Visualizing Energy Affordability

Presented at ACEEE Rural Energy Conference

Heather Pohnan
Southern Alliance for Clean Energy
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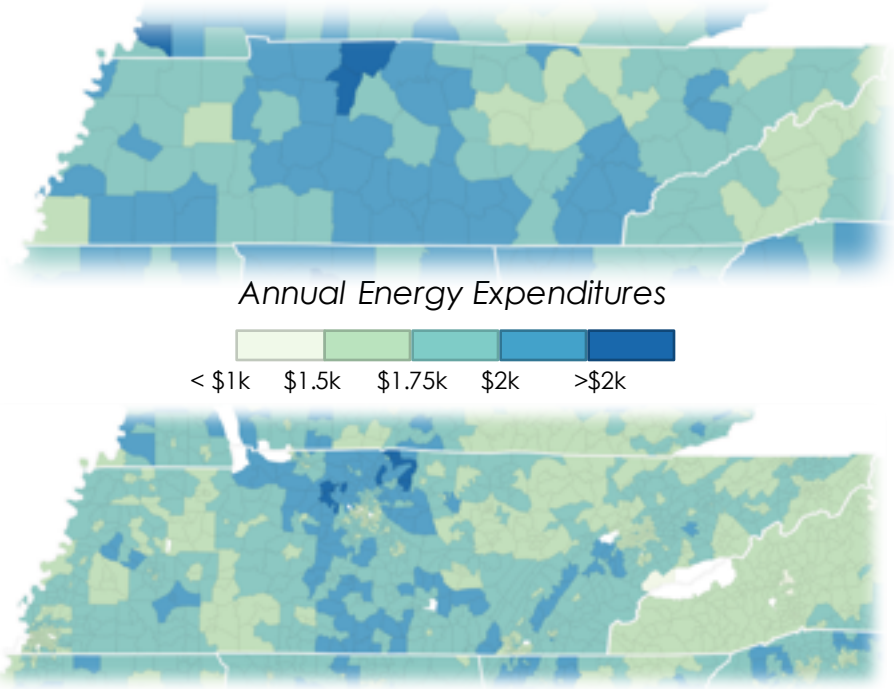
Why do energy burdens and geography matter?

Why energy burdens?
As a standalone concept it centers energy cost discussions on customer needs and impacts("ability to pay") Also valuable for:

- Financial planning
- Indicator of income inequality
- Need for DSM/efficiency

Energy burden vs. affordability threshold (6% or 10%) measures energy affordability.

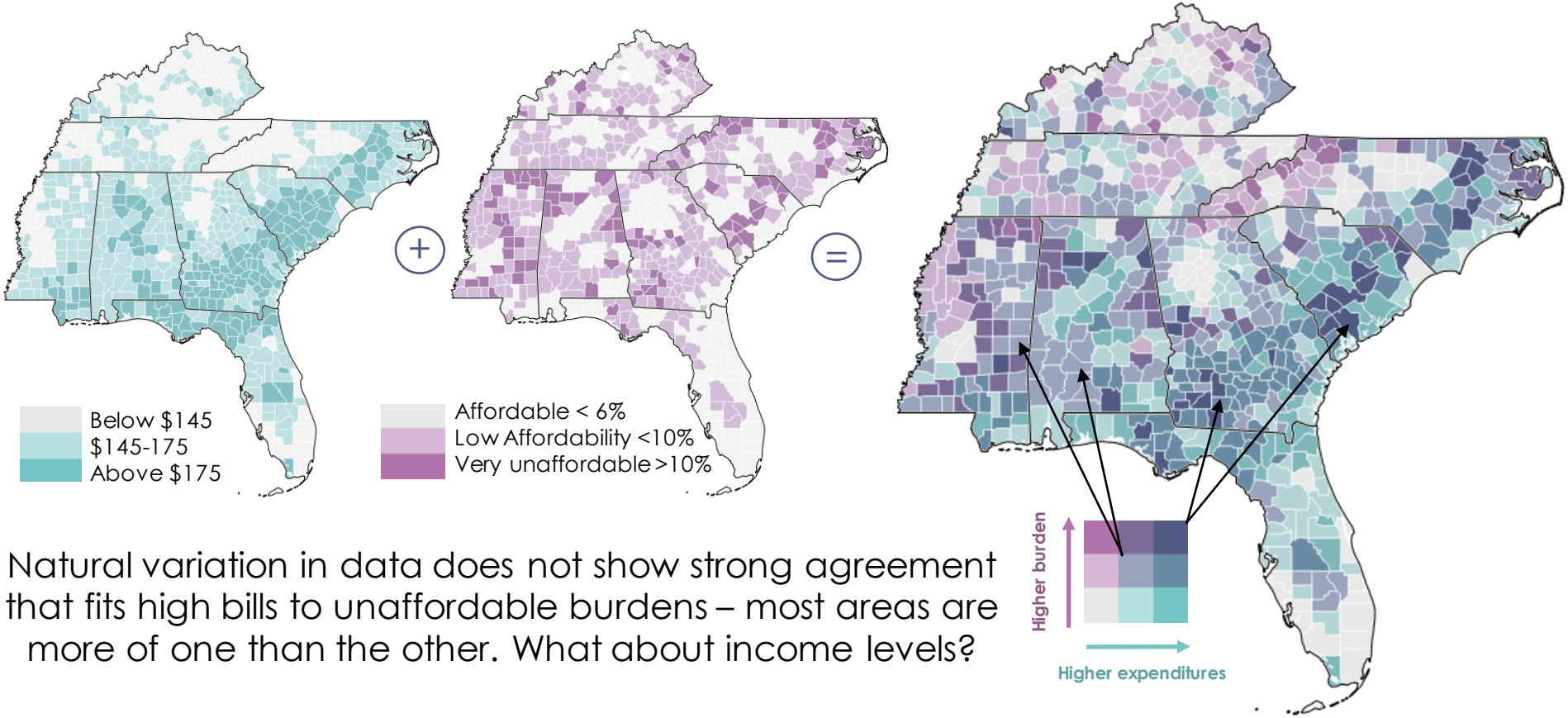
- Energy burdens can be classified as either affordable or unaffordable
- "Affordability gap" = compare energy burden to threshold value to determine gap and $ value between the two.
- Aggregate impacts add up!



Why maps & geography?
- Geography can determine customer base
- Determine scale of problem (above)
- Location data strengthens outreach efforts

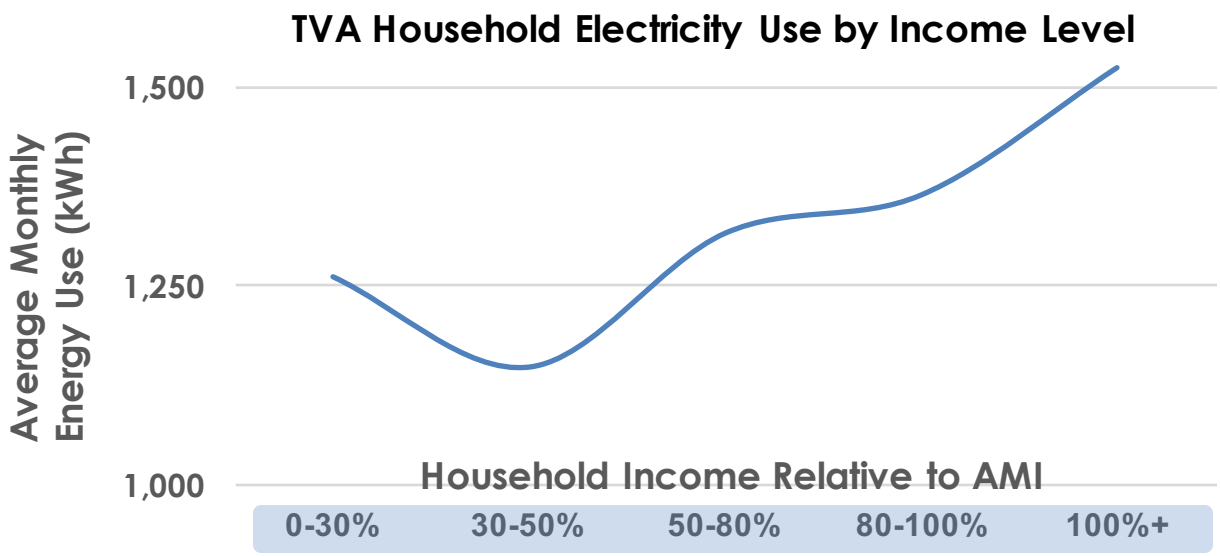
What can maps tell us about customer energy burdens?

Average **energy expenditures** and **energy burden** by county, all income levels



Natural variation in data does not show strong agreement that fits high bills to unaffordable burdens – most areas are more of one than the other. What about income levels?

Lower bills and lower usage does not equal lower burdens



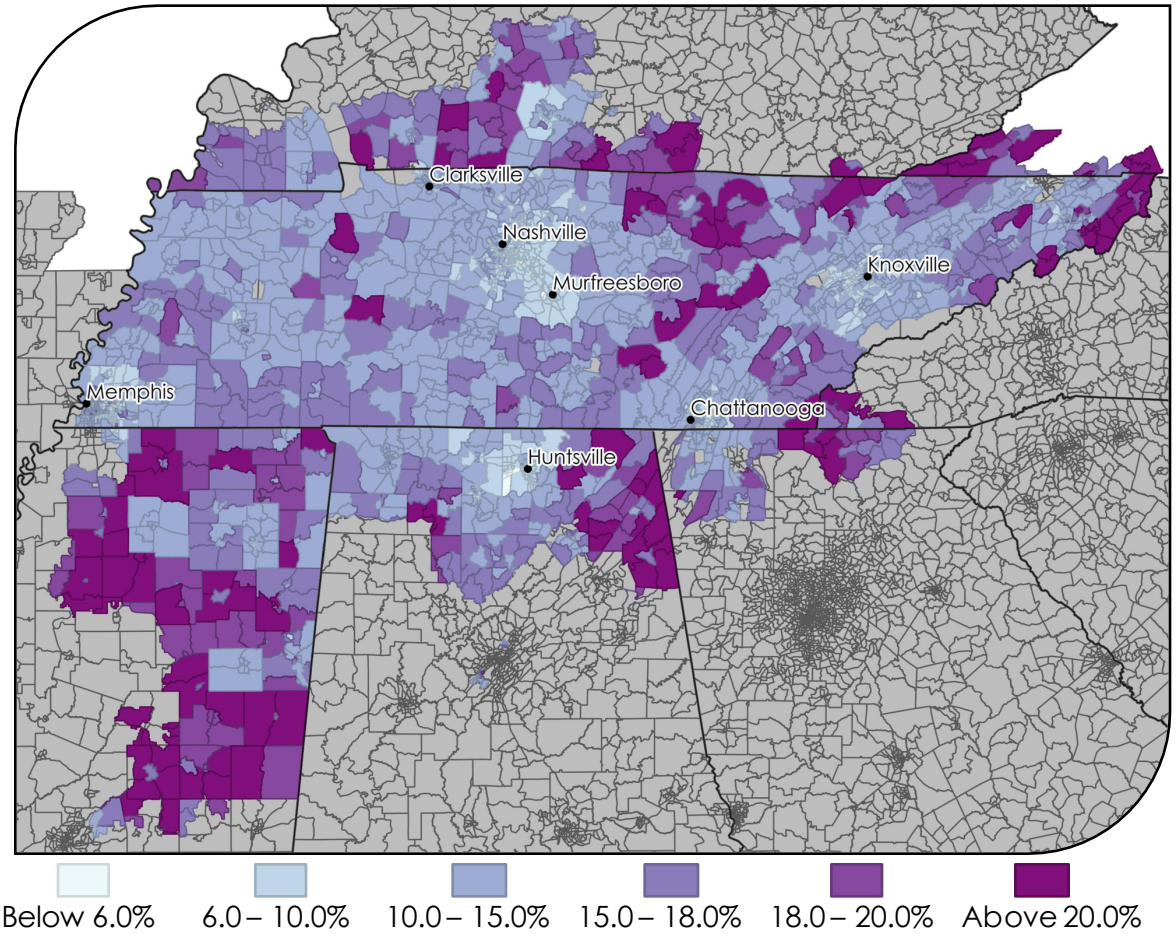
	0-30%	30-50%	50-80%	80-100%	100%+
Estimated kWh Electricity Use	1,260	1,147	1,315	1,363	1,523
Average Electricity Bill	$131	$120	$136	$140	$155
Average Monthly Energy Bill	$196	$197	$216	$218	$240
Average Energy Burden	24.4%	13.8%	8.6%	6.3%	3.1%

Account for mandatory fees, credits, $/kwh rate

Income relative to area median income (AMI) show that even average bills yield unaffordable burdens for low-income (<80% AMI) households.

Modest reductions in monthly costs can be enough to lower some customer burdens < 6%

What can maps tell us about utilities & energy burdens?

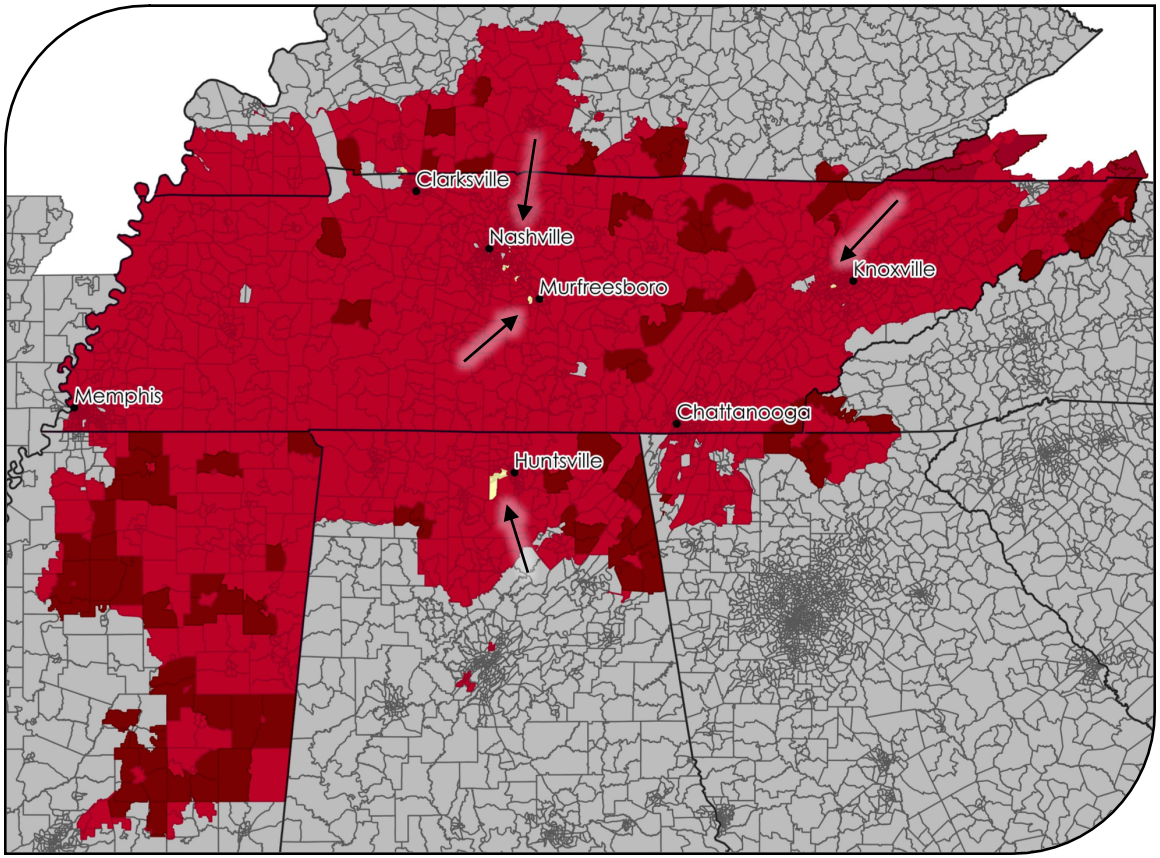


Scales of geography: census tracts are small enough to aggregate to utility service area, but county-scale may be too coarse to divide.

Higher burdens not close proximity to large urban metro areas (pop >75k)

System-wide, the average burden is 12.6% for LMI customers (4.8% for all).

Where are energy costs affordable for low-income customers?



Affordable | Unaffordable | Extremely Unaffordable

Same data as before, but narrow to affordable vs. not affordable.

Left shows 6% threshold, 10% is qualitatively similar

There are a few small pockets where customers fall within the affordable category.

What do those areas physically look like?

What we can learn: community characteristics

20 tracts where average is affordable for low-income customers, all in urban metro areas. 273 tracts >20%, overwhelmingly rural.

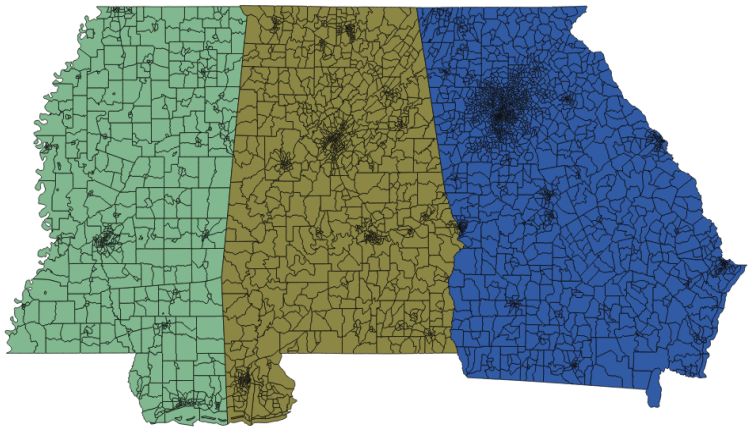
Aerial view gives snapshot of how high vs. low burden areas differ in terms of land use & density.

Dense urban populations vs. relatively isolated rural communities.

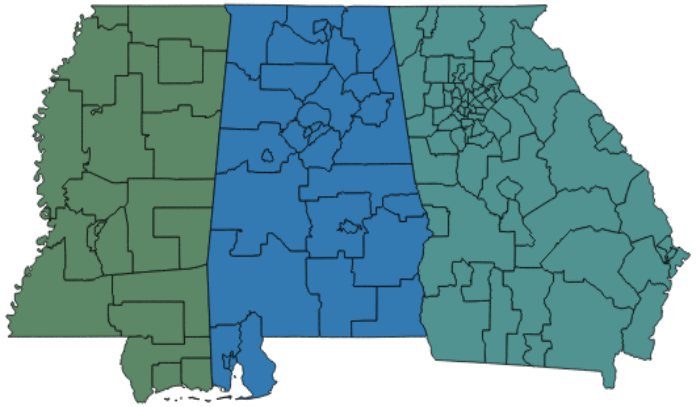
Energy Burden: Below 6%

Energy Burden: Above 20%

Demographic-based comparisons of energy burdens



Census tract geography for LEAD data



Public Use Micro Area (PUMA) geography for ACS data

Data collection in American Community Survey (ACS) by U.S. Census Bureau or Residential Energy Consumption Survey (RECS) by EIA are limited to very general geographic areas due to privacy & population threshold requirements.

This makes it difficult to segment data by both utility & demographic *or* by both rural & demographic since geography is less precise. Urban areas easily meet population requirements so in-depth demographic analysis is available (ACEEE study).

Demographic-based comparisons: who is experiencing high energy burdens?

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
RT	SERIALNO	DIVISION	PUMA	REGION	ST	ADJHSG	ADJINC	WGTP	NP	TYPE	ACR	AGS	BATH	BDSP	BLD	BUS	CONP	ELEP
H	2.012E+12	5	2800	3	13	1045360	1056030	30	0	1	2		1	3	2	2		
H	2.015E+12	5	2600	3	13	1012636	1013916	6	1	1	1	1	1	3	2	2	0	70
H	2.015E+12	5	2600	3	13	1012636	1013916	6	5	1	3	1	1	3	2	2	0	350
H	2.015E+12	5	3200	3	13	1012636	1013916	3	2	1	1	1	1	2	2	2	0	160
H	2.015E+12	5	2800	3	13	1012636	1013916	23	0	1	3		1	3	2	2	0	400
H	2.015E+12	5	3200	3	13	1012636	1013916	34	4	1	2	1	1	3	2	2	0	170
H	2.015E+12	5	2700	3	13	1012636	1013916	10	4	1	2	1	1	3	2	2	0	260
H	2.015E+12	5	2800	3	13	1012636	1013916	3	3	1	1		1	3	3	2	0	130
H	2.015E+12	5	2600	3	13	1012636	1013916	56	0	1	2		2	2	1	2	0	130

"I'm 58 years old. I usually work 52 hours per week. I work as a clergy. I do not have health insurance. 13.2% of my income goes towards energy costs"

"I work for a local government. I got married in 1974. I attended college for less than one year. I spend 10.8% of my household's income on energy.

"I gave birth within the past 12 months. I am 28 years old. I arrive at work at 6:35 am. My household energy costs take up 16.8% of my annual income."

A reminder that most data is simplified abstractions of complex systems, issues, and people – it can supplement, but not replace, outreach & engagement to utility ratepayers.

THANK YOU FOR LISTENING!

CONTACT INFORMATION:

Heather Pohnan
Energy Policy Manager
Southern Alliance for Clean Energy
heather@cleanenergy.org

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Approaches to Lowering Burdens

Lower or eliminate mandatory monthly fees – Many utility bills do not itemize fixed fees, so customers do not know when fixed fees are increased.

Mandatory fees limits a customer's ability to lower their bills since large portion of bill comes costs not related to volumetric usage.

For some TVA distributors, fixed monthly fees could make up as much as 14.7% of a monthly bill for the average customer (see top 10 highest to right), with an average of 7.8% throughout the entire system.

Distributor Utility	Mandatory Monthly Fee	Mandatory Fee as % of Average Bill
Meriwether Lewis Electric Cooperative	$29.93	14.7%
Forked Deer Electric Cooperative	$27.40	14.7%
4 County Electric Power Association	$28.40	14.6%
Morristown Utility Systems	$15.00	13.8%
Cumberland Electric Member Corp	$29.00	13.2%
Joe Wheeler Electric Member Corp	$26.00	12.7%
CDE Lightband	$16.16	12.6%
Upper Cumberland Electric Member Corp	$17.36	12.3%
Hopkinsville Electric System	$19.06	11.2%
Duck River Electric Member Corp	$22.00	11.2%
TVA Average	**$14.73**	**7.8%**

Approaches to Lowering Burdens

Utility energy efficiency programs – Guidelines to use federal funds (DOE/LIHEAP weatherization) do not always match local needs. Possible programs for rural areas:

- ***On-bill finance*** – tariff-based (inclusive financing) rather than loan-based so that it is available to customers other than owner-occupied single family houses.
- ***Manufactured homes*** – TVA program was successful in market transformation, achieving savings, and addressing customer needs (see below).
- ***Neighborhood program delivery*** – Neighborhood may be qualified on the tract or block group level, making eligibility easier to navigate for customer and utility.

Housing Unit Type	Total U.S. (Millions)	Reducing/Forgoing Food or Medicine	Unhealthy Temperature	Disconnect/ Delivery Stop Notice	Unable to Use Heating
Single-family	80.9	18.5%	8.9%	13.1%	4.4%
Multifamily	30.5	24.9%	13.4%	14.8%	4.6%
Mobile Homes	6.8	44.1%	25.0%	30.9%	17.6%

DATA SOURCES AND METHODS

Primary datasets and methods used:

U.S. Department of Energy Better Building Initiative, Low-Income Energy Affordability Dataset (LEAD) census tract raw data. Available at: www.openei.org/dataset/celica-data For each census tract, a weighted average based on number of occupied households was used to calculate average energy expenditures (electricity, gas, and other fuel types), household income, and the resulting burden.

TVA electric retail service territory shapefile available at https://hifld-geoplatform.opendata.arcgis.com/

by Homeland Infrastructure Foundation-Level Data (HIFLD) and georeferenced directly from PDF of distributor service areas: https://www.tva.gov/Energy/Public-Power-Partnerships/Local-Power-Companies

Satellite imagery of census tracts from Bing Maps API via the open layer QGIS plugin. Polygon centroids were used to zoom to exact center of census tract at a scale of 1:50,000. This method was repeated for equal number of census tracts in both categories. Imagery does not represent the entire land area of the tract.

Data regarding monthly mandatory fees and hydro allocation credits for TVA distributor utilities was collected by SACE from public documents, utility representatives, and ratepayers directly reporting fixed fees and their visibility on bills. This was used to estimate the kwh electricity usage and resulting costs *not* coming from fixed fees.

County-level expenditure and burden data was processed by NREL as part of the "Solar For All" project and is available at https://maps.nrel.gov/solar-for-all/

MAPPING METHODS & ASSUMPTIONS

Threshold values for affordable vs. unaffordable utility service: A value of 6% is derived from housing literature that suggests that housing/shelter costs should be no more than 30% of household income, and household energy costs should be no more than 20% of that 30%. This results in 6%, but a range of values may be evaluated later if a different rule of thumb is adopted by a regulator or proven with statistical evidence.

Classifications for maps were chosen to examine how the average energy burden for the comparison geography (census tract, county, etc.) fit definitions of energy affordability. Therefore, this custom distribution primarily utilized intervals of 6% and 10%. Some consideration was given to the natural breaks in data (using jenks optimization method) to choose middle stops. Below is the frequency of census tracts for low-income households in the TVA service territory only.