.3 Energy Burden

Thus far, this analysis has shown the vast differences in the adoption of rooftop solar and how income, race, and homeownership are all correlated with one another and help to produce these uneven patterns. These characteristics also have a determining role in shaping energy burden, with some people facing higher burdens than others. Black, Hispanic, and low-income households, along with renters across demographics are more likely to be energy burdened (Drehbol & Ross 2016). Many of the neighborhoods where we've seen a sudden increase in solar over the past two years are also tracts with high energy burdens. Given these changes, we could expect rooftop solar in Black neighborhoods to have a positive effect on energy burdens.

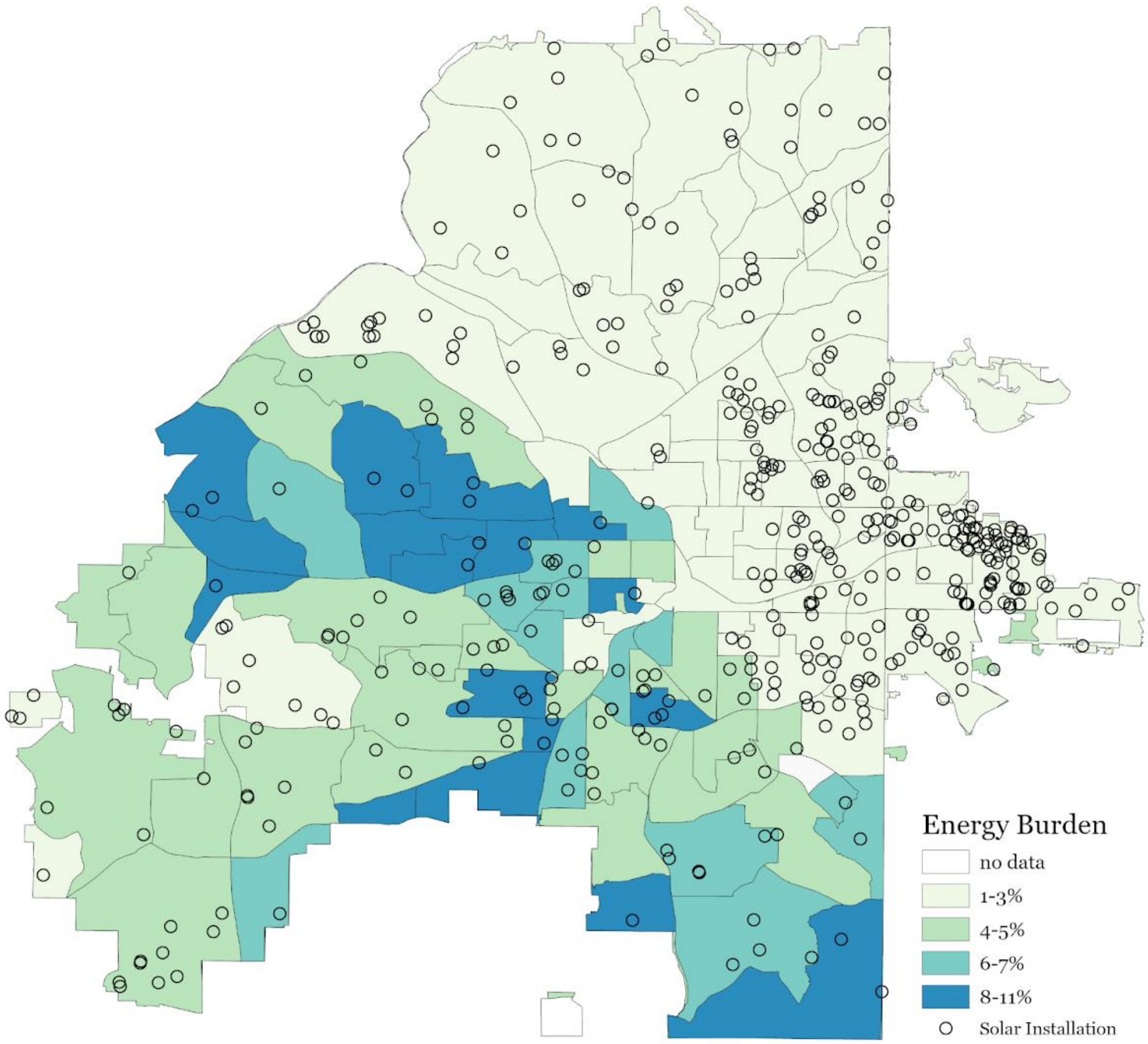

Figure 10: Energy burdens by census tract across Atlanta.

28% of households in the Atlanta area have a high energy burden (Drehobl 2020), signifying that a substantial percentage of the population would stand to benefit from the decreased long-term costs and security of residential rooftop solar. Inside the city of Atlanta, every census tract that is considered moderately to extremely burdened is also majority Black. Increasing the amount of rooftop solar in Black and low-income neighborhoods can provide new economic opportunities and greater localized control over resources, something research has shown to be highly beneficial for disadvantaged communities (van der Schoor et al. 2016). In

Atlanta, this means that individuals who are currently spending 6% or more of their monthly income on energy bills could have the opportunity to decrease dependence on the utility company, while also gaining more control over their finances and reducing difficult decision making about trading off utility bills for other basic necessities. Financing solar is already an economic obstacle for many and the lack of deep incentives in the city and at the state and federal level continue to keep this opportunity out of reach for many. Groups in Atlanta, such as the Southern Alliance for Clean Energy (SACE) and the Partnership for Southern Equity, have been studying this issue for years. Electric bills are high in the state of Georgia and have increased steadily throughout the past decade as Georgia Power and the Public Service Commission continue to pass added costs onto customers.

In combination with this issue is that the city also has an aging housing stock. New construction is primarily producing luxury condos in wealthier neighborhoods or flipping and rebuilding homes in quickly developing areas. Neighborhoods like Oakland City, with a 96% Black population and an energy burden of 8-9%, have more than 64% of its single family housing aged 80-110 years old (Khan 2016). Older homes are often less energy efficient, with poorer insulation, low-quality heating and cooling systems, and leaky windows, qualities which only worsen the energy burden of the low-income tenants who are most likely to occupy them (Hernández and Phillips 2016).

High energy burdens in the city show yet another instance of where the different demographic components mentioned above intersect. Black and low-income households are more likely to be energy burdened, as well as renters across all demographics (CEPL 2018; ACEEE 2022). As we see solar move into the neighborhoods on the east and south sides of

Atlanta that have higher energy burdens and are majority Black and low-income neighborhoods, this could play a significant role in ameliorating current disparities.

5.4 Temporal Change Across the City

In the above subsections, I have shown three major factors often used in solar adoption research (Kwan 2012; Reames 2021; Darghouth et al. 2022; Leppert and Kennedy 2022) and how they each separately influence the adoption of residential rooftop solar and its demographic makeup in the city. However, there are circumstances unique to Atlanta that complicate these variables. The spatial organization of Atlanta has been rapidly changing in recent years and performing an aggregated analysis, such as the one above, can be misleading. Once we move away from looking at this data within these (sometimes) simplistic descriptors, disaggregate the variables, and ground them within the context of Atlanta, we see very different conclusions. What is happening in Atlanta's solar market is not only influenced by systemic inequalities that impact adoption nationwide, but is exacerbated by the reorganization of people within the city, deliberate actions of elected officials, and increasing corporate ownership in the housing market. It is not Black, low-income, or energy burdened households that are benefiting from this new increase of solar in the city. Instead, the rest of this study will show that it is generally whiter and wealthier populations receiving the economic and environmental benefits of solar.

The recent shift of rooftop solar into low-income and Black neighborhoods mentioned earlier could have displayed a unique deviation from national patterns, moving toward the goal of energy justice advocates in decreasing the racial and economic disparities in the energy sector. However, upon analysis at the level of individual properties, it is not legacy homeowners who are benefiting from the increase in solar, but an exhibit of the displacement and changing geographies of Atlanta.

If we combine all the tracts that make below 80% area median income, a threshold used by the US Department of Housing and Urban Development to define low-income neighborhoods, 153 out of the 456 homes with solar in Atlanta are in census tracts making around $51,000 or less, half of which earn about $30,000 or less. While the median value of these homes is well under the citywide median, about $200,000 lower, the sales history of these homes highlights a troubling trend. Since 2005, 36% of the homes in these middle to lower-income tracts have sold for less than $55,000, many of which sold for between $4,000 and $20,000[9]. Additionally, of the 79 census tracts in which these 153 homes are located, all but eight have seen increases of median income increases upwards of $22,000 between 2010-2019. Despite appearing as though the median value of homes with solar has decreased drastically, and thus likely a lower median income for those homeowners, instead we see a sharp and sudden increase in home sale prices in lower-income areas, likely the result of foreclosures and house flipping, alongside new populations with increased wealth in the area. The city of Atlanta's median HHI has recently surpassed that of its surrounding suburbs, as wealthier households move into the city and low-income households are forced out to the suburbs due to quickly increasing living costs in the city and the lack of public and affordable housing (Immergluck 2022). These indications suggest less of a change in accessibility of solar installation for lower-income households and more a depiction of broader changes in the class and race composition of these neighborhoods.

In sequence with this, the racial composition of Atlanta has also changed rapidly as home prices and cost of living continue to increase, alongside both the movement, and pushing out, of Black residents to the suburbs. This has resulted in Atlanta changing from a Black majority to

[9] Missing data on 22 of the 153 homes. Stat is based on 47 out of the 131 homes with data.

plurality. According to the *Atlanta Journal Constitution*, Atlanta's population has grown by over 70,000 people in the last decade, of which 50% of new residents are white and 9% were Black (Richards 2021). These changes mean that as the city of Atlanta takes strides toward the goal of 100% clean energy by 2035, longtime residents of the city may not be the ones who are served by this transition. As Atlanta's demographics change, the benefits of its clean energy transition are afforded to an increasingly white population.

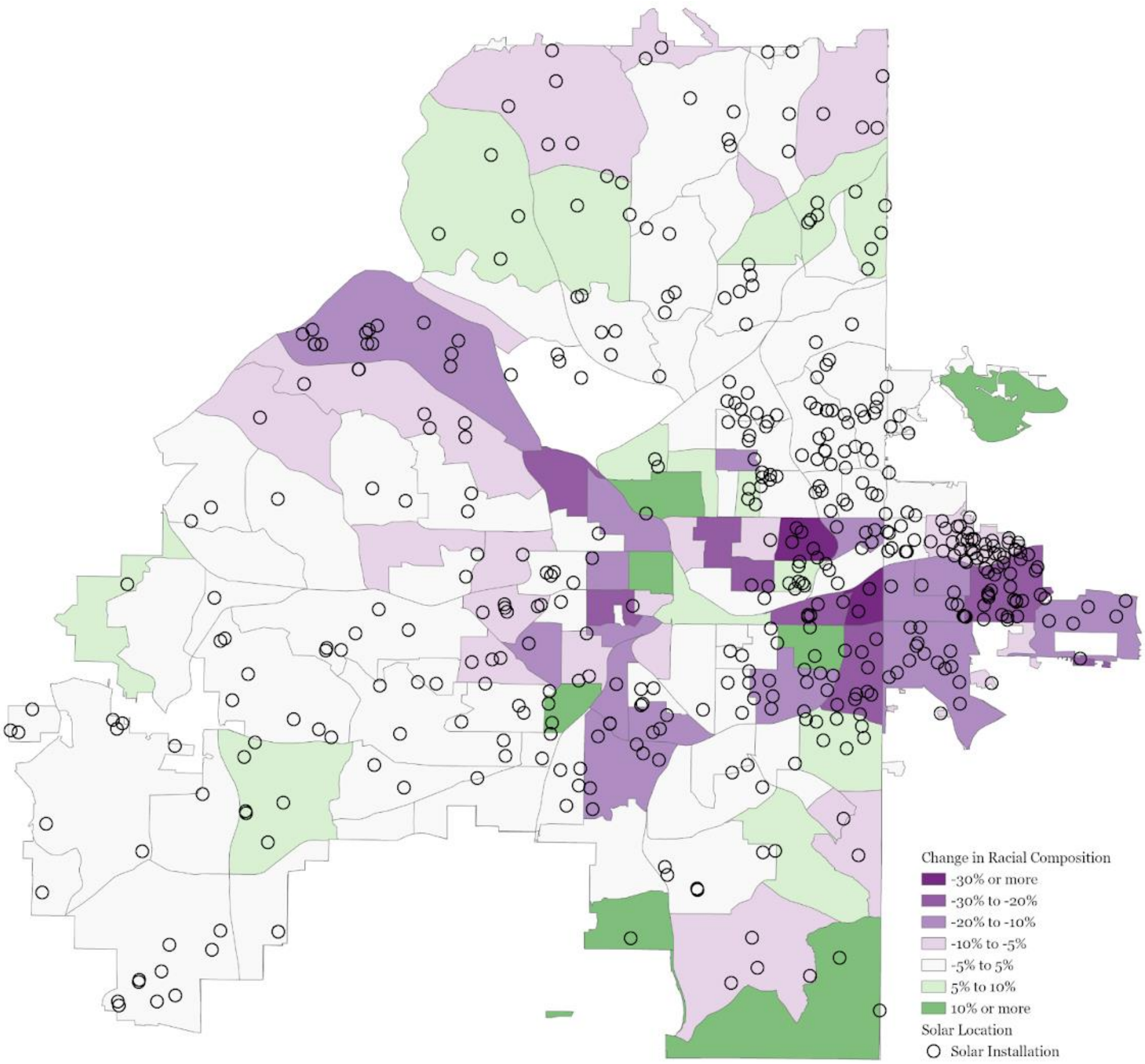

Figure 11: Change of racial composition in Atlanta between 2010 and 2019.

A number of neighborhoods across the city have seen drastic changes in racial composition over the past ten years, leaving some historically Black neighborhoods with a white majority or no racial majority. Of the 456 homes with rooftop solar, including the 247 that have been installed since 2021, 198 are in census tracts that have lost 5% or more of the Black population in the past 10 years. The eastside of Atlanta, including neighborhoods such as Old Fourth Ward, Reynoldstown, Edgewood, Kirkwood, East Atlanta, Candler Park, Virginia-Highland, and parts of Inman and Grant Park, have seen some of the highest rates of racial change and the greatest number of rooftop solar panel installations.

Old Fourth Ward, a historically Black neighborhood and landmark for civil rights activism in the eastern part of Atlanta, has undergone massive restructuring over the past decade. Once the center of Atlanta's Black middle and upper-class and birthplace of Martin Luther King, Jr., census tracts in the neighborhood have lost anywhere between 9-33% of their Black populations. Old Fourth Ward saw hundreds of foreclosures and liquidations in the aftermath of the 2008 recession, pushing out swaths of people in the following years. Since then, median sale prices of homes in this area have since increased by $200,000-$500,000. In the past year alone, home prices have increased almost 17% (Rocket Homes 2022). One of the census tracts within the Old Fourth Ward neighborhood contains four homes with rooftop solar. According to Zillow, all four of these homes have an estimated value between $750,000 and $1.2 million, numbers unheard of in this neighborhood until recently. One home, located at 670 Willoughby Way NE, is a new build from 2016 with a purchase price of $765,000 and is now valued at over $941,000. The owners were some of the first people in the area in 2018 to add solar, ahead of surrounding neighbors by a few years. The neighborhood now has a total of 15 units with solar, many of which sit on land that has increased in value by between $40,000 and $233,000.

Kirkwood, a neighborhood that saw massive white flight in the 1960s and 70s leading to a majority of Black residents, has now had a reversal in this trend. The neighborhood has lost 27% of its Black population over the last decade as it continues to experience the aches and pains of gentrification. Today, Kirkwood has 36 units with rooftop solar, the majority of which are occupied by white homeowners. Just north of Kirkwood, Lake Claire holds the second highest number of solar panels, with 28 rooftop units, 22 of which were added in the past three years. This neighborhood is 87% white and has a median home sale price of $830,000. Based on national and city trends, high rates of solar in these neighborhoods are to be expected.

Alternatively, on the other side of the city, Mozley Park, a neighborhood that is over 96% Black, has gone from no rooftop solar in 2020 to nine permits by 2022. This neighborhood has one of the highest concentrations of rooftop solar among majority Black neighborhoods. The median HHI is less than $25,000 and the median value of homes with solar is just over $257,000. Following a foreclosure in 2019, the house at 165 Mathewson Place was sold in 2020 to an LLC and was remodeled. In 2021, the home was valued by the city for $152,700, but then sold later that same year to an individual for $510,000. Another example of this undervaluation is Bush Mountain/Oakland City in south Atlanta, which went from no solar installations in 2019 to seven permits in 2022. The neighborhood has a median HHI below $40,000 and is 96% Black. A home in this neighborhood at 1115 Princess Ave SW sold back and forth between corporate owners after a foreclosure in 2006. In 2020, it was remodeled after sale. In 2021, when this house sold for $470,000, the city had it valued at $376,000. This is where we can start to see a trend come together that the growth of rooftop solar in low-income Black neighborhoods isn't actually due to legacy residents making these changes to their homes, but rather to those newcomers to these neighborhoods who are able to take advantage of the historic undervaluation that occurs in Black

neighborhoods. What has occurred in neighborhoods like Kirkwood and Old Fourth Ward over the past ten years highlights a possible future for neighborhoods like this one.

Figure 12: A comparison of the house located on Princess Avenue from 2018 to 2022.

Figure 13: Another example, showing a home at 1688 Oak Knoll Cir SE in Lakewood Heights that was assessed in 2021 for a value of $30,200 and sold the same year for $175,000.

Studies have already linked neighborhood environmental upgrades, such as green infrastructure and rooftop PV systems, to increases in home prices and cost of living (Rice et al 2020; Hoehn 2012). These relationships and their ongoing impacts on communities are alternately known as environmental, green, or ecological gentrification, and have strong implications for their social and economic impacts (Checker 2011; Sax et al 2022). If prices continue to rise in these low-income and Black neighborhoods, it is renters who will face the highest vulnerability to displacement. Renters not only have little to no say in solar deployment

but are also the group who may face the highest potential displacement from rising housing costs. Many of these neighborhoods are currently occupied primarily by renters, with rates of rentership between 65-80%. These are the households that would benefit the most from rooftop solar but will continue to lose out if the clean energy transition in Atlanta maintains this status quo.

5.5 External Impacts on Housing

Homeownership plays a large role in the accessibility to solar and cannot be removed from the function of race and income. Income inequality and the racial wealth gap have caused vast differences in homeownership between Black and white Americans. White homeowners dominate the housing market when compared to ownership rates for Black and other racial minorities. Inequitable solar adoption will only exacerbate current social inequalities if we maintain the status quo of tying these opportunities to wealth and homeownership.

In the two neighborhoods mentioned above, Mozley Park and Bush Mountain/Oakland City, 14 of the 16 homes with solar have had some mix of ownership involving a bank, corporation, or both at some point in the home’s history. Conversely, Grant Park and Virginia Highlands, both majority white neighborhoods, have a total of 32 homes with rooftop solar. Of the 30 with available data, only 5 have had corporate or bank ownership at some point. Overall, more than half of all homes with solar in majority Black census tracts have been owned by a bank, corporation, or a combination of the two at some point in the home’s history. When we only look at homes that were last sold after 2010, 72% have been owned by a bank or corporation. Comparatively, only 24% of homes in no majority or majority white census tracts have had mixed ownership. For homes last sold after 2010 in these tracts, the amount only increases to 30%.

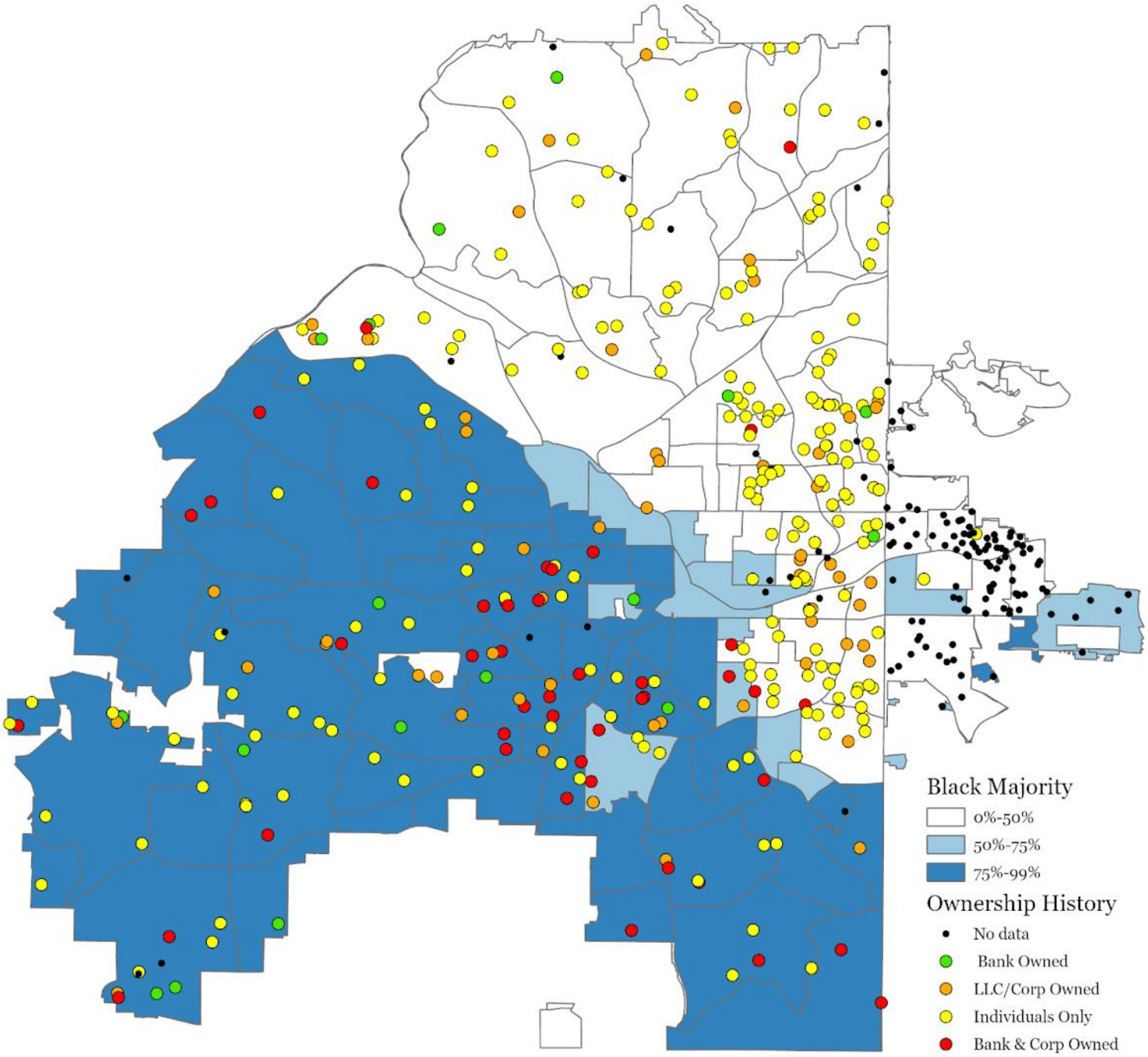

Figure 14: Map of majority Black census tracts and each home with solar's ownership history.

The 2008 recession slashed homeownership in Atlanta, hitting Black neighborhoods much harder than their white counterparts (Badger 2016). Many Black neighborhoods in Atlanta saw steep declines in home values after the recession and have recovered little since (Raymond et al 2015). In 2012, the city "ha[d] the most government-owned foreclosed properties for sale," of any major city in the U.S (Rich 2012). The Great Recession and the foreclosures that came with it, left some neighborhoods, primarily those on the west and south side, prime for gentrification. Disinvestment by the city, the failure to act by the state, and the encouragement

from the federal government for private, corporate involvement in the single-family housing market has led to a massive transfer of wealth and ownership from individual homeowners in Atlanta to outside investors (Immergluck 2022). This current move toward reinvestment, through individual single-family home rebuilds and renovations, as well as larger scale neighborhood capital improvement projects, is operating on an *out with the old, in with the new* mindset. These lower cost, newly renovated homes with solar in majority Black census tracts are predominantly homes that were lost during the Recession, bought up by corporations or investors, and are now going to newcomers who are benefiting from the systemic undervaluing of homes in Black neighborhoods. Neighborhoods once historic and home to a variety of income levels are now being squandered to make way for luxury condos and flipped homes with price tags twice as high as they might have previously been. Many former residents have since lost wealth and have been forced into an unforgiving rental market, one that creates a barrier to both building wealth and possible access to energy relief from solar.

We see that these lower valuations have made it easier for outsiders to purchase homes at significantly lower prices. Gentrification in these neighborhoods is occurring due to a culmination of multiple factors, including undervaluation, redevelopment, and a strained housing market. Atlanta's population has increased quickly over the past decade and with that, in addition to the slow nature of building new housing, a strain has been put onto the neighborhoods that drew people to the city in the first place. This has resulted in people having to turn elsewhere for housing, oftentimes in lower-income areas where housing is cheap but central location and access to amenities is still high enough.

Through all of this, we see the illusion of greater diversity across income and race in solar adoption is really just an influx and relocation of white and higher income people into these

neighborhoods. 80% of Atlanta's census tracts have seen an increase in median HHI between 2010-2019[10]. These tracts hold 85% of all rooftop solar. Many of the previously majority Black neighborhoods that have seen recent jumps in home value alongside an increasingly white population, have had growth in their median HHI between $30,000-$50,000 in the past ten years. Many of the still Black majority tracts where solar has appeared since 2021 have seen increases as well. Using the city of Atlanta's gentrification vulnerability tool[11], which creates a weighted system based on percent nonwhite, percent renters, percent without BA degree, and percent of households below 80% of HUD-adjusted median family income, we find neighborhoods such as Grove Park, Adair Park, and Vine City were all found to be at the highest risk for gentrification in 2015. These neighborhoods have seen significant increases in new buyers purchasing previously foreclosed, LLC-owned, or flipped homes that were made affordable due to the losses in the neighborhood caused by the Great Recession. These are the homes with rooftop solar that were part of the sudden increase on the westside in 2021-2022, showing it's not higher rates of adoption by the majority of low-income and Black residents in these neighborhoods. What is beginning to happen on the south and westside of Atlanta, with increasing housing prices and an influx of new residents, is similar to patterns on the eastside from merely a decade ago. It appears that rooftop solar installations may provide another method for tracking the movement of these changes of population and housing patterns in the city.

[10] 388 permits are in census tracts that have seen median HHI increases between 2010-2019. 132 of 165 tracts; https://opendata.atlantaregional.com/datasets/GARC::change-2010-2019-by-census-tract-2019/explore
[11] https://garc.maps.arcgis.com/apps/webappviewer/index.html?id=c36bb3b8c0744aa7a04a52031473790a

6 CONCLUSION

Rooftop solar is one of several possible paths to decarbonizing the energy grid, providing the potential for positive impact at both the community and individual level. However, without equal access to, and adoption of, residential rooftop solar, present patterns of inequity will persist and many communities will continue to be left out of the environmental and financial benefits that solar offers. Throughout my time researching and creating this project, I came across a gap in research that addresses the connections between rooftop solar and housing and the effects it has on neighborhood change. There is well-documented research on the impacts of other types of green infrastructure projects that impact home values and population change, but rooftop solar, as far as I am aware, has not been included in these studies. My goal for this project was to understand what created the unique geography of rooftop solar in Atlanta. I set out to join the efforts of geographers and other social scientists to bring a more critical lens to energy production, distribution, and the spatial patterns of consumption and to incorporate the political motivations, ethics, governance, and social consequences of energy.

As this research has demonstrated, the city of Atlanta exhibits strong connections between residents' access to homeownership, the adoption of rooftop solar, and how housing and populations are being restructured citywide. Integrated with demographic variables, the data shows that there is an uneven distribution of rooftop solar beyond geographic location alone. If this data had only been displayed in its aggregated form, it would appear to showcase progress toward parity among racial and class groups. Instead, I show that the reshuffling of demographic groups across the city post-Great Recession and ongoing redevelopment continues to push primarily Black and low-income residents out of the city as the costs of living and housing specifically inflate dramatically. This displays just how many confounding factors shape the

landscape of rooftop solar, home value and ownership, racial and economic segregation, gentrification, and more.

As the city of Atlanta's population has continued to grow over the past decade, its residents have become wealthier and whiter. The incursion of white residents into Black and low-income neighborhoods has shifted the racial and economic makeup of these areas. Formerly historically Black neighborhoods on Atlanta's eastside have lost upwards of 20-30% of their Black populations over the past decade and have seen the cost of living skyrocket. Many of these neighborhoods are now both majority-white and some of the highest adopters of rooftop solar anywhere in Atlanta. Through the tracking of rooftop solar permits, we can see these trends beginning to take place in majority-Black neighborhoods on the west and south sides through the sudden appearance of rooftop solar. The majority of these homes with new installations were homes lost during the Great Recession and are previously foreclosed, corporate owned, or part of the burgeoning industry of house flipping. The data shows that these homes with solar in these Black and low-income neighborhoods are frequently selling well above appraised value to households making well above the median HHI income for the rest of the neighborhood.

These Black neighborhoods are undergoing the same transition that occurred on the east side less than a decade ago: higher income residents moved into these neighborhoods, pushing out longtime residents through increased cost of living and housing scarcity. The patterns of solar adoption in these low-income neighborhoods on the opposite side of the city foreshadow what is likely to occur in the coming decade in the absence of substantial changes in local policy or in the broader housing market.

As these geographies of population and rooftop solar adoption change, so continues the undisguised suppression of access to solar by the PSC and Georgia Power. The social and

economic impacts of the Georgia Public Service Commission's decision to limit participation in the solar buyback program is one of many resolutions that has protected the profits of Georgia Power while continuing to submit customers to high utility costs for dirty energy. Even worse, Georgia Power's endeavors only hinder the stated efforts of the city of Atlanta to increase energy efficiency, decrease energy consumption, and expand renewable access. In conjunction with the greater social, economic, and racial factors intersecting with the basic prerequisites of admission into the solar market – namely wealth and homeownership –these factors have created an energy landscape that is at once entirely unrepresentative of its customer base and increasingly exacerbating the divide between those with access to cleaner energy and financial advantages and those without.

6.1 Looking Forward

A study on the solar equity gap performed by the Department of Energy's Lawrence Berkeley National Laboratory looked at policy and business models that have been successful in altering deployment patterns into underrepresented communities (O'Shaughnessy et al 2020), naming low- to moderate-income (LMI) specific financial incentives, PV leasing, and property-assessed clean energy (PACE) financing as the top opportunities. These options, along with the current available federal solar tax credit, occur primarily at the national level. However, 16 states and Washington, D.C. have established programs that offer these incentives for rooftop solar, but as prices continue to decline, so have incentives. For LMI households that otherwise may not adopt rooftop solar, these incentives are critical and have proven to shift deployment into these communities (O'Shaughnessy et al 2020). Currently, in the state of Georgia, there is no LMI-focused clean energy program. Beyond that, there is no general state incentive or assistance program either. The Public Service Commission and the Georgia legislature have the opportunity

to change the lives of millions of residents and provide programs for increased solar adoption and decreased sovereignty for Georgia Power in the market.

Additionally, part of what is holding the city of Atlanta back from achieving its clean energy goals, and also impacting individual practicality for solar, is how monopoly utilities operate and are regulated. Monopoly utilities sell energy at cost and profit from investing in physical infrastructure, like power plants and transmission wires. As it stands now, Georgia Power is guaranteed a certain monetary return on investment by the Public Service Commission. The set requirement of revenue discourages innovation and because this set up passes expenses onto customers, there is no incentive for efficiency because that is not how the utility makes money. This means fuel costs, natural gas leaks, and more do not impact the utility and therefore there is little willpower to make any changes or environmental upgrades.

It will remain difficult to get utilities to transition to cleaner, more efficient grid investments if we continue to create and perpetuate a system that incentives overspending. A number of states are moving toward Performance Based Regulation (PBR) to align decarbonization goals with utility profit motives, compensating utilities based on performance instead of infrastructure investments (Wilson et al. 2022). No states in the southeast have implemented or even made significant inquiry into the possibility of a PBR based system. Again, Georgia has the opportunity to be a pioneer here and take the lead on a possible outcome that could benefit both utilities and customers, while also providing cleaner and more efficient energy.

If rooftop solar is not an option for individual households due to cost or ownership status, increased investment by the city or local groups in community solar is an additional step for working to close the race and income gaps in access to the environmental and financial benefits

of clean energy. This would also provide an accessible option to renters who are not able to make electrical or structural changes to their units. There are numerous options to decrease utility costs and energy usage for low-income households; energy assistance programs, deep financial incentives, and community solar are all noteworthy courses of action. Ultimately, regardless of how these goals are achieved, it is clear that a large percentage of Atlanta's population, both in the city and the metro area, is getting left behind and pushed out of both the housing *and* solar energy market.

This research only scratches the surface of the relationship between rooftop solar and gentrification. Focusing on the interconnection between housing patterns, income, race, and financial incentives provided by a city and state will remain critical for researchers in the coming years as it is likely that these patterns will show up, if they have not already, in cities across the country. I also hope this work compels public officials, researchers, and individuals alike to confront the question of who a 'green city' is really for (Garcia-Lamarca et al 2021). The city of Atlanta has established its desire to become a carbon-neutral city in the coming decade, but through the continuous implementation of green infrastructure, prioritization of corporate interests, lack of resistance to an unfriendly energy market statewide, and more have all had detrimental impacts on low-income and Black legacy residents. Without significant changes to the structure of urban economies and housing markets, the installation of solar and other energy efficiency improvements in historically disinvested neighborhoods is likely to become just another indicator of gentrification. As the city of Atlanta inches closer to its net-zero goals, it is an increasingly white population who will reap the benefits of the clean energy transition and not the populations who are already on the frontlines of climate change and energy vulnerability.

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