frontiers | Frontiers in Sustainable Energy Policy

TYPE Original Research
PUBLISHED 17 August 2023
DOI 10.3389/fsuep.2023.1180830

Contextual factors in local energy policy choices: comparative case of solar energy policy in two cities

Cali Curley[1]*, Patricia Aloise-Young[2], Nicky Harrison[3], Corey Kewei Xu[4], Gerald P. Duggan[2] and Daniel Zimmerle[2]

[1]Department of Political Science, University of Miami, Coral Gables, FL, United States, [2]Systems Engineering, Colorado State University, Fort Collins, CO, United States, [3]United Way Indianapolis, Indianapolis, IN, United States, [4]Thrust of Innovation, Policy, and Entrepreneurship, The Hongkong University of Science and Technology (Guangzhou), Kowloon, Hong Kong SAR, China

Check for updates

OPEN ACCESS

EDITED BY
Saba Siddiki,
Syracuse University, United States

REVIEWED BY
Giliberto Capano,
University of Bologna, Italy
Liliana Proskuryakova,
National Research University Higher School of Economics, Russia

*CORRESPONDENCE
Cali Curley
✉ calicurley@miami.edu

RECEIVED 06 March 2023
ACCEPTED 05 May 2023
PUBLISHED 17 August 2023

CITATION
Curley C, Aloise-Young P, Harrison N, Xu CK, Duggan GP and Zimmerle D (2023) Contextual factors in local energy policy choices: comparative case of solar energy policy in two cities.
Front. Sustain. Energy Policy 2:1180830.
doi: 10.3389/fsuep.2023.1180830

Numerous recent calls have been made for policy design research to embed itself throughout the policy process and explore avenues for matching tools and targets. These calls have argued that policy design research, while emphasizing the content and the choice of design, has been under-leveraged, particularly in exploring rationales for effectiveness. In this paper, we conduct a comparative case study to explore variation in participation rates for two similarly categorized solar policies across two mid-sized cities. In this regard, three contextual factors are examined, including the population characteristics, the existing configuration of policies, and the physical environment, which all contribute to shaping policy effectiveness. We argue that policy design is situated within an explicit context and that without capturing the context, the effectiveness of policies may not translate if diffused.

KEYWORDS

policy design, contextual factors, solar policy, rooftop solar, community solar

1. Introduction

The growing interest in policy design has focused on demonstrating that specific design features influence how target participants perceive the policy and its effectiveness (Howlett, 2018; Curley et al., 2020). Most current research in policy selection is being conducted from rational and/or behavioral perspectives. Rational policy design integrates an analysis of the problem, information about the instruments used for intervention, and the barriers and values addressed by the potential intervention. The behavioral approach to policy selection argues for appropriately matching specific individuals or households with policy tools (Howlett, 2019). The effort to match tools to targets can be viewed as an enhanced rational policy tool choice effort because it considers the sociodemographic context in which the policy is enacted. While much research exploring these phenomena utilizes binary data to measure policy presence, there have been more recent efforts to develop measures for nuance and variation in design features (see Siddiki and Curley, 2022 for further discussion).

Despite these changes to measuring policy design content, the incorporation of context has been mainly limited to studies of implementation. Policy enactment, for example, has made great strides in understanding the implications of the context of a successful implementation process (Braun et al., 2011). Policy enactment refers to the idea that administrators interpret and translates policy into the current implementing environment. Ball et al. (2011) refer to four elements of context in policy enactment: "situated contexts, professional cultures, material contexts, and external contexts and expectations from broader policy context" (p.21). In policy enactment research, the focus is often on the context of the implementing body in a local environment that determines and shapes policy implementation. In most instances, context is treated as a limitation to the generalizability of policy research. These elements combined suggest that we need to better understand the role of context, this paper focuses on the characteristics of the target population, the configuration of existing policies, and the physical environment in which the policy will be implemented. We do this with an explicit effort to understand the how context of a policy design might influence policy effectiveness.

This paper utilizes a comparative case analysis of solar (or photovoltaic, PV) policy selection in two mid-sized cities to demonstrate the benefit of taking a more holistic and contextualized approach to policy design and tool choice. Through this exploratory study, we discover four key takeaways for understanding the context in a policy design necessary for research. In order to identify these key takeaways, we lean on the literature to identify three contextual factors critical to understanding the success of policy designs for solar PV policy: population characteristics, the configuration of existing institutions and policies, and the physical characteristics of the environment within each community. While these contextual factors in policy design might be moderately different depending on the policy topic, we suppose that these are relevant contexts for solar policy design and effectiveness.

2. Literature overview: solar policy

Previous research on U.S. solar policy has included both state-level policy design and incentives (Sarzynski et al., 2012; Yi and Feiock, 2012; Shrimali and Jenner, 2013; Cheng and Yi, 2017; Koski and Siddiki, 2022) and local solar policy tools such as green purchasing projects (Simcoe and Toffel, 2014), adopting solar arrays for governments [EERE (Office of Energy Efficiency and Renewable Energy), 2020], land use and zoning for renewables (Becker, 2019), expedited permitting (Li and Yi, 2014), education and outreach initiatives (Li and Yi, 2014), and financial incentives to residents (Li and Yi, 2014). The financial incentives bucket of policy tools includes rebates, direct grants, direct loans/low-interest loans (Kelly, 2016), feed-in-tariffs (FIT), productions-based incentives (other than FIT), interest rate buy-downs, property tax credits and abatements (Borenstein and Davis, 2016; Matisoff and Johnson, 2017), and sales tax incentives. Financial policy tools aim to make accessing solar technology easier by reducing the cost barrier (Li and Yi, 2014). These solar policies are often part of more extensive sustainability efforts (e.g., climate action plans). Local governments are motivated to adopt climate action plans and solar policies due to political factors (Yi and Feiock, 2012), citizen demands (Devine-Wright, 2011; Graff et al., 2018), economic opportunities or costs (Sawhney and Rahul, 2014), and related regional policy adoption (Simcoe and Toffel, 2014). In response to these pressures, local policymakers develop consumer-focused solar policies to increase rooftop solar and/or community solar farms (Hsu, 2018; Peters et al., 2018).

Rooftop PV is the installation of solar panels on the roof of a building. These types of panels may be purchased or leased. This strategy allows individuals to generate electricity using the area on their roofs. Net-metering is a commonly used policy to incentivize rooftop PV. This practice allows customers to offset their electricity consumption and possibly earn money from 'selling' their overproduction back to the utility.

Community solar farms are large arrays of PV panels, sited on public or private lands, from which customers purchase energy. Four primary models for community solar exist: utility-sponsored model, on-bill crediting, special purpose entity model, and non-profit "buy a brick" model [SEIA (Solar Energy Industries Association), 2020]. Unlike rooftop PV, the community solar farm approach does not typically allow individuals to earn money from overproduction.

In Section 3, we detail the solar policy instruments present in our case study cities. To inform our analysis of these policy instruments, in the following sections, we identify and explore existing research on contextual variables that have been demonstrated or hypothesized to relate to policy design and effectiveness. Specifically, we discuss characteristics of the target population and the physical environment, as well as the compatibility of existing policy instruments. This research was foundational to our inductive analysis of the specific solar policies in place in Tallahassee and Fort Collins with a focus on the relation between contextual variables and policy design and effectiveness.

2.1. Context of policy design

Policy design research has unfolded in two primary avenues; the first is designing the policy itself, while the second is exploring the designed policy's content (Siddiki and Curley, 2022). The process of designing has often centered on the choices of designers. This might include exploring political motives (May, 1991) and emphasizing tool choice and the characteristics of those tools (Hood, 1983; Salamon, 2002). These tools have also been connected to expectations regarding behavior change of the targeted population (Capano and Howlett, 2020). Similarly, research into policy bundling and mixes suggests that some tools can complement or limit another tool's effectiveness (Rogge and Reichardt, 2016; Howlett and Mukherjee, 2017). Despite this, there is little known about well-designed policy mixes. This may be partly due to the difficulty of distinguishing the impact of design attributes from the contextual environments that enable them to succeed. While the implementation gap has been clearly noted as a mechanism for designs to fail, policy design research has yet to unpack context's role in the success (or failure) of policy as designed. The following sections explore the potential for the target population's characteristics, the configuration of existing institutions and policies, and the physical environment to influence the efficacy of policy design.

2.1.1. Configuration of existing institutions and policies

Policymakers utilize a mix of policy tools when attempting to affect the behavior of the target population. Policy tools can be used to regulate and alter the behavior of actors on both the supply and demand sides of a market. Regulations achieve their objective by requiring or banning certain activities (Krause et al., 2019); they typically are not favored among the target population because they operate by constraining choice. In contrast, incentives influence behavior by increasing the marginal cost of undesirable activities or goods and decreasing the cost of desirable ones while continuing to offer target populations a choice (Krause et al., 2019).

Policy mixes are often needed because one tool alone cannot achieve the desired public good (Krause et al., 2019). However, the tools included in a policy mix can have interactive effects (Yi and Feiock, 2012)—they can intentionally or unintentionally compete with (Kern et al., 2017) or complement (Rogge and Reichardt, 2016) one another. This can occur due to silos within the organization, and to the piecemeal accumulation of policies over time. Additionally, the political self-interest of a policymaker can lead to the selection of a policy tool motivated by the political payoff, with little to no care given to whether it will be effective or how it may interact with existing policies (Flanagan et al., 2011). In extreme cases, policymakers may intentionally stunt effective policy to serve their political self-interests.

Despite efforts to understand cohesion in policy tools (Howlett and Rayner, 2007), the ability to identify policies that work together or against one another is limited (Gasteiger, 2018; Capano and Howlett, 2020). Extant research on policy mixes emphasizes the temporality of adoption (Rayner et al., 2017; Halász, 2019), tool interactions that enhance (Lecuyer and Bibas, 2012) or interfere with (Grabosky, 1995) policy outcomes, and the rationality of patching and packaging policies (Howlett and Rayner, 2007; Kern et al., 2017). However, existing efforts to compare policy mix effectiveness do not consider the impact of contextual factors beyond the policies within the mix, such as alternative policy arrays, political or physical environments, and social contexts (such as Kern et al., 2017). Thus, this previous research assumes that the effectiveness of policy mixes does not vary as a function of their context.

2.1.2. Characteristics of the target population

Target populations are considered an element of rational policy design (Schneider and Sidney, 2009). Research on target populations unpacks the distribution of burdens and benefits based on existing social constructions. This body of work, highlighted in a review by Pierce et al. (2014), includes income (Brucker, 2007; Gollust and Lynch, 2011), race (Sidney, 2001, 2005; Garrow, 2012), immigration status (Yoo, 2001, 2008; DiAlto, 2005), employment sectors (Schroedel and Jordan, 1998; Patterson and Keefe, 2008; Ingram and Schneider, 2011), age (Campbell, 2003; Lockhart et al., 2008; Bushouse, 2009; Hudson, 2013), homeownership (Hunter and Nixon, 1999), sexual orientation (Donovan, 1993, 1997), offender status (Miller, 2012), and gender identity (Bensonsmith, 2005). Research in this area often focuses on who gets what – after the policy is designed and selected. However, recent work from Krause et al. (2019) suggests that community characteristics relating to the social construction of the targeted groups, including “race, political leaning, income, and population,” influence and shape which policy tool is selected (p. 477). Krause’s work connects the previous studies on targets with the argument that targets are intentionally and rationally chosen to achieve a specific goal. While targets may be deliberately selected, tools may be chosen based on the perceived deservingness of those targets; more pointedly, the social construction of the target population may determine the distribution of benefits and burdens via tool choice (Capano and Lippi, 2017; Krause et al., 2019). This implies that the targets and the larger context of community characteristics and the community’s perception of the target population likely influence the policy’s design and the efficacy of the match between tool and target.

Policy tool selection is a process that includes anticipating the target population’s barriers to participation, response to the specific tool, and a resulting behavioral change in line with desired policy goals (Howlett and Ramesh, 2003). Despite the importance of policy targets in the policy tool selection process (Howlett, 2018; Maor, 2020; Paddeu and Aditjandra, 2020), relatively little is known about what motivates targets (Capano and Howlett, 2020). Howlett (2018) characterized the process of matching the policy tool to the target population as “calibrating incentives and disincentives to achieve expected levels of compliance and outcomes” (pp. 6). However, this often proves more difficult than policy actors expect (Howlett, 2018), suggesting that they need to develop a greater understanding of the target audience’s motivations rather than relying on intuition.

2.1.3. Physical environment

Physical environments can both affect and be affected by public policy. Possible relevant physical characteristics include the existing built environment, the slope of the land, the presence of natural structures such as bodies of water and trees, and local climate considerations. For any policy that is dependent (directly or indirectly) on land use and weather-related factors, the regional physical characteristics of the environment may have implications for success. For example, health policies that incentivize walking or riding bikes as alternate transit may be less effective in locations that receive frequent rain or snow. If policymakers do not consider the physical environment during policy design and selection, the policy is unlikely to have the desired effect.

Policies such as land use and zoning (Wilson et al., 2003), streets and sidewalks (Lopez and Hynes, 2006), public park formation (Simis et al., 2016), and even site selection for power plants (Czarnowska and Frangopoulos, 2012) directly impact the physical environment. Moreover, through their influence on the physical environment, these policies can influence health (Lopez and Hynes, 2006; Wilson et al., 2008b), the ability to work (Guthrie et al., 2019), and overall happiness (Cloutier et al., 2018) of individuals in that environment. For example, the field of environmental justice research links the built environment to outcomes such as healthy behaviors (Wilkie et al., 2018), education access (Shirazi and Keivani, 2017), racial justice (Wilson et al., 2008a), and pollution exposure (King, 2015). Each policy that shapes the physical environment has long-standing ramifications for the ability of new policies to be effective. However, the link between historical policy decisions and other policies’ ability to be effective is less well understood (Li et al., 2017; Capano and Howlett, 2020). In addition, changes in the physical environment can hold important implications for the transferability of effective policy tools between locations, particularly when seeking to manage common Pool resources (Ruddle, 1998; Khan, 2005). Therefore, it is surprising that the physical environment’s role in policy outcomes has received scant attention in the policy choice (selection and design) literature.

2.1.4. Summary

In theory, a policy is designed to meet the needs of a given community, but every community’s needs will differ according to the contextual environment, which suggests that policies cannot transfer into a new environment without considerable alteration. This argumentation suggests that policy designs themselves should be developed based on the context of the community. In other words, a policy should be intentionally re-designed by altering the design according to a series of factors. The current rationale for re-designing policy is that the context of the tool (i.e., target population, local environment, politics, technology, and the policy mix) has changed and is limiting its effectiveness (Edmondson et al., 2019). However, there is little evidence that these contextual factors – community populations, configurations of the existing policy, and physical environment – are considered during policy design (Chapman et al., 2016) and tool selection. The following section overviews existing solar policy research to provide background for our exploratory comparative case study of solar policy effectiveness in two communities.

3. Methodology

Given our emphasis on understanding how context informs outcomes, we utilize a comparative case-study approach (Yin, 2003). Case studies are essential in building "context-dependent knowledge" (Flyvbjerg, 2006, pg. 6), and qualitative comparative case studies are considered helpful in theory development (Baxter and Jack, 2008). Our goal is not to draw large-scale generalizations but to demonstrate how energy policy effectiveness depends on the context of policy choices. Our comprehensive case studies include an exhaustive review of documents published on government websites related to existing policies and solar program participation data gathered through a partnership with the respective utilities.

Our case cities are Fort Collins, Colorado, and Tallahassee, Florida. We selected two cities with council-manager forms of government and similar population sizes, both of which are served by a municipally owned electric utility (MOU). These factors combine to suggest that the city governments should have similar levels of control and capacity to offer solar programs. Furthermore, by focusing on two cities with MOUs, we can ensure that they have the same internal capacity related to the programming and do not face investor-owned utilities' barriers (Homsy, 2016; Curley et al., 2021).

Both communities have solar power policy bundles to promote participation in rooftop solar and community solar farms. However, the utilities differ based on electric distribution and generation status: Fort Collins is a non-generating, distributive utility, whereas Tallahassee is a generating and distributing utility. Previous research suggests that utilities experience different barriers to implementing renewables if they are distributive but non-generating (Krause, 2011). Appendix A1 provides further details about the MOUs (City of Tallahassee Utilities, TU; City of Fort Collins Utilities, FCU).

4. Case description

The following sections detail participation in solar programs in Tallahassee and Fort Collins and the contextual factors that may account for observed differences across the two cases. Specifically, we report on the contextual factors in these two cities regarding their solar policies, population characteristics, and physical environments as they might relate to solar policy design, selection, and effectiveness.

4.1. Policy descriptions: rooftop PV

4.1.1. Tallahassee

Tallahassee Utilities expanded its low-interest loan program to allow residential customers to borrow up to $20,000.00 to install rooftop PV systems. To qualify for the solar loan program, Tallahassee Utilities requires that all solar installers are FSEC certified, and that the customer participates in a Tallahassee Utilities energy audit before installing the loan item. TU offers net metering but does not allow a customer's bill below zero dollars. Any additional credits can be transferred to the next month but expire at the end of the year (defined by the net metering anniversary date).

4.1.2. Fort Collins

Fort Collins' solar policy toolkit for rooftop PV includes Fort Collins' Solar Rebate Program (SRP), solar loans, and net metering (bill credits; City of Fort Collins, 2019a). The city's solar installation sizing limitation is relevant to each, dictating that the size may not exceed 120% of the typical annual use. Through SRP, residential customers can receive rebates for their solar installation, with rebate amounts calculated based on $0.50/Watt of generation capacity and total rebates possibly varying each year (City of Fort Collins, 2019b,c). These rebates are in addition to federal incentives. The loan program allows customers to receive a loan for 100% of the project cost for solar installations. Participants repay their loans through their monthly utility bills (City of Fort Collins, 2019c). Finally, the FCU net metering program provides bill credits that vary based on Time-of-Day pricing. Thus, solar energy reduces the customer's bill by the rate at that time of day, with excess generated solar energy credited at a slightly lower rate (City of Fort Collins, 2019c); there is no direct cap on the credits; however, the sizing limitations of existing solar installations ultimately set an upper limit on the credits.

4.2. Policy descriptions: community solar

4.2.1. Tallahassee

Tallahassee has two solar farms that provide customers with community solar. Solar farm #1 became operational in 2018 and was installed at roughly $33.2 million. It spreads over 120 acres near Tallahassee Airport (Hamlin, 2018). Solar farm #1 is 20 megawatts (American Cities Climate Challenge, 2020). The utility offered three enrollment levels; customers can use solar for 25, 50, or 100 percent of their monthly electricity consumption. In addition, they provide a fixed 0.05 cent fuel charge for 20 years instead of the natural gas fuel charge (035 cents), which fluctuates over time. Solar farm #2, which became operational in January 2020, is a 40-megawatt facility (American Cities Climate Challenge, 2020) and spans 240 acres by the Tallahassee Airport (Woolson, 2020). The solar farm operation guidelines are documented in the city ordinances via Sec. 21–24. More information regarding these and other solar-related policies is discussed in Appendix A.3.

4.2.2. Fort Collins

The Fort Collins community solar program began in 2015. Customers participating in the Community Solar Program receive bill credits based on their subscription level, associated solar array production amount, and time-of-day pricing, ranging from 5.23 cents per kilowatt-hour to 22.92 cents per kilowatt-hour (City of Fort Collins, 2020b). The city of Fort Collins Utility has priced these 305-watt panels, including a 1$ per watt rebate, paired with federal incentives, bringing the panel cost down to $484.95 (Ferrier, 2015). There is an operation and maintenance fee of 9.38375% for the net solar credits generated by the array (City of Fort Collins, 2020e). The

Riverside Community Solar Array was installed as a pilot program in partnership with the Clean Energy Collective. The 0.632-megawatt (632 kW) PV facility spans 6 acres (Braun, 2017). Thus, the community solar arrays in Tallahassee generate nearly 100 times as much electricity as the array in Fort Collins.

4.3. Program participation

Figure 1 documents actual participation rates in the respective programs for each city. Participation in the Solar Rooftop PV programs is much higher in Fort Collins than it is in Tallahassee. However, we see the opposite pattern for Community Solar.

The first solar farm reached maximum capacity in Tallahassee before it was active. Upon opt-in, participants per kWh rate increased by 43% (from 0.035 to 0.05). This means that participants are actively charged more, with no ability to engage in net metering, to participate in the Tallahassee Community Solar program. Despite this, demand for solar energy in the city was still high, and Tallahassee had a waitlist for the next solar farm rollout in Tallahassee. Tallahassee had enough participation in the community solar programs to reach total capacity for solar subscriptions at the end of 2019 before the second solar farm was operational.

Interest in community solar is also strong in Fort Collins. There is a waitlist to join the Fort Collins Community Solar Program (City of Fort Collins, 2020a). Participation in community solar is limited by capacity constraints, although community solar capacity growth is motivated by customer interest and demand. However, the community solar program in Fort Collins requires upfront participant buy-in. This means that people essentially buy a panel for a specific amount of money and are then credited for the power those panels produce. Both of these programs are labeled as community solar; however, they operate functionally differently. This is likely due in part to the nature of Fort Collins Municipal utility as a distributional, non-generating utility; as a result, Fort Collins Utility likely faces additional barriers in expanding its community solar program.

We see that residential customer subscriptions are much higher in Tallahassee than in Fort Collins, and there has been a significant increase in Tallahassee's community solar program in a much shorter time than the Fort Collins program. In Fort Collins, the participation rate for rooftop solar programs is much higher than that seen in Tallahassee. Given the interest in Tallahassee for the community solar program, it suggests that the interest is present within the community for increasing rooftop solar participation. The following sections will explore the contextual factors that might help to explain the variation in participation rates despite the perceived demand for solar-focused programs.

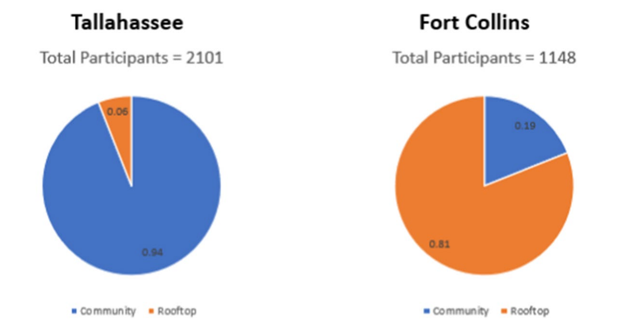

FIGURE 1
Policy participation comparison.

5. Assessing contextual factors

The following section will explore the three factors that we identified through the literature overview as potentially relevant to defining appropriate context for policy design. The existing solar policies at the state level that promote the residential use of solar energy in each community are described in Sections 3.1.2.1 through 3.1.2.3. These policies are summarized and compared in Appendix A.1. Complimentary policies are described in Section 3.1.2.4. In addition to state policies, the federal government offers an additional 30% tax credit on purchasing solar electric systems (City of Fort Collins, 2019c; Solar Energy Industries Association, 2021). After the configuration of existing policies (section 4.1), the target population characteristics (section 4.2), and the physical environment (section 4.3) are assessed below. These sections are then summarized and used to provide key takeaways in section 5.

5.1. Configuration of existing policies

5.1.1. Existing solar policy – state level

5.1.1.1. Florida

Each city's desire and ability to adopt solar programs is likely shaped by state-level policy, as suggested in our literature review above. Florida was ranked 8th in 2018 (3rd in 2017) for its total solar generation, with 252,597 homes powered by solar, and roughly 1% of the state's electricity use comes from solar. Florida does not have a renewable portfolio standard. However, as of 2019, Florida had eight renewable energy incentives (DSIRE, 2020d). This includes a) a sales tax exemption, which provides relief from the financial burden of purchasing solar systems by decreasing the overall cost, and b) a property tax exemption for certain eligible technologies, including solar water heaters, solar PV, wind, and geothermal heat pumps (DSIRE, 2020a). The tax incentive amount is 100% of the added property value of the technology for residential installations and 80% for non-residential. Several regulations oversee all solar systems (approved by the Florida Solar Energy Center), and installing contractors meet licensing requirements. Florida also instituted rules that prevent homeowners' associations from limiting the ability of homeowners to install rooftop solar on their properties.

5.1.1.2. Colorado

When Colorado adopted its Renewable Energy Standards (RES) in 2004, it was the first state in the U.S. to institute such initiatives due to a public vote. Colorado's RES requires a percentage of utility power to be generated by renewable sources. Specifically, investor-owned utility power should be 30% renewable, while cooperatives and municipal utility's renewable share depends on facility size, ranging from 10 to 20% (National Conference of State Legislatures, 2019). At the time of this study, Colorado residents were exempt from 100% of the sales and use taxes that result from residential solar system installations. Colorado also offers property tax incentives for residential, commercial, industrial, and agricultural properties. For residential solar, owners are exempt from paying taxes on any increase in property values added by installing solar technology and other renewable energy technologies are exempt as well (DSIRE, 2020a,b,c). Colorado was ranked 8th in solar energy generation in 2014 (12th in 2018), with roughly 3% of total electricity use powered by solar and about 215,974 homes utilizing solar. As of 2019, Colorado had 13 renewable energy incentives (DSIRE, 2020e). Appendix A.2 provides additional context and synthesis of state-level policy offerings.

5.1.2. Complementary policies

Both cities have a webpage dedicated to sustainability and the activities undertaken to achieve sustainability. Fort Collins has a single department-the Sustainability Services Area-dedicated to environmental sustainability and addresses economic and social sustainability (City of Fort Collins, 2020d). This department reports to one of the Deputy City Managers and operationalizes sustainability as the synergy that results from economic health, environmental protection, and intentional equitable policy; each of these has a dedicated budget line and a total of 28 full-time equivalents between them (City of Fort Collins, 2019a). The City of Tallahassee has a sustainability director and emphasizes community preservation (City of Tallahassee, 2020a). Still, it does not have a dedicated sustainability department (City of Tallahassee, 2019a) or associated budget (City of Tallahassee, 2019c).

Differences in policies regulating the built and natural environmental elements that influence solar panel feasibility, placement, and productivity will impact solar uptake. Specific examples include land use policies limiting the placement of solar panels, building codes specific to roofing regulations, and urban tree policies and programming.

5.1.2.1. Solar zoning ordinances

The siting of rooftop (residential) and community solar panels is regulated at the city and county levels for Tallahassee and Fort Collins. The county and city ordinances combined primarily define panel installation classifications, height and setback requirements, approved zoning districts, the application process, and the pricing structure for energy produced for each city. There are multiple notable differences between the zoning ordinances, both in design and stipulations, that may impact the adoption of solar. Appendix A.3 gives a complete list of each city's requirements in the ordinance's original language and a detailed narrative of the differences and their implications for solar adoption.

In Tallahassee, Leon County takes on most responsibility for the ordinance structure, with the city outlining the energy production pricing structure. Tallahassee has three ordinances covering price, and Leon County has one solar ordinance that details the rest. In contrast, a Fort Collins municipal code search returns 44 codes and regulations that mention solar. In Fort Collins, the structure of the zoning code relevant to solar panels results in the applicable ordinances being scattered throughout the city codes, which increases complexity and introduces a potential barrier to adoption.

In addition to differences in the complexity of the codes, there are differences in their content. For example, the communities differ in their attention to protecting access to sunlight for solar energy production. Whereas Tallahassee provides a statement about the ability to obtain a solar easement, Fort Collins devotes more effort and specificity to protecting solar access. This solar access provision removes barriers to rooftop/residential PV and community solar adoption in Fort Collins.

Additional ordinances that impact community solar adoption include the set-back, fencing, and landscaping requirements that protect viewsheds and land quality while promoting safety. Height limits for rooftop PV, set-back requirements, and the permit process appear to be more stringent in Fort Collins. Implementation influences how these code differences will impact solar uptake. Greater stringency may enhance solar adoption by guaranteeing appropriate installation and placement or act as a barrier to adoption due to challenges in achieving compliance. One area where Tallahassee's code is stricter is the Leon County Ordinance No 2020–01 specification that building-mounted solar systems must endure a wind load of 120 miles per hour, which adds a requirement to the permitting process. Community solar may face further obstacles in Tallahassee, given additional restrictions against placement in agricultural/silvicultural/conservation or preservation areas. However, while such regulations may impact the ability to develop a community solar farm, they do not have implications for resident participation in a community solar program once established. Table 1A in Appendix A.3 compares the solar zoning ordinances of Leon County/Tallahassee and Fort Collins.

5.1.2.2. Building regulations

Neither city specifies roofing regulations; however, the building codes for Florida and Colorado provide a list of allowed roofing materials. Each state lists the following allowable materials: asphalt shingles, concrete and clay tile, metal roof shingles, mineral-surfaced roll roofing, slate shingles, wood shingles, wood shakes, and photovoltaic shingles (International Code Council, 2020; UpCodes, 2020). Colorado also provides one additional allowable material, metal panels. The variety of acceptable materials may suggest that city building regulations do not appear to hinder solar adoption. However, restrictions set forth by Homeowners' Associations may add an extra level of complexity to rooftop solar installations in both locations.

5.1.2.3. Tree protections

The city of Tallahassee has clear guidelines about protected tree status and appears to have stricter rules around tree protection. Within Tallahassee's tree canopy ordinance, each tree has a critical protection zone to prevent root damage from digging and soil compaction during construction. The ordinances also outline a tree credit system based on the size of the tree, which is applied when the removal of a tree is subject to reforestation requirements. These protections extend to essentially any tree greater than 4 inches in diameter, particularly in areas of development. In addition, certified arborists in Tallahassee can grant tree protection beyond those currently listed. These regulations act as additional burdens to land selection for solar development; this is particularly important for community solar.

The City of Fort Collins' ordinance also establishes a process to protect trees during development. It designates a 6-inch or greater diameter to establish protection; however, Fort Collins does not appear to have as many protections as Tallahassee. The tree protection plan in Fort Collins does establish protection and dictates tree replacement but does not utilize a point system as presented in the City of Tallahassee. Fort Collins appears to have fewer protections and greater built-in flexibility than Tallahassee.

5.1.2.4. Forestry programs

The city of Tallahassee houses an Urban Forestry focus within its Planning Department. The 2018 Urban Forest Master Plan guides the department's conservation of the current tree canopy and implements strategies to help it grow. Canopy protection occurs through community education and outreach efforts, the Leon County Canopy Roads committee, and the Adopt-A-Tree program's implementation, allowing Tallahassee residents who live along a city-or county-maintained roadway to have a tree planted for free.

The parks department houses Fort Collins' forestry focus. The department summarizes its primary activities as follows: pruning the urban forest, conducting a risk assessment for community trees, tree replacement, identifying and controlling insects and disease, using industry standards and licensed arborists, collaborating with developers and landscapers to preserve plant diversity, and engaging in public outreach and information campaigns (City of Fort Collins, 2020c).

TABLE 1 Comparing city demographics.

	Tallahassee	Fort Collins
Population	189,907	161,175
Municipal utility electricity customers	122,000 total customers; 102,480 residential	70,500 total customers; 63,000 residential
65 and over %	8.1%	8.8%
% White alone	57.4%	89%
% Black African American	35%	1.2%
% Foreign-born	8.2%	6.4%
Median value home	$177,900	$265,900
Own occupied housing	39.6%	53.9%
High School Grad	92.5%	96%
Bachelors or higher	47.5%	52.5%
Registered Democrats (County)	53.7%	27.7%
Support Renewable Energy	67%	68%

5.2. Population characteristics

Table 1 offers an overview of population characteristics for Tallahassee and Fort Collins. They are both similarly sized cities with universities and a population with high levels of education; however, Tallahassee tends to be more racially diverse with lower levels of owner-occupied housing than Fort Collins. In addition, the county-level voter registration data suggests that Tallahassee is more Democratic than Fort Collins; however, each city appears to have the same degree of support for renewable energy as measured by the Yale Climate Opinion Map 2020 for renewable energy support (Howe et al., 2015). The remaining data for Table 1 comes from the U.S. Census quick facts website (Census Bureau, 2019), the MOUs website for each city, and the departments of state websites for voter registration (Colorado Secretary of State, 2021; Florida Department of State, 2021).

This section demonstrates that each city likely has unique population characteristics that might shape their ability to engage in the policies. Lower rates of home ownership in Tallahassee means the eligible number of participants in a policy design that requires homeownership will already be lower than can be observed in Fort Collins.

5.3. Physical environment

The following Sub-sections focus on the role of climate and tree cover as they are relevant to solar policy. We recognize that the context of the physical environment can refer to a much broader field of elements relevant to the specific policy issue itself.

5.3.1. Climate

Florida has a subtropical climate characterized by heat and humidity. Temperatures frequently exceed 90°F during 6 months of the year and are accompanied by a relative humidity of 50% or greater. These conditions result from abundant sunlight (particularly April through November), an average of nearly 60 inches of rainfall per year, and proximity to large bodies of water. Tallahassee is in Northern Florida and is moderately cooler than more Southern parts of the state, experiencing an average of 18 days below freezing from November through March (Black, 2003). The average temperature in Tallahassee is 67°F, with an average high of 81°F in the hottest month (July) and an average low of 51°F in the coldest month (January; Climate Data, 2020b). The city's average wind speeds range from 5 to 7.5 miles per hour (Florida Climate Center, 2020). However, Tallahassee can also be subject to strong winds from tropical storms and hurricanes. Hurricane season officially begins in Florida in June and ends in November. Depending on the storm category, wind speeds during hurricanes can range from 74 to 157 miles per hour or higher (Collins et al., 2017).

Fort Collins is a cold semi-arid climate (Climate Data, 2020a). The warmest month is July, with an average high temperature of 85°F, and in January, the coldest month, the average low temperature is 13°F. The annual average precipitation is 15.08 inches, and the average annual snowfall is 47 inches, with the highest average snowfall of 10.2 inches in March (Western Regional Climate Center, 2020).

5.3.2. Tree cover

As of 2015, based on LIDAR data, Tallahassee has an overall tree canopy coverage of 55% (City of Tallahassee, 2020c). Based on a 2020 analysis of 2016 LIDAR data, Fort Collins has tree canopy coverage of 21.62% (Rasmussen, 2020). The canopy coverage difference of approximately 33% is evident in the aerial images shown in Figures 2A,B, these images come from Google Maps (2018, 2019).

5.4. Summary of contextual factors

The discussion above unpacks some evident variation in existing environments that likely contribute to variation in policy participation. First, the current policy bundle for solar panels is more extensive in Fort Collins than in Tallahassee, presumably increasing participation rates in rooftop solar for Fort Collins. Second, variation across population characteristics (i.e., homeownership, median income) suggests that rooftop solar policy participation is more likely in Fort Collins. Lastly, tree cover is higher in Tallahassee, which means that conditions for rooftop solar may be less conducive, and siting community solar may be more complicated than in Fort Collins.

Residential solar installations often require tree removal to maximize generation from the PV array. The necessity for tree removal could discourage some homeowners from pursuing rooftop PV because of the resulting loss of cooling and aesthetics. Given the denser tree canopy and higher number of cooling days in Tallahassee, this would appear to be a greater issue. Thus, the physical environment may help explain variation in participation rates and address alternative policy designs that could increase solar installation. Table 2 below compares how these contextualizing factors might shape policy participation.

In addition, potential costs associated with weather events, such as hurricanes and possible wind damage to the panels, may limit residential willingness to invest in solar panels in Tallahassee. Unlike Tallahassee, Fort Collins does not have frequent significant wind or hurricane events. However, Fort Collins does experience strong wind events and hailstorms that can result in replacing roofing, requiring the removal and re-installment of solar systems to do so. While most insurance companies will treat solar panels as part of the home structure, some insurance policies may not cover roofs or the attached solar panels once installed (Hurtibise, 2016). In addition, most insurance companies increase insurance rates to protect solar panels. The increasing financial burden and risks of placing solar panels on one's roof in Tallahassee may decrease participation. Given the barriers to involvement in rooftop solar in Tallahassee, it is no wonder that community solar provides opportunities for participation without the additional costs related to hurricane losses, increasing insurance costs, tree removal, etc. Despite having similar levels of demand for the policy and the existence of solar incentives, the contextual environment (i.e., characteristics of the population, configuration of policy bundles, and physical environment) influence the designed policy from being equally effective in both cities. Alternative policy mechanisms, such as city or state insurance coverage for solar panels and reimagining rooftop solar ownership (rather than community solar), may be considered by policymakers to help overcome the barriers of instituting an effective rooftop solar program in Tallahassee.

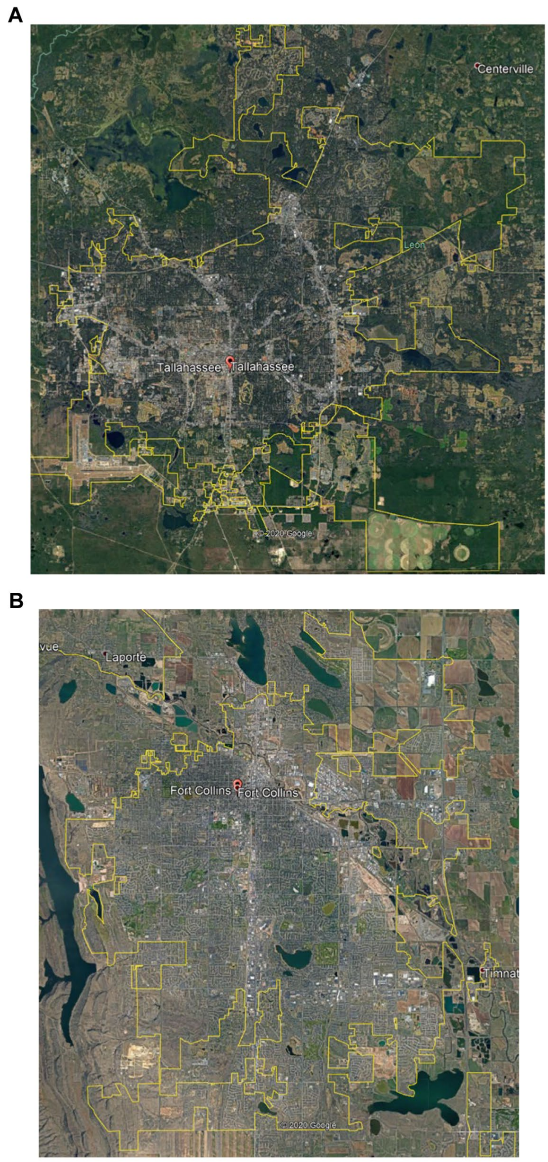

FIGURE 2
(A) Tree cover in Tallahassee. Tallahassee: 10/11/2018; 24.73miles up. **(B)** Tree cover in Fort Collins. Fort Collins: 7/17/2019; 24.12miles up.

6. Discussion

6.1. Alignment between context and effectiveness

Some key factors contribute to lower rooftop PV participation in Tallahassee than Fort Collins. First, the existing solar and complementary policy configuration suggests that Tallahassee will have fewer participants in the rooftop PV program than Fort Collins. More specifically, the financial incentives are smaller for Tallahassee residents, and participants are not allowed to net meter beyond zero (the utility does not pay the household for credits). The second is that tree protection and forestry programs shape the physical environment; Tallahassee has an older canopy that suggests that homes are heavily shaded and not ideal for rooftop PV installation. However, Fort Collins, which is more newly developed, has a younger tree canopy in many residential spaces which might make rooftop PV more appealing. Third, the community characteristics suggest that home ownership and racial homogeneity are higher in Fort Collins, consistent with previous findings that white, upper-middle-income, and highly educated individuals appear to participate in these programs at higher rates than other groups (Wolske, 2020). The collective impact of the above contextualizing factors suggests that rooftop PV would likely be a more effective policy in Fort Collins than in Tallahassee. The contexts described above for Tallahassee, such as shaded roofs, zoning rules, lower homeownership rates, and a lower median

TABLE 2 Contextual factor supports which policy: community or rooftop?

Context category	Factor	Fort Collins	Tallahassee
Population characteristics	Home Ownership Rate: Higher in Fort Collins	Rooftop	Community
	Income: Higher in Fort Collins	Rooftop	Community
Policy bundle	State policy: Colorado has more resources for Rooftop available	Rooftop	Community
	Solar Zoning Ordinance: More complex and stringent in Fort Collins	Depends on Implementation	Rooftop
	Solar Zoning Ordinance: Wind Load Rating Requirement in Tallahassee	Rooftop	Community
	Solar Zoning Ordinance: Solar Access Protection is greater in Fort Collins	Rooftop	Community
	Tree Protections: More stringent in Tallahassee	Limited Impact	Limits Rooftop
	Forestry Program: Conservation and canopy growth	Limited Impact	Limits Rooftop
Physical environment	Tree Cover: Tallahassee urban tree canopy	Limited Impact	Limits Rooftop
Policy effectiveness (participation) more likely for		Rooftop	Community Solar

income, are likely to limit the effectiveness of large-scale rooftop solar incentives.

6.2. Contextualizing policy design

Based on the case comparison conducted above, we have identified specific factors that are likely relevant to policy design effectiveness. This section outlines those specific features and offers a series of takeaways that should be explored in alternative policy contexts for their generalizability. These takeaways explicate the potential avenues in which policy design should consider community context prior to implementation. Doing this will likely help target scarce resources into more effective policy.

6.2.1. Population characteristics

refer largely to the potential Pool of participants. Contextualizing this group means understanding the limitations and considerations of the potential targets. In this case, elements of the population's financial capabilities and homeownership are likely to directly impact participation based on the proposed policy design. Therefore, communities with higher rates of homeownership and higher median income are likely more able to engage in residential rooftop solar policies. Given that we see higher rates of homeownership and more expensive homes in Fort Collins, we could expect higher rates of participation in programs that require more upfront Capital and access to the property. This suggests that matching the characteristics of the community to the policy tool is likely important for design effectiveness.

Takeaway 1: Considering population characteristics in tool selection will help to increase policy effectiveness.

6.2.2. Existing policy configuration

refers to the idea that policy design can be hindered or amplified by existing policy within a community. This means that prior to selecting a design preference, the configuration of potentially impactful policies is needed. In the case of the policies described here, Tallahassee, Florida does not have the same degree of benefits that can be offered to incentivize residents of Fort Collins, Colorado. This makes it more likely that an additional inducement in Fort Collins is likely to have a significant impact on adoption rates and that owning solar panels might be a more relevant factor than simply green energy. This seems to be evident in the design of their community solar program which still centers solar panel ownership, which likely activates state-level benefits as well.

Takeaway 2: The full slate of existing policies is likely to interact, potentially in complementary ways that increase the effectiveness of a policy design.

However, policy configurations can also limit the effectiveness of a particular policy. We see this through the included building regulations and tree protections that are put into place. Specifically, in Tallahassee where building codes related to roofing and higher protections for trees might limit the ability of solar rooftops to be effective, we might suspect lower participation in rooftop PV programs.

Takeaway 3: The existing configurations of related policies are likely to interact with the proposed policy design, potentially in conflicting ways that decrease the effectiveness of the proposed policy design.

6.2.3. Physical environment

refers to the actual characteristics of the geographic location where the policy is being considered. In this case, we are looking at two different communities, one in Northern Florida and the other in Colorado. The weather and physical conditions of the locality are relevant for considering policy design. In the state of Florida there are hurricane events that can lead to unstable insurance markets, Colorado has the potential for blizzard conditions. While technology can be installed to help melt snow from the solar panels, large-scale wind events (such as hurricanes) can create additional risks for solar panel installation, particularly with the need for additional insurance riders in complicated insurance markets. Another potentially complicated physical environment constraint is tree cover. Roof-top solar power requires homes to have spaces with high degrees of shade, however, the city of Tallahassee has a very strong tree protection policy compared to Fort Collins (as discussed above). This suggests that both elements like available sunshine, lack of shading, and weather might act as potential barriers for policies that emphasize individual ownership of rooftop PV.

Takeaway 4: The physical environment, such as tree cover and weather, influences the ability of some policy design strategies to be limited in their effectiveness.

6.2.4. Putting it all together

The above discussions suggest that there are four factors that contextualize the ability of specific policy designs to be effective. We see evidence in this case that elements such as characteristics of the population, existing policies, and the physical environment can interact and contribute to varied levels of policy effectiveness. In the City of Tallahassee, we see population characteristics such as lower house values and homeownership rates, combined with strong tree protections, fewer policy incentives, and high rates of tree cover and more risk from severe weather limit the effectiveness of rooftop PV programs. However, the demand for solar energy still exists, it simply needs to be met through more innovative policy design or alternative policy solutions, which we see through high rates of participation in community solar. Alternatively, Fort Collins experiences higher levels of home ownership and larger incentives, with fewer physical environment barriers, which appears to be related to much higher levels of increased participation in their rooftop solar program and much lower levels of participation and engagement in community solar.

6.3. Implications for policy design

In this paper, we compare two solar policies across two communities to identify what contextual factors influence the effectiveness of solar policy design. This comparative case study specifically demonstrates that policy participation and effectiveness are impacted by the relevance of design choices related to contextual factors of population characteristics, existing policy configurations, and physical environments. The interaction of these factors, coupled with the program's design features, are likely to inform and potentially predict policy effectiveness in a more complete way than is typically captured by current research. These factors significantly affect research on policy adoption, design, and implementation.

Given the apparent relevance of contextual factors identified in this paper, policies may diffuse in ways that are inconsistent with their ability to be effective. Policy transfer research hints at this, that contexts of communities are relevant for policy effectiveness, however, if these contextual factors were considered during the design stage inappropriate policy transfer could be avoided. This suggests that there should be a role for integrating design features, these contextual factors, and the theoretical lenses of diffusion to best understand which policy (or design feature) is most appropriate for any given community. While these factors emphasize the need of policy adoption, policy enactment predominately emphasizes the organizational and situational needs for implementing policy; however, this research might argue that successful implementation depends on having a clear understanding of the potential contextual factors that might act as barriers to participation. These contextual factors can help to alter policy design or encourage the adoption of additional strategies to overcome ineffective design transfer.

Although studies on policy implementation (enactment), policy learning (failure), and policy transfer may consider some of the factors explicitly addressed here, their inclusion in policy design, especially rational policy tool choice research, is limited. In this study, we have laid out a series of key takeaways for how we might expect these contextual factors to be relevant to policy design. However, the present study is limited by its exploratory nature, and future research should examine the quantitative impact of these contextual features on policy choices and effectiveness more systematically. Integrating these elements in the study of policy design, particularly policy choice, may enable policymakers and scholars to enhance policy effectiveness, improve equity in distributing and delivering public goods and services, and decrease inefficiencies in government spending.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

This was a collaborative project across two institutions that were working with different municipally-owned utilities. The outcome data demonstrated very clear differences. CC and her student NH put together an initial draft manuscript that explored the potential reasons for those differences. PA-Y helped to refine the manuscript and make edits to the paper. Other co-authors read a draft of the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This work was supported by the National Science Foundation. Grant Number: NSF 1444745 University of Miami funding for open access publication fee.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling editor SS declared a past co-authorship with the author CC.

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsuep.2023.1180830/full#supplementary-material

References

American Cities Climate Challenge (2020). Transaction Tracker. Retrieved from Local Government Renewables Action Tracker. Available at: https://cityrenewables.org/transaction-tracker/ and https://www.google.com/url?q=http://datasets.wri.org/dataset/0dc2e15a-8be7-45ba-a49e-7b0e787e948f/resource/1411079c-4175-47ec-83f8-4b52d8104f69/download/localgovernmentrenewablesactiontrackerjune2020&sa= (Accessed June 24, 2023).

Ball, S. J., Maguire, M., and Braun, A. (2011). *How schools do policy: Policy enactments in secondary schools*. New York: Routledge.

Baxter, P., and Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *Qual. Rep.* 13, 544–559. Available at: http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf

Becker, F. P. (2019). Solar-permissive model zoning ordinances: Rationale, considerations, and examples. *Appl. Energy*

Bensonsmith, D. (2005). "Jezebels, Matriarchs, and Welfare Queens: The Moynihan Report of 1965 and the Social Construction of African-American Women in Welfare Policy" in *Deserving and Entitled: Social Constructions of Public Policy*. eds. A. L. Schneider and H. M. Ingram (Albany, NY: State University of New York Press), 243–260.

Black, R. J. (2003). Florida Climate Data. University of Florida IFAS Extension. Resource Document. Available at: https://ufdcimages.uflib.ufl.edu/IR/00/00/47/86/00001/EH10500.pdf. (Accessed June 24, 2023).

Borenstein, S., and Davis, L. W. (2016). The distributional effects of US clean energy tax credits. *Tax Policy Eco.* 30, 191–234. doi: 10.1086/685597

Braun, T. (2017). Press Release: CEC and Fort Collins Utilities Break Ground on Community Solar Array: Brownfield Site Hosts Shared Solar Facility, Supports City's Climate and Energy Goals. Cleaner Energy Company. Available at: https://cleanenergyco.com/news/press-release-cec-and-fort-collins-utilities-break-ground-on-community-solar-array/ (Accessed March 2020).

Braun, A., Ball, S. J., Maguire, M., and Hoskins, K. (2011). Taking context seriously: Towards explaining policy enactments in the secondary school. Discourse: Studies in the cultural politics of education, 32(4), 585–596.

Brucker, D. L. (2007). Substance Abuse Treatment Participation and Employment Outcomes for Public Disability Beneficiaries with Substance Use Disorders. *J. Behav. Health Serv. Res.* 34, 290–308. doi: 10.1007/s11414-007-9073-3

Bushouse, Brenda K. (2009). *Universal Preschool: Policy Change, Stability, and the Pew Charitable Trusts*. Albany, NY: SUNY Press.

Campbell, Andrea Louise. (2003). *How Policies Make Citizens: Senior Political Activism and the American Welfare State*. Princeton, NJ: Princeton University Press

Capano, G., and Howlett, M. (2020). The knowns and unknowns of policy instrument analysis: Policy tools and the current research agenda on policy mixes. *SAGE Open*. doi: 10.1177/2158244019900568

Capano, G., and Lippi, A. (2017). How policy instruments are chosen: Patterns of decision makers' choices. *Policy. Sci.* 50, 269–293. doi: 10.1007/s11077-016-9267-8

Chapman, A., McLellan, B., and Tezuka, T. (2016). Strengthening the energy policy making process and sustainability outcomes in the OECD through policy design. *Adm. Sci.* 6:9. doi: 10.3390/admsci6030009

Cheng, Q., and Yi, H. (2017). Complementarity and substitutability: A review of state level renewable energy policy instrument interactions. *Renew. Sust. Energ. Rev.* 67, 683–691. doi: 10.1016/j.rser.2016.09.069

City of Fort Collins. (2019a). Adopted Biennial Budget: 2019–2020. City of Fort Collins: Fort Collins Colorado. Available at: https://www.fcgov.com/citymanager/files/201920-biennial-budget.pdf?1551998128 (Accessed June 24, 2023).

City of Fort Collins. (2019b). Frequently Asked Questions. Retrieved from City of Fort Collins [US]: Available at: https://www.fcgov.com/utilities/residential/renewables/solar-rebates/faqs (Accessed June 24, 2023).

City of Fort Collins. (2019c). Solar Rebates. Retrieved from City of Fort Collins [US]: Available at: https://www.fcgov.com/utilities/residential/renewables/solar-rebates (Accessed June 24, 2023).

City of Fort Collins (2020a). Fort Collins Community Solar. Available at: https://www.fcgov.com/utilities/residential/renewables/fort-collins-community-solar (Accessed June 24, 2023).

City of Fort Collins (2020b). Residential Electric Rates. Utilities. Available at: https://www.fcgov.com/utilities/residential/rates/electric [Accessed March 4, 2020].

City of Fort Collins (2020c). Forestry. Parks Department. Available at: https://www.fcgov.com/forestry/about-us [Accessed March 4, 2020].

City of Fort Collins (2020d). Organization Chart. Available at: https://www.fcgov.com/file-gateway/?id=112 [Accessed March 27, 2020].

City of Fort Collins (2020e). Riverside Community Solar Program Requirements, Terms and Conditions, and Rules - DRAFT. Available at: https://www.fcgov.com/utilities//img/site_specific/uploads/fcu-riversidecommunitysolarprogramrules.pdf?1595601466 (Accessed June 24, 2023).

City of Tallahassee (2019a). Department Descriptions. Available at: https://www.talgov.com/uploads/public/documents/fm/fy19budget/fy19DepartmentDescriptions.pdf [Accessed March 7, 2020].

City of Tallahassee (2019b). Electric System Integrated Planning. Ten Year Site Plan: 2019–2028. City of Tallahassee Utilities: Tallahassee, Florida. Available at: http://www.psc.state.fl.us/Files/PDF/Utilities/Electricgas/TenYearSitePlans/2019/City%20of%20Tallahassee.pdf (Accessed June 24, 2023).

City of Tallahassee (2019c). Fiscal Year 2019 Budget Report. Available at: https://www.talgov.com/transparency/budget-fy19.aspx [Accessed March 27, 2020].

City of Tallahassee (2020a). City of Tallahassee Organizational Values. Available at: https://www.talgov.com/uploads/public/documents/cotnews/cot-orgchart.pdf [Accessed March 27, 2020].

City of Tallahassee (2020b). Electric Utilities. Available at: https://www.talgov.com/you/you-electric.aspx [Accessed March 11, 2020].

City of Tallahassee (2020c). Urban Forestry. Available at: https://www.talgov.com/place/pln-urbanforestry.aspx (Accessed June 24, 2023).

Climate Data (2020a). Colorado Climate. Climate-Data.Org. Resource Document. Available at: https://en.climate-data.org/north-america/united-states-of-america/colorado-928/ (Accessed June 24, 2023).

Climate Data (2020b). Tallahassee Climate. Climate-Data.Org. Resource Document. Available at: https://en.climate-data.org/north-america/united-states-of-america/florida/tallahassee-1630/ (Accessed June 24, 2023).

Cloutier, S., Berejnoi, E., Russell, S., Morrison, B. A., and Ross, A. (2018). Toward a holistic sustainable and happy neighborhood development assessment tool: A critical review of relevant literature. *Ecol. Indic.* 89, 139–149. doi: 10.1016/j.ecolind.2018.01.055

Collins, J. M., Paxton, C. H., Wahl, T., and Emrich, C. T. (2017). Climate and Weather Extremes. Florida's Climate: Changes, Variations, & Impacts. Available at: https://floridaclimateinstitute.org/docs/climatebook/Ch20-Collins.pdf (Accessed June 24, 2023).

Colorado Secretary of State (2021). 2021 Voter Registration Statistics. Available at: https://www.sos.state.co.us/pubs/elections/VoterRegNumbers/VoterRegNumbers.html (Accessed June 24, 2023).

Curley, C., Feiock, R., and Xu, K. (2020). Policy Analysis of Instrument Design: How Policy Design Affects Policy Constituency. *J. Comp. Policy Anal. Res. Pract.* 22, 536–557. doi: 10.1080/13876988.2020.1749517

Curley, C., Harrison, N., Kewei, X., and C. and Zhou, S., (2021). Collaboration mitigates barriers of utility ownership on policy adoption: evidence from the United States. *J. Environ. Plan. Manag.* 64, 124–144. doi: 10.1080/09640568.2020.1755241

Czarnowska, L., and Frangopoulos, C. A. (2012). Dispersion of pollutants, environmental externalities due to a pulverized coal power plant and their effect on the cost of electricity. *Energy* 41, 212–219. doi: 10.1016/j.energy.2011.08.004

Devine-Wright, P. (2011). Public engagement with large-scale renewable energy technologies: breaking the cycle of NIMBYism. *Wiley Interdiscip. Rev. Clim. Chang.* 2, 19–26.

DiAlto, S. (2005). "From 'Problem Minority' to 'Model Minority': The Changing Social Construction of Japanese Americans" in *Deserving and Entitled: Social Constructions and Public Policy*. eds. A. L. Schneider and H. M. Ingram (Albany, NY: State University of New York Press), 81–103.

Donovan, M. C. (1993). Social Constructions of People with AIDS: Target Populations and United States Policy, 1981–1990. *Policy Stud. Rev.* 12, 3–29.

Donovan, M. C. (1997). The Problem with Making AIDS Comfortable: Federal Policy Making and the Rhetoric of Innocence. *J. Homosex.* 32, 115–144.

DSIRE (2020a). Property Tax Abatement for Renewable Energy Property. NC Clean Energy Technology Center, NC State University. Available at: https://programs.dsireusa.org/system/program/detail/5426 (Accessed June 24, 2023).

DSIRE (2020b). Property Tax Exemption for Residential Renewable Energy Equipment. NC Clean Energy Technology Center, NC State University. Available at: https://programs.dsireusa.org/system/program/detail/4210 (Accessed June 24, 2023).

DSIRE (2020c). Renewable Energy Property Tax Assessment. NC Clean Energy Technology Center, NC State University. Available at: https://programs.dsireusa.org/system/program/detail/2388 (Accessed June 24, 2023).

DSIRE (2020d). Zip Code: 32301. NC Clean Energy Technology Center, NC State University. Available at: https://programs.dsireusa.org/system/program?zipcode=32301 (Accessed June 24, 2023).

DSIRE (2020e). Zip Code: 80521. NC Clean Energy Technology Center, NC State University. Available at: https://programs.dsireusa.org/system/program?zipcode=80521. (Accessed June 24, 2023).

Edmondson, D. L., Kern, F., and Rogge, K. S. (2019). The co-evolution of policy mixes and socio-technical systems: Towards a conceptual framework of policy mix feedback in sustainability transitions. *Res. Policy* 48:103555. doi: 10.1016/j.respol.2018.03.010

EERE (Office of Energy Efficiency and Renewable Energy). (2020). Procuring Solar for Federal Facilities. Available at: https://www.energy.gov/eere/solar/procuring-solar-federal-facilities [Accessed March 11, 2020].

Ferrier, P. (2015). ground Broken on 2,000-panel solar garden, Coloradoan. Available at: https://www.coloradoan.com/story/money/2015/03/26/groundbreaking-fort-collins-solar-garden/70447692/ (Accessed June 24, 2023).

Flanagan, K., Uyarra, E., and Laranja, M. (2011). Reconceptualising the 'policy mix'for innovation. *Res. Policy* 40, 702–713. doi: 10.1016/j.respol.2011.02.005

Florida Climate Center (2020). Average Wind Speed. Florida Climate Center. Resource Document. Availble at: https://climatecenter.fsu.edu/products-services/data/other-normals/average-wind-speed (Accessed June 24, 2023).

Florida Department of State (2021). Voter Registration by County and Party. Availble at: https://dos.myflorida.com/elections/data-statistics/voter-registration-statistics/voter-registration-reportsxlsx/voter-registration-by-county-and-party/ (Accessed June 24, 2023).

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qual. Inq.* 12, 219–245.

Garrow, E. E. (2012). Does Race Matter in Government Funding of Nonprofit Human Service Organizations? The Interaction of Neighborhood Poverty and Race. *J. Public Adm. Res. Theory*. 24, 381–405. doi: 10.1093/jopart/mus061

Gasteiger, E. (2018). Do heterogeneous expectations constitute a challenge for policy interaction? *Macroecon. Dyn.* 22, 2107–2140. doi: 10.1017/S1365100516001036

Gollust, S. E., and Lynch, J. (2011). Who Deserves Health Care? The Effects of Causal Attributions and Group Cues on Public Attitudes About Responsibility for Health Care Costs. *J. Health Polit. Policy Law* 36, 1061–1095. doi: 10.1215/03616878-1460578

Google Maps (2018). Tallahassee. Google Maps online. Available at: maps.google.com (Accessed June 24, 2023).

Google Maps (2019). Fort Collins. Google Maps online Available at: maps.google.com (Accessed June 24, 2023).

Grabosky, P. N. (1995). Regulation by reward: On the use of incentives as regulatory instruments. *Law Policy* 17, 257–282. doi: 10.1111/j.1467-9930.1995.tb00150.x

Graff, M., Carley, S., and Konisky, D. M. (2018). Stakeholder perceptions of the United States energy transition: Local-level dynamics and community responses to national politics and policy. *Energy Res. Soc. Sci.* 43, 144–157. doi: 10.1016/j.erss.2018.05.017

Guthrie, A., Fan, Y., Crabtree, S., and Burga, F. (2019). *Those Who Need it Most: Maximizing Transit Accessibility and Removing Barriers to Employment in Areas of Concentrated Poverty*. Center for Transportation Studies, University of Minnesota.

Halász, G. (2019). Designing and implementing teacher policies using competence frameworks as an integrative policy tool. *Eur. J. Educ.* 54, 323–336.

Hamlin, M. (2018). Tallahassee Int'l Adds Second Solar Farm & Creates Sustainability Master Plan. Airport Improvement. Available at: https://airportimprovement.com/article/tallahassee-int-l-adds-second-solar-farm-creates-sustainability-master-plan (Accessed June 24, 2023).

Homsy, G. C. (2016). Powering sustainability: Municipal utilities and local government policymaking. *Environ. Plann. C: Gov. Policy* 34, 1076–1094. doi: 10.1177/0263774X15596530

Hood, C. (1983) *The Tools of Governments*, Basingstoke: Macmillan.

Howe, P. D., Mildenberger, M., Marlon, J. R., and Leiserowitz, A. (2015). Geographic variation in opinions on climate change at state and local scales in the USA. *Nat. Clim. Chang.* doi: 10.1038/nclimate2583

Howlett, M. (2018). The criteria for effective policy design: character and context in policy instrument choice. *J. Asian Publ. Policy* 11, 245–266.

Howlett, M. (2019). *Designing public policies: Principles and instruments*. New York: Routledge.

Howlett, M., and Mukherjee, I. (2017). Policy design: from tools to patches. *Can. Publ. Adm.* 60:140. doi: 10.1111/capa.12209

Howlett, M., and Ramesh, M. (2003). *Studying Public Policy: Policy Cycles and Policy Subsystems*, Toronto, Oxford University Press.

Howlett, M., and Rayner, J. (2007). Design principles for policy mixes: Cohesion and coherence in 'new governance arrangements'. *Polic. Soc.* 26, 1–18. doi: 10.1016/S1449-4035(07)70118-2

Hsu, J. H. Y. (2018). Predictors for adoption of local solar approval processes and impact on residential solar installations in California cities. *Energy Policy* 117, 463–472. doi: 10.1016/j.enpol.2018.03.008

Hudson, R. B. (2013). The Transformed Political World of Older Boomers. *J. Gerontol. Soc. Work.* 56, 85–89. doi: 10.1080/01634372.2013.753825

Hunter, C., and Nixon, J. (1999). The Discourse of Housing Debt: The Social Construction of Landlords, Lenders, Borrowers and Tenants. *Hous. Theory Soc.* 16, 165–178. doi: 10.1080/14036099950149893

Hurtibise, R. (2016). Insurers widening lists of things they won't cover. SunSentinel. Available at: https://www.sun-sentinel.com/business/jobs/fl-what-homeowner-insurance-doesnt-cover-20160422-story.html (Accessed June 24, 2023).

Ingram, H., and Schneider, A. L. (2011). Science, Democracy, and Water Policy. *J. Contemp. Water Res. Educ.* 113, 21–28.

International Code Council (2020). 2017 Florida Building Code - Building, Sixth Edition - July 2017. Resource Document. Available at: https://codes.iccsafe.org/content/FBC2017?site_type=public (Accessed June 24, 2023).

Kelly, R. M. (2016). *Policy & Privilege in Photovoltaics: a Community Level Analysis In San Diego County*. doi: 10.15368/theses.2016.97

Kern, F., Kivimaa, P., and Martiskainen, M. (2017). Policy packaging or policy patching? The development of complex energy efficiency policy mixes. *Energy Res. Soc. Sci.* 23, 11–25. doi: 10.1016/j.erss.2016.11.002

Khan, J. (2005). The importance of local context in the planning of environmental projects: examples from two biogas cases. *Local Environ.* 10, 125–140. doi: 10.1080/1354983052000330815

King, K. E. (2015). Chicago residents' perceptions of air quality: objective pollution, the built environment, and neighborhood stigma theory. *Popul. Environ.* 37, 1–21. doi: 10.1007/s11111-014-0228-x

Koski, C., and Siddiki, S. (2022). Linking policy design, change, and outputs: policy responsiveness in American state electricity policy. *Policy Stud. J.* 50, 553–574. doi: 10.1111/psj.12442

Krause, R. M. (2011). Policy innovation, intergovernmental relations, and the adoption of climate protection initiatives by US cities. *J. Urban Aff.* 33, 45–60. doi: 10.1111/j.1467-9906.2010.00510.x

Krause, R. M., Hawkins, C. V., Park, A. Y., and Feiock, R. C. (2019). Drivers of Policy Instrument Selection for Environmental Management by Local Governments. *Public Adm. Rev.* 79, 477–487. doi: 10.1111/puar.13025

Lecuyer, O, and Bibas, R. (2012). *Combining climate and energy policies: synergies or antagonism? Modeling interactions with energy efficiency instruments*. (SSRN Scholarly Paper). Social Science Research Network.

Li, S., Tong, L., Xing, J., and Zhou, Y. (2017). The market for electric vehicles: indirect network effects and policy design. *J. Assoc. Environ. Resour. Econ.* 4, 89–133. doi: 10.1086/689702

Li, H., and Yi, H. (2014). Multilevel governance and deployment of solar PV panels in US cities. *Energy Policy* 69, 19–27. doi: 10.1016/j.enpol.2014.03.006

Lockhart, C., Giles-Sims, J., and Klopfenstein, K. (2008). Cross-State Variation in Medicaid Support for Older Citizens in Long-Term Care Nursing Facilities. *State Local Gov. Rev.* 40, 173–185. doi: 10.1177/0160323X0804000304

Lopez, R. P., and Hynes, H. P. (2006). Obesity, physical activity, and the urban environment: public health research needs. *Environ. Health* 5:25. doi: 10.1186/1476-069X-5-25

Maor, M. (2020). Policy over-and under-design: an information quality perspective. *Policy. Sci.* 53, 395–411. doi: 10.1007/s11077-020-09388-x

Matisoff, D. C., and Johnson, E. P. (2017). The comparative effectiveness of residential solar incentives. *Energy Policy* 108, 44–54. doi: 10.1016/j.enpol.2017.05.032

May, P. J. (1991). Reconsidering policy design: policies and publics. *J. Publ. Policy* 11, 187–206. doi: 10.1017/S0143814X0000619X

Miller, Hugh T. (2012). *Governing Narratives: Symbolic Politics and Policy Change*. Tuscaloosa, AL: University of Alabama Press.

National Conference of State Legislatures (2019). State Renewable Portfolio Standards and Goals. Available at: https://www.ncsl.org/energy/state-renewable-portfolio-standards-and-goals (Accessed June 24, 2023).

Paddeu, D., and Aditjandra, P. (2020). Shaping urban freight systems via a participatory approach to inform policy-making. *Sustainability* 12:441. doi: 10.3390/su12010441

Patterson, D. A., and Keefe, R. H. (2008). Using Social Construction Theory as a Foundation for Macro-Level Interventions in Communities Impacted by HIV and Addictions. *J. Sociol. Soc. Welf.* 35, 111–126.

Peters, M., Fudge, S., High-Pippert, A., Carragher, V., and Hoffman, S. M. (2018). Community solar initiatives in The United States of America: Comparisons with–and lessons for–the UK and other European countries. *Energy Policy* 121, 355–364. doi: 10.1016/j.enpol.2018.06.022

Pierce, J. J., Siddiki, S., Jones, M. D., Schumacher, K., Pattison, A., and Peterson, H. (2014). Social construction and policy design: A review of past applications. *Policy Stud. J.* 42, 1–29. doi: 10.1111/psj.12040

Rasmussen, S. (2020). Sustainability in Fort Collins: exploring the drivers of urban tree canopy and household water consumption in a growing, semi-arid city (Doctoral dissertation, Colorado State University). Available at: https://mountainscholar.org/bitstream/handle/10217/212051/Rasmussen_colostate_0053N_16211.pdf?sequence=1.cholar.org/bitstream/handle/10217/212051/Rasmussen_colostate_0053N_16211.pdf?sequence=1 (Accessed June 24, 2023).

Rayner, J., Howlett, M., and Wellstead, A. (2017). Policy Mixes and their Alignment over Time: Patching and stretching in the oil sands reclamation regime in Alberta, Canada. *Environ. Policy Gov.* 27, 472–483. doi: 10.1002/eet.1773

Rogge, K. S., and Reichardt, K. (2016). Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Res. Policy* 45, 1620–1635. doi: 10.1016/j.respol.2016.04.004

Ruddle, K. (1998). The context of policy design for existing community-based fisheries management systems in the Pacific Islands. *Ocean Coast. Manag.* 40, 105–126. doi: 10.1016/S0964-5691(98)00040-4

Salamon, L.M. (2002) *The Tools of Government: A Guide to the New Governance*, Oxford: Oxford University Press.

Sarzynski, A., Larrieu, J., and Shrimali, G. (2012). The impact of state financial incentives on market deployment of solar technology. *Energy Policy* 46, 550–557. doi: 10.1016/j.enpol.2012.04.032

Sawhney, A., and Rahul, M. (2014). Examining the regional pattern of renewable energy CDM power projects in India. *Energy Econ.* 42, 240–247. doi: 10.1016/j.eneco.2014.01.007

Schneider, A., and Sidney, M. (2009). What is next for policy design and social construction theory? 1. *Policy Stud. J.* 37, 103–119. doi: 10.1111/j.1541-0072.2008.00298.x

Schroedel, J. R., and Jordan, D. R. (1998). Senate Voting and Social Construction of Target Populations: A Study of AIDS Policy Making, 1987–1992. *J. Health Polit. Policy Law* 23, 107–132. doi: 10.1215/03616878-23-1-107

SEIA (Solar Energy Industries Association) (2020). Community Solar. Initiatives. Available at: https://www.seia.org/initiatives/community-solar (Accessed June 6, 2022).

Shirazi, M. R., and Keivani, R. (2017). Critical reflections on the theory and practice of social sustainability in the built environment–a meta-analysis. *Local Environ.* 22, 1526–1545. doi: 10.1080/13549839.2017.1379476

Shrimali, G., and Jenner, S. (2013). The impact of state policy on deployment and cost of Solar photovoltaic technology in the U.S.: a sector-specific empirical analysis. *Renew. Energy* 60, 679–690. doi: 10.1016/j.renene.2013.06.023

Siddiki, S., and Curley, C. (2022). Conceptualising policy design in the policy process. *Policy Polit.* 50, 117–135. doi: 10.1332/030557321X16346727541396

Sidney, M. S. (2001). Images of Race, Class, and Markets: Rethinking the Origin of U.S. Fair Housing Policy. *J. Policy Hist.* 13, 181–214. doi: 10.1353/jph.2001.0006

Sidney, M. S. (2005). "Contested Images of Race and Place: The Politics of Housing Discrimination" in *Deserving and Entitled: Social Constructions and Public Policy*. eds. A. L. Schneider and H. M. Ingram (Albany, NY: State University of New York Press), 111–137.

Simcoe, T., and Toffel, M. W. (2014). Government green procurement spillovers: Evidence from municipal building policies in California. *J. Environ. Econ. Manag.* 68, 411–434. doi: 10.1016/j.jeem.2014.09.001

Simis, M., Awang, A., and Arifin, K. (2016). From Ex-landfill to Public Park: Impact on local community's quality of life and living environment. *Procedia Soc. Behav. Sci.* 222, 763–771. doi: 10.1016/j.sbspro.2016.05.157

Solar Energy Industries Association (2021). Residential ITC Phasedown. Available at: https://www.seia.org/research-resources/residential-itc-phasedown (Accessed June 24, 2023).

U.S. Census Bureau (2019). Quickfacts Fort Collins city, Colorado; Tallahassee city, Florida. Available at: https://www.census.gov/quickfacts/fact/table/fortcollinscitycolorado,tallahasseecityflorida/PST045219 (Accessed June 24, 2023).

UpCodes (2020.) Chapter 15 Roof Assemblies and Rooftop Structures. Resource Document. Available at: https://up.codes/viewer/colorado/ibc-2018/chapter/15/roof-assemblies-and-rooftop-structures#15 (Accessed June 24, 2023).

Western Regional Climate Center (2020). Ft Collins. Colorado (053005): Period of Record Monthly Climate Summary. Resource Document. Available at: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?co3005 (Accessed June 24, 2023).

Wilkie, S., Townshend, T., Thompson, E., and Ling, J. (2018). Restructuring the built environment to change adult health behaviors: a scoping review integrated with behavior change frameworks. *Cities Health* 2, 198–211. doi: 10.1080/23748834.2019.1574954

Wilson, J. S., Clay, M., Martin, E., Stuckey, D., and Vedder-Risch, K. (2003). Evaluating environmental influences of zoning in urban ecosystems with remote sensing. *Remote Sens. Environ.* 86, 303–321. doi: 10.1016/S0034-4257(03)00084-1

Wilson, S. M., Heaney, C. D., Cooper, J., and Wilson, O. (2008a). Built environment issues in unserved and underserved African-American neighborhoods in North Carolina. *Environ. Justice* 1, 63–72. doi: 10.1089/env.2008.0509

Wilson, S. M., Hutson, M., and Mujahid, M. (2008b). How planning and zoning contribute to inequitable development, neighborhood health, and environmental injustice. *Environ. Justice* 1, 211–216. doi: 10.1089/env.2008.0506

Wolske, K. S. (2020). More alike than different: Profiles of high-income and low-income rooftop solar adopters in the United States. *Energy Res. Soc. Sci.* 63:101399. doi: 10.1016/j.erss.2019.101399

Woolson, J. D. (2020). New Addition at Tallahassee Int'l Creates World's Largest On-Airport Solar Farm. Airport Improvement. Available at: https://airportimprovement.com/article/new-addition-tallahassee-int-l-creates-world-s-largest-airport-solar-farm (Accessed June 24, 2023).

WXTL Tallahassee (2018). City of Tallahassee recognized as 2018 Utility of the Future Today. Available at: https://www.wtxl.com/news/city-of-tallahassee-recognized-as-utility-of-the-future-today/article_33a3109e-b2e2-11e8-8ed0-5ffc2cafb814.html (Accessed June 24, 2023).

Yi, H., and Feiock, R. C. (2012). Policy tool interactions and the adoption of state renewable portfolio standards. *Rev. Policy Res.* 29, 193–206. doi: 10.1111/j.1541-1338.2012.00548.x

Yin, R. K. (2003). *Case study research: Design and methods* (*3rd ed.*). Thousand Oaks, CA: Sage.

Yoo, G. J. (2001). Constructing Deservingness: Federal Welfare Reform, Supplemental Security Income, and Elderly Immigrants. *J. Aging Soc. Policy* 13, 17–34. doi: 10.1300/j031v13n04_02

Yoo, G. J. (2008). Immigrants and Welfare: Policy Constructions of Deservingness. *J. Immigr. Refug. Stud.* 6, 490–507. doi: 10.1080/15362940802479920