 doi:10.20944/preprints201811.0120.v1

Data Descriptor

SolarView: Georgia Solar Adoption in Context

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Abstract: Despite a global push in the development and implementation of widespread alternative energy use, significant disparities exist across given nation-states. These disparities, frequently referred to as the local-national gap, reflect both technical and economic factors, as well as the social, political, and ecological gaps between how communities see energy development and national/global policy goals. This dataset is an attempt to bridge the local-national gap regarding solar PV adoption in the state of Georgia (U.S.A.). This dataset is an aggregation of variables from seven different publicly-available sources that was designed to help researchers interested in the context underlying solar adoption on the local scale of governance (e.g. the county level). The SolarView database includes information necessary for informing policymaking activities such as solar installation information, a historical county zip code directory, county-level census data, housing value indexes, renewable energy incentive totals, PV rooftop suitability percentages, and utility rates. As this is a database from multiple sources, incomplete data entries are noted.

Keywords: solar; technology adoption; demographics; mixed methods

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1. Summary

Despite a global push in the development and implementation of widespread alternative energy use, significant disparities exist across given nation-states with regard to local adoption. It is becoming increasingly apparent that individual communities do not necessarily share the same energy wants and needs with one another, and as noted in multiple studies of energy development projects [1,2] the alignment of value systems between energy sources and local needs play a significant role in how—if at all—these sources are used [3].

The social and physical distances between where people live their daily lives and where governments define national priorities are a critical, yet only recently-explored, phenomena. A burgeoning area of research, studies of this 'local-national gap,' seek to establish a space for national policy analyses and studies of individual motivations with community-level dynamics. These disparities reflect both technical and economic factors, as well as the social, political, and ecological gaps between how communities see energy development and national/global policy goals. Known as the "local-national gap," many nations struggle with fostering meaningful conversations about the role of alternative energy technologies within communities. Mitigation of this problem first requires understanding the distribution of existing alternative energy technologies at the local level of policymaking. Moreover, access to datasets that respect these gaps and make clear their strengths and limitations in addressing such issues are not as publicly visible as they are needed to be in order to address such pain points.

As described in Tidwell, Tidwell, and Nelson (2018) [4], there is a state within the United States of America that proves to be an interesting case study for investigating issues of local adoption of national renewable energy policy: Georgia. The Energy Information Administration positions Georgia as a leader in biomass energy production and an emerging space for the deployment of photovoltaic solar in the utility, commercial, and residential sectors [5]. Its status as an emergent space for PV solar is reflective of the perceived high potential for solar energy in Georgia in terms of solar insolation — it having some of the highest in the southeastern United States (Figure 1).

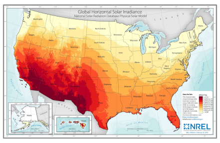

Figure 1. Solar irradiance map of the United States[6]

As a result of the size of the Georgia economy (9th in the country by Gross Domestic Product), and its existing energy system characteristics, Georgia is posited to be one of the states with the highest potential for solar deployment [7]. Recent trends in solar adoption seem to reflect these analyses.

Between 2017 and 2018, total net generation from solar photovoltaic rose from 22nd in the nation [8] to 9th [5], moving Georgia from laggard to leader in solar power production [9]. Policy changes, including the Solar Power Free-Market Financing Act of 2015, have opened possibilities for integrating solar from third-party producers despite the lack of net metering policies or a Renewable Portfolio Standard. Despite this seemingly positive uptake in energy generation through solar-powered technologies, a closer look locally indicates that the primary driving force is the integration of several utility and commercial-scale solar facilities. In 2018, Georgia ranked 37th in power generated from residential PV solar: making it the lowest ranked state amongst the top ten in total PV solar energy production. Despite recent increases in the annual generation of electricity from solar installations in the state of Georgia—primarily a result of new utility-scale installations [5]—there is still a significant amount of potential for solar technology adoption for Georgia (see Table 1 [10]).

Table 1. Georgia Energy Data solar electric installations Summary.

Use Sector	Number of Installations	Capacity	Annual Generation
Residential	1046	5,822.99 kW	8,128,855.02 kWh
Non-Residential	599	52,755.53 kW	74,278,797.37 kWh
Utility	235	1,250,862.51 kW	1,873,396,033.13 kWh

One might wonder how a state positioned for high technical potential could have such low levels of adoption.

In Tidwell and Tidwell (2018) [11], they share how the Social Energy Atlas has been charged with the mission to collect over 1,500 individual narratives of perception around solar technology adoption at the county level in the state Georgia so as to better understand this gap between national policy and analyses indicating a strong potential for solar energy technology use in the state and its rather low adoption on the ground. The goal of this project goal is to cultivate a multimodal dataset for understanding the collective norms and values society shares surrounding energy systems. As the first phase of its project, the Social Energy Atlas, funded by the U.S. Department of Energy Solar Energy Technologies Office, has identified existing publicly available sources of local solar technology adoption information and has aggregated them together to create a resource for better understanding the context of PV adoption at the local level: the SolarView database.

To address the limitation of existing adoption trend datasets at the scale of local governance (e.g. county governments), this data descriptor for SolarView depicts how the aggregation of seven independent databases was conducted, so as to afford the Social Energy Atlas the ability to contextualize solar technology adoption at a local level of scale through the analysis of quantitative

 doi:10.20944/preprints201811.0120.v1

data for the state of Georgia, U.S.A., and demonstrate the complexity systems that are currently giving rise to significant disparity in adoption practices in this state using Gini coefficient calculations [4].

The rest of the paper seeks to describe the dataset that has been produced during the first phase of the Social Energy Atlas' research activities, as well as how it was brought together. In Section 2., a detailed description of the data comprising SolarView is provided. Section 3 provides the methods that were employed for curating and reusing the data. Finally, this data descriptor ends with Section 4 detailing notes for users of this database going forward.

2. Data Description

The data contained within the Supplementary Materials provides a contextually-focused perspective on solar adoption in the state of Georgia, USA, at the county level and is comprised of nine relational CSV files. While currently there are no solar installation data points for 11 of Georgia's 159 counties, this dataset does include contextual data that has been curated for every county. Descriptions of the variables included in the dataset are provided below, while justifications for the curation of this dataset from each data source can be found in *3. Methods*.

2.1. County Identification

The primary variable upon which this dataset is organized is the FIPS code for each county within the state of Georgia. The data within county-name.csv is the basis upon which the entire database is organized.

2.2. Historical County Zip code Directory

Zip codes, while useful to many social scientists, are a dynamic class of variables constantly being added to, changed, and realigned to different counties per the need of the U.S. Postal Service [12]. Thus, a historical directory of zip codes was determined to be necessary for this project and was included for the years 2010-2018 and can be found in *zipcode-county.csv*.

Table 2. List of variables included in sea-zipcode-county.csv

Variable	Description
sea-zip-id	Unique ID for Zip code entries
zip	Zip code
fips	FIPS code for each county
year	Year for which a zip code and county relationship is valid

2.3. Solar Installation Data

For each documented solar installation in the state of Georgia, a series of characteristics was included as part of the data analysis for better understanding the context underlying solar technology adoption on the county level.

Table 3. List of variables included in sea-solar-installations.csv.

Variable	Description
sea-install-id	Unique ID for identifying originating data source
zipcode	Zip code for solar installation
fips	County fips ID of solar installation
town	Town or municipality of solar installation
state	State of solar installation location
system-type	Type of solar system for the installation
sector	Sector type for installation location: e.g. residential or utility
install-date	Date of installation
utility	Utility of the installation
federal-cong-dist	Federal Congressional District of installation
state-senate-dist	State Senate District of installation
state-house-dist	Federal House of Representatives District of installation
lat	Latitude of solar installation (key)
long	Longitude of solar installation (key)

As this data was curated from multiple outside sources, its completeness is not guaranteed. Refer to Section 3.3 *Resulting Dataset* for details regarding data verification for this table.

2.4. Solar Rooftop Suitability

Data is also included for better understanding the disparity in the presence of solar installations in the state of Georgia and that relationship in conversation with the degree of rooftop suitability available for each county.

Table 4. List of variables included in sea-solar-suitability.csv

Variable	Description
zipcode	Zip code for each rooftop suitability estimation
locale	Classification of the nature of the area: e.g. large suburb or fringe rural areas
nbld	Number of existing rooftops identified in that location and included in the estimation
pct-suitable	Estimated percent suitability of existing rooftops for PV

2.5. County Demographics

A selected number of U.S. Census Bureau demographic variables were also included for contextual analysis.

 doi:10.20944/preprints201811.0120.v1

Table 5. List of variables included in sea-county-census.csv

Variable	Description
fips	County fips ID
med-income	Median income for the county
owner-occ	Estimated percentage of homes occupied by its owner for the county
pop-total	Total estimated population for the county
dem-fem-pct	Estimated percentage of female residents in the county
dem-male-pct	Estimated percentage of male residents in the county
dem-white-pct	Estimated percentage of White residents in the county
dem-baa-pct	Estimated percentage of Black or African American residents in the county
dem-aian-pct	Estimated percentage of American Indian or Alaskan Native residents in the county
dem-a-pct	Estimated percentage of Asian residents in the county
dem-nhpi-pct	Estimated percentage of Native Hawaiian or Pacific Islander residents in the county
dem-two-pct	Estimated percentage of residents identifying as being of two or more races in the county
dem-hl-pct	Estimated percentage of Hispanic or Latino residents in the county
dem-vet	Estimated number of veterans residing in the county
dem-hh	Estimated number of households in the county

2.6. Zillow Indexes

Median home value and rental value indexes are also provided for analysis. Due to the rural nature of Georgia and limited number of available data points for public sales and rental information in some counties, there are not values for all of Georgia's 159 counties. Refer to 3.3 *Resulting Dataset* for details regarding data verification for this table.

Table 6. List of variables included in sea-county-zillow.csv

Variable	Description
fips	County fips ID
med-zhvi	Median Zillow Home Value Index
med-zrvi	Median Zillow Rental Value Index

2.7. Renewable Energy Incentives

For each county, there are varying levels of renewable energy incentives documented as being available. The number of active incentives by type are provided in sea-dsire-incentives.csv.

Table 7. List of variables included in sea-dsire-incentives.csv

Variable	Description
fips	County fips ID
fed-total	Total number of federal incentives
fed-fin-incent-total	Total number of federal financial incentives
fed-fin-incent-corp-deprec	Number of federal corporate depreciation financial incentives
fed-fin-incent-corp-tax-credit	Number of federal corporate tax credit financial incentives
fed-fin-incent-corp-tax-deduction	Number of federal corporate tax deduction financial incentives
fed-fin-incent-corp-tax-exemption	Number of federal corporate tax exemption financial incentives
fed-fin-incent-grant-prog	Number of federal grant program financial incentives
fed-fin-incent-loan-prog	Number of federal loan program financial incentives
fed-fin-incent-pers-tax-credit	Number of federal personal tax credit financial incentives
fed-fin-incent-pers-tax-exemption	Number of federal personal tax exemption financial incentives
fed-reg-policy	Total number of federal regulatory policies
fed-reg-policy-appeq-eff-stand	Number of federal appliance and equipment efficiency standard regulatory policies
fed-reg-policy-energy-stand-build	Number of federal energy standards for public buildings regulatory policies
fed-reg-policy-gpp	Number of federal green power purchasing regulatory policies
fed-reg-policy-interconn	Number of federal interconnection regulatory policies
fed-tech-res	Total number of federal technical resources
fed-tech-res-energy-analysis	Number of federal energy analysis technical resources
fed-tech-res-training-info	Number of federal training information technical resources
state-total	Total number of state incentives
state-fin-incent-total	Total number of state financial incentives
state-fin-incent-grant-prog	Number of state grant program financial incentives
state-fin-incent-loan-prog	Number of state loan program financial incentives
state-fin-incent-other	Number of state other financial incentives
state-fin-incent-PACE-fi	Number of state PACE financing financial incentives
state-fin-incent-perf-based	Number of state performance-based financial incentives
state-fin-incent-rebate	Number of state rebate financial incentives
state-fin-incent-sales-tax	Number of state sales tax financial incentives
state-reg-policy	Total number of state regulatory policies
state-reg-policy-build-energy-code	Number of state building energy code regulatory policies
state-reg-policy-energy-stand-build	Number of state energy standards for public buildings regulatory policies
state-reg-policy-interconn	Number of state interconnection regulatory policies
state-reg-policy-net-metering	Number of state building net metering regulatory policies
state-reg-policy-solar-wind-access	Number of state solar and wind access regulatory policies
state-tech-res	Total number of state technical resources
state-tech-res-energy-analysis	Number of state energy analysis technical resources
state-tech-res-other	Number of state other technical resources
state-tech-res-training-info	Number of state training information technical resources

2.8. Electric Utilities

As many diverse local governance structures the state of Georgia has, it also has a great number of utilities that help to provide infrastructural resources across the state. There are two files that help to provide information about the utility landscape of this state: a table listing the names and ownership structures of each utility (See Table 8) and a table listing the utility rates by zip code for the state (See Table 9).

Table 8. List of variables included in sea-utility-id.csv

Variable	Description
utility-id	Unique identifier for each utility
name	Utility name
ownership	Ownership type

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Table 9. List of variables included in sea-utility-rates.csv.

Variable	Description
sea-rate-id	Unique identifier for the utility rate for each zip code
year	Year for which the rate is provided
zip	Zip code for each utility rate
utility-id	Unique identifier for each utility
service-type	Type of rate service
comm-rate	Commercial rate per kWh
ind-rate	Industry rate per kWh
res-rate	Residential rate per kWh

2.9. File Architecture

The Georgia SolarView dataset is a relational database. The previously described .CSV files are related to one another through either zip code or fips ID.

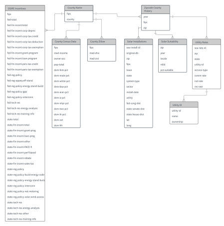

Figure 2. This figure is an entity relationship diagram depicting the relationships between all of the .CSV files for this dataset that are described in Tables 1 through 8.

A README file and a copy of Figure 1 are included in the data archive as well.

3. Methods

Main methods applied to collect and treat, as well as to use and reuse the data. Notes on validation and curation techniques applied. Notes on data quality, noise, etc.

3.1. Data Sources

The SolarView database is an aggregation of seven independent data sources that each provided an important aspect of solar adoption at the county-level in Georgia, U.S.A.:

1. Georgia Energy Data Solar Map [10]
2. Open PV Project [13]
3. American Community Survey (2016) [15]
4. PV-Suitable Rooftop Resources [14]
5. U.S. Electric Utility Companies and Rates [18]
6. Zillow Research Data [16]
7. DSIRE Programs [17]

All available entries that correlated with Georgia's 159 counties and the zip codes within them were marked for inclusion in the aggregated dataset.

Not all variables within each of the seven databases were included for SolarView, however. Only those variables that were determined to be of imminent or future interest to the Social Energy Atlas' focus on understanding local Georgia perspectives of solar technology adoption were retained. Once the variables of interest for SolarView had been identified, three independent queries were performed on the seven databases and returned the same number of results each time. Convinced of the validity of these outputs, the contents of those queries was then verified for completeness.

In order to determine if the data comprising the SolarView database was complete, it was verified in two ways: first by importing it into a Drupal [citation] CMS that was configured according to the relationships described in Figure 1, and secondly by flattening all of the data and parsing it through an Apache SOLR 6.6 indexer. Through this process, it was confirmed that several of the data streams comprising the SolarView aggregated database were incomplete in nature–an observation that was expected by the research team.

3.2. Dataset Verification

First of all, all of the solar installation in the SolarView database was collected from two different sources: Southface's *Georgia Energy Data Map* and the National Renewable Energy Laboratory's *Open PV Dataset* [10,13]. These two sources have similar, but yet different, metadata systems. *Georgia Energy Data Map* had a more comprehensive metadata standard, so the decision was made to use its variables so as not to lose future information that might be useful. Thus, the following variables for sea-solar-installations.csv are incomplete for one or more data points: zipcode (1), town (40), utility (1544), federal-cong-dist (1380), state-senate-dist (1380), state-house-dist (1380), lat (22), and long (22).

It was also determined that data was incomplete for the file labeled sea-county-zillow.csv. Zillow uses a combination of data points such as physical characteristics of the home, prior sales history, tax assessments, and geographic location to estimate sales prices using a proprietary statistical model that is backed by machine learning processes [19]. The resulting home sales value or rental value prices are an estimation based off of the patterns they observe in the data. As a result, Zillow is often unable to calculate prices for areas in which they have a statistically limited number of data points. For Georgia's 159 counties that are described in the SolarView database, there are 75 counties for which no Zillow Home Value Index is available and 42 counties for which no Zillow Rental Value Index data is available.

4. User Notes

The data can be visualized and viewed through a faceted search provided through the Social Energy Atlas SolarView web portal. This node.JS GIS application is powered by a SOLR index that dynamically visualizes the number of installations per county based off of contextual filtering (see Figure 2).

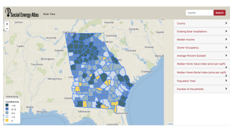

Figure 3. The Social Energy Atlas SolarView web application provides a dynamic experience for users interested in visually searching and experiencing patterns in Georgia (U.S.A.) solar adoption data.

The data itself can be accessed as a supplement to this Data Descriptor.

Supplementary Materials: The following are available online at URL.

Acknowledgments: This project was funded by the U.S. Department of Energy's Solar Energy Technology Office, award DE-EE0007664. Moreover, the authors would like to acknowledge SouthFace for its work in managing and updating the Georgia Energy Data portal, from which most of the solar installation data was retrieved. We would also like to acknowledge the work of Steffan Nelson and Marcus Hill in migrating this dataset into the Social Energy Atlas SolarView web application (http://sea.galib.uga.edu/solarview).

Author Contributions: Conceptualization: J.H.T.; methodology: J.H.T.; validation: J.H.T., M.H., S.N., and A.T.; investigation: J.H.T., S.T., M.H., and A.T.; data curation: J.H.T.; data verification: S.T. and M.H.; writing–original draft preparation: J.H.T.; writing–review and editing: J.H.T. and A.T.; project administration: J.H.T.; funding acquisition: J.H.T.

Conflicts of Interest: The authors declare no conflict of interest.

 doi:10.20944/preprints201811.0120.v1

Abbreviations

The following abbreviations are used in this manuscript:

SEA: Social Energy Atlas
PV: photovoltaic solar
NREL: National Renewable Energy Laboratory
DSIRE: Database of State Incentives for Renewables & Efficiency

References

1. McKay, K. Socio-Cultural Dimensions of Cluster vs. Single Home Photovoltaic Solar Energy Systems in Rural Nepal. *Sustainability.* 2010, 2, 494-504. doi:10.3390/su2020494
2. Zhao, X., Zhao, H., Jiang, L., Lu, C., and Xue, B. The Influence of Farmers' Livelihood Strategies on Household Energy Consumption in the Eastern Qinghai-Tibet Plateau, China. *Sustainability,* 2018, 10, 1-12. doi:10.3390/su10061780
3. Sovacool, B. Exploring and Contextualizing Public Opposition to Renewable Electricity In the United States. *Sustainability.* 2009, 1(3), 702-721.
4. Tidwell, J.H., Tidwell, A.S.D., Nelson, S. "Surveying the Solar Power Gap: Assessing the Spatial Distribution of Emerging Photovoltaic Solar Adoption in the State of Georgia, U.S.A. *Sustainability* (2018) doi:10.20944/preprints201810.0184.v1.
5. *Electric Power Monthly;* United States Department of Energy, Energy Information Administration, U.S. Government Printing Office: Washington, DC, 2018.
6. Global Horizontal Solar Irradiance 1998-2016. Available online: https://www.nrel.gov/gis/images/solar/solar_ghi_2018_usa_scale_01.jpg (accessed January 2018)
7. Croucher, M. Optimal Deployment of Solar Index. *The Electricity Journal.* 2010, 23, 75–81. https://doi.org/10.1016/j.tej.2010.09.015
8. Electric Power Monthly; United States Department of Energy, Energy Information Administration, U.S. Government Printing Office: Washington, DC, 2017.
9. Rojc, P. Georgia's Conservative Path to a Solar Power Boom. *Planetizen,* 2018.
10. *Georgia Energy Data.* Available online: http://www.georgiaenergydata.org/solarmap (accessed in January 2018).
11. Tidwell, J.H., Tidwell, A.S.D. Energy ideals, visions, narratives, and rhetoric: Examining sociotechnical imaginaries theory and methodology in energy research. *Energy Research & Social Science.* 2018, 39, 103–107. https://doi.org/10.1016/j.erss.2017.11.005
12. King, G., 2011. Ensuring the data-rich future of the social sciences. *science.* 2018, 331(6018): 719-721.
13. *The Open PV Project;* National Renewable Energy Laboratory, Available online: https://openpv.nrel.gov/ (accessed in January 2018).
14. Phillips, C and Melius, J. U.S. PV-Suitable Rooftop Resources. 2016 (Accessed January, 2018). doi:10.7799/1258436
15. *American Community Survey, 2010-2016 Five-Year Profiles;* United States Census Bureau, [Online] 2018, generated by Jacqueline Hettel Tidwell; using American FactFinder (January, 2018).
16. *Zillow Research 2018 Data;* 2018, generated by Jacqueline Hettel Tidwell Available online: https://www.zillow.com/research/data/ (accessed in January, 2018)
17. *DSIRE-Programs.* Available online: http://programs.dsireusa.org/system/program?fromSir=0&state=GA (accessed in January, 2018).
18. *U.S. Electric Utility Companies and Rates: Look-up by Zipcode (2014);* 2018; generated by Jacqueline Hettel Tidwell (January, 2018). Available online: https://opennei.org/doe-opendata/dataset/u-s-electric-utility-companies-and-rates-look-up-by-zipcode-2014
19. Zillow Research. "Zillow Home Value Index: Methodology. Available online: https://www.zillow.com/research/zhvi-methodology-6032/ (accessed in October 2018).