Dynamically Mapping Need: An Environmental Justice Framework for Tailoring Utility Program Offerings and Outreach to Underserved Communities

Jamie Hamilton, Cadmus, New York, NY; Rowan Lavelle, Cadmus, Portland, OR; Jill Steiner, Consumers Energy, Jackson, MI

ABSTRACT

Identifying disadvantaged communities (DACs) and ensuring equitable access to utility programs has emerged as a major priority for communities and the utilities that serve them. Previous national standards, such as the Justice40 initiative, emphasized using a broad set of population characteristic and environmental data to prioritize areas for program tailoring and outreach. While national initiatives have shifted focus, state-directed policies and legislation continue to spur utilities to apply a broader environmental justice framework and develop new analytical methods to achieve their equity goals.

Consumers Energy, a dual fuel Michigan utility, enlisted Cadmus to develop a Low Income Needs Assessment (LINA) gap analysis and interactive mapping tool to help the utility address the specific needs of communities within its service territory. We developed a custom need-scoring system and dashboard that allows the user to dynamically explore geographic relationships between public demographic and environmental data with utility-provided low-income program participation data. The tool enables Consumers Energy to conduct more strategic outreach and tailor programs to focus on the identified needs of the communities the utility wants to serve.

In this paper, we show how the LINA tool framework is helping Consumers Energy identify where they are underserving disadvantaged customers and develop pathways to reach these customers. Centralizing all the available data within the dynamic needs scoring tool allows program planners to investigate the nuances that exist within underserved communities, leverage these insights to coordinate with community-based organizations (CBOs), and improve engagement with disadvantaged customers.

Integrating Environmental Justice into Equity Definitions

Ensuring equity in utility program participation has become a major focus of program planning, targeting, and evaluation over recent years. In January 2021, the Biden-Harris administration launched the Justice40 Initiative, establishing a nationwide goal that 40% of certain federal investments, including clean energy and energy efficiency programs, directly benefit DACs that are marginalized, underserved, or overburdened by pollution (The White House 2025). Subsequent Justice40 guidance directed these programs to use the Climate and Economic Justice Screening Tool (CEJST), a nation-wide marginalized community mapping tool, to identify DACs based on a wide range of environmental justice and demographic data at the census tract level (CEQ 2024). Although federal focus has shifted and the CEJST was taken down in early 2025, states and utilities have found mapping and analyzing program participation with geographic information systems (GIS) to identify underserved areas and areas with high levels of need increasingly important to program planning and outreach.

Despite the changes in federal guidance surrounding equity initiatives, states have continued to prioritize reaching DACs. States are tailoring federal tools and definitions of need to identify and serve the specific needs of their communities. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) sought to better serve its local needs with its own state-specific, environmental justice-focused tool: The MiEJScreen (EGLE 2024). Michigan's environmental justice mapping tool allows users to map environmental, health, and socioeconomic data across the state and provides an overall score for each census tract. It includes a map of census tracts in Michigan, color coded based on percentile scores that reflect each tract's relative environmental risk factors. The overall MiEJScreen score is a composite of indicator variables that contribute to the Environmental Conditions and Population Characteristics sub-scores, as described in Figure 1. This tool provides a way to explore how environmental factors impacting their communities overlap at the census tract level. A limitation of tools exploring population characteristics and environmental risk factors is that they cannot illustrate causal relationships between, or the compounding effects of, their component variables. However, they are still useful for exploring correlative relationships and their geographic patterns to gain a deeper understanding of the lived experience of those communities.

Categories	Environmental Exposure	Environmental Effects	Sensitive Populations	Socioeconomic Factors
Indicators	NATA Air Toxics Cancer Risk NATA Respiratory Hazard Index NATA Diesel Particulate Matter Particulate Matter ($PM_{2.5}$) Ozone Traffic Density	Proximity to Cleanup Sites Proximity to Hazardous Waste Facilities Impaired Water Bodies Proximity to Solid waste Sites and Facilities Lead Paint Indicator Proximity to RMP Sites Wastewater Discharge Indicator	Asthma Cardiovascular Disease Low Birth Weight Infants Blood Lead Level Life Expectancy	Low Income Population Black, Indigenous, People of Color Population Educational Attainment Linguistic Isolation Population Under Age 5 Population Over Age 64 Unemployment Housing Burden
Sub Scores	**Environmental Conditions** (Average percentile of Environmental Exposure indicators + 0.5 x average percentile of Environmental Effects indicators) / 1.5		**Population Characteristics** (Average percentile of Sensitive Population indicators + average percentile of Socioeconomic Factor indicators) / 2	
Score	Final Composite Score = Environmental Conditions score x Population Characteristics score **MiEJScreen Score**			

Figure 1. MiEJScreen Score Component Details. *Source*: MiEJScreen Factsheet, 2024.

In 2021, Consumers Energy launched the Flint Initiative, a geotargeting outreach initiative in and around Flint, a city in eastern Michigan, to provide energy waste reduction (EWR) interventions to economically vulnerable customers. Flint has historically been underserved and highly impacted by economic and environmental injustice such as the lead contamination of the public water supply (Masten, Davies, and McElmurry 2016). The Flint Initiative aims to address customer energy burden, arrearage, and health and safety concerns through targeted outreach and coordination with community agencies, local government, and healthcare organizations. Consumers Energy also piloted a Health & Safety initiative that offered repairs and upgrades to homes that could not otherwise be served.

With the support of stakeholders such as environmental and customer advocates, Consumers Energy sought to build on the success of the Flint Initiative by expanding its geotargeting efforts. Consumers Energy worked with Cadmus to develop a Low Income Needs Assessment (LINA) tool to "identify historical participation and coverage of [Consumers Energy]'s income qualified programs, characterize low-income areas using available datasets, and develop scenarios for ranking geographies based on high need criteria or for optimizing specific benefits to inform future prioritization of services." (Michigan Public Service Commission 2022).

While tools like the CEJST and MiEJScreen provide a comprehensive picture of communities' relative need, targeted energy and environmental justice initiatives like the ones undertaken by Consumers Energy necessitate a dynamic approach that can provide iterations of varied prioritization scenarios that emphasize specific population characteristics and indicators of interest. The LINA tool was specifically developed to meet this customizable, iterative need.

Dynamically Mapping Prioritization Scenarios

Cadmus' development of a dynamic need-scoring system within the LINA tool facilitates strategic outreach and program tailoring for Consumers Energy to address the specific needs of communities in Michigan. This process builds on the industry's use of GIS, gap analyses, and layering program participation and Census data to reach underserved customers. Geocoding participant data and intersecting it with census geographies to leverage American Community Survey (ACS) characteristic data can be a powerful approach to exploring how program participation varies by census-geography attributes (Crowley et al. 2019, Crowley et al. 2022). Our approach expands on previous work by developing a dynamic method of geotargeting that allows users to create multiple prioritization scenarios focusing on different population and environmental characteristics. This method highlights that that DACs are not homogenous, even with a utility service territory, and identifying where those burdens and needs differ can aid in reaching distinct populations of unserved customers.

The LINA tool serves both as an explorable visualization of low-income program participation gap analyses and as a customizable need-scoring mapping application. For each census tract, the tool estimates the program-eligible population, calculates the percentages of households served and unserved by existing programs, and dynamically creates need scores based on user-selected variables. The tool allows users to visualize the gap analysis and custom need scores on reactive heat maps of the utility's territory.

To generate need scores, the LINA tool integrates historical low-income program participation data with demographic and housing data from the ACS (ACS 2024), DAC indicators from the CEJST, environmental justice data from the MiEJScreen, and energy cost burden information from the U.S. Department of Energy (DOE)'s Low-income Energy Affordability Data (LEAD) Tool (DOE 2024). The user can select and combine several metrics from a drop-down list to specify criteria for need; the tool can then calculate percentile scores for each variable and score them to create a composite need score for each census tract in the service territory. The diverse data consolidated within the LINA tool allows Consumers Energy to dynamically model its priority "needs" (whether they be program saturation, environmental or socioeconomic burden, demographic characteristics, or some combination therein) and identify the areas of greatest need within their service territory. Systematically mapping different definitions of need and identifying areas of opportunity allows Consumers Energy to increase outreach to customers and CBOs in underserved communities and design custom program offerings that address communities' specific energy affordability needs.

Methodology

Our geographic analysis aggregated data at the census tract level allowing us to integrate data from multiple relevant sources, ensure customer privacy, and create an informative and easy to use tool. Smaller geographic areas (such as block groups) or more commonly understood areas (such as ZIP Codes) presented challenges to the practical utilization of our tool. The need to integrate MiEJScreen scores and LEAD energy burden data with ACS characteristics meant that the most granular common geography was census tracts. Additionally, Consumers Energy wanted the tool to be publicly accessible to its community-based partners, which required that customer data be aggregated enough to protect customer privacy and that the information be digestible for a broader audience. Though ZIP Codes are often easier for groups less familiar with census geographies to work with, they are a poor geographic unit of analysis due to their heterogeneity. Population sizes can vary greatly across ZIP Codes and, as described by Wirtshafter and Samiullah (2005), so can the demographic compositions within individual ZIP Codes. Census tracts provide the best balance because they are compatible with multiple data sources, large enough to protect customer privacy, and small enough to have sufficient demographic homogeneity.

Gap Analysis

We first conducted a gap analysis of historical participation in Consumers Energy's low-income programs to determine gaps in participation and areas of opportunity. This involved estimating the number of customers that would be eligible to participate in the programs and subtracting the number of customers who had already participated.

For the gap analysis, we estimated the number of single- and multifamily income-eligible customers per census tract within the utility territory using household information from the ACS. Single- and multifamily households were distinguished by the number of dwelling units in the building, with single family defined as only one dwelling unit (attached or detached) and multifamily as any number of dwelling units greater than one. We intersected the utility territory shapefiles for each service territory type—gas, electric, and combined—with the census tract shapefile from the TIGER/Line® shapefile database (TIGER/Line® 2024). Households and their characteristics were assumed to be uniformly distributed throughout a census tract and were weighted by the percentage of the tract's land area within the utility service territories. For each census tract, we multiplied the estimated number of households meeting the income eligibility requirements (at or below 200% FPL) by the percentage that are single- or multifamily homes to give an eligibility estimate for both household types. We acknowledge the ecological fallacy in this method of estimating sub-group populations from the census tract level data. Although the population estimates are known to include this inaccuracy, they still provide a helpful comparison for the likely size of the eligible customer population between different tracts.

After estimating eligible populations by tract, we mapped historical participation to latitude-longitude coordinates with the Google Maps Geocoding API and intersected the point layer with the utility-served census tract areas to calculate the number of served households in each tract.[1] The number of single- and multifamily participants was subtracted from the respective eligibility estimates for each census tract to determine the number and percentage of eligible households yet unserved (Figure 2).

[1] Consumers Energy separates historical participation into three Phases based on the energy efficiency measure type, and customers could participate in one or multiple Phases. For this analysis, each customer only counted as one instance of participation even if they participated in more than one Phase. The Phases included 0, 1, and 2. Phase 0 comprised solely of EWR kits and was not counted towards program participation. Phase 1 included the installation of low-cost measures and assessments for the need for higher-cost measures. Phase 2 consisted of the installation of the higher-cost measures identified in Phase 1 such as insulation, space heating, or water heating equipment. If a customer participated in Phases 1 and 2, only their participation in Phase 2 was considered in the total participation counts and gap analysis.

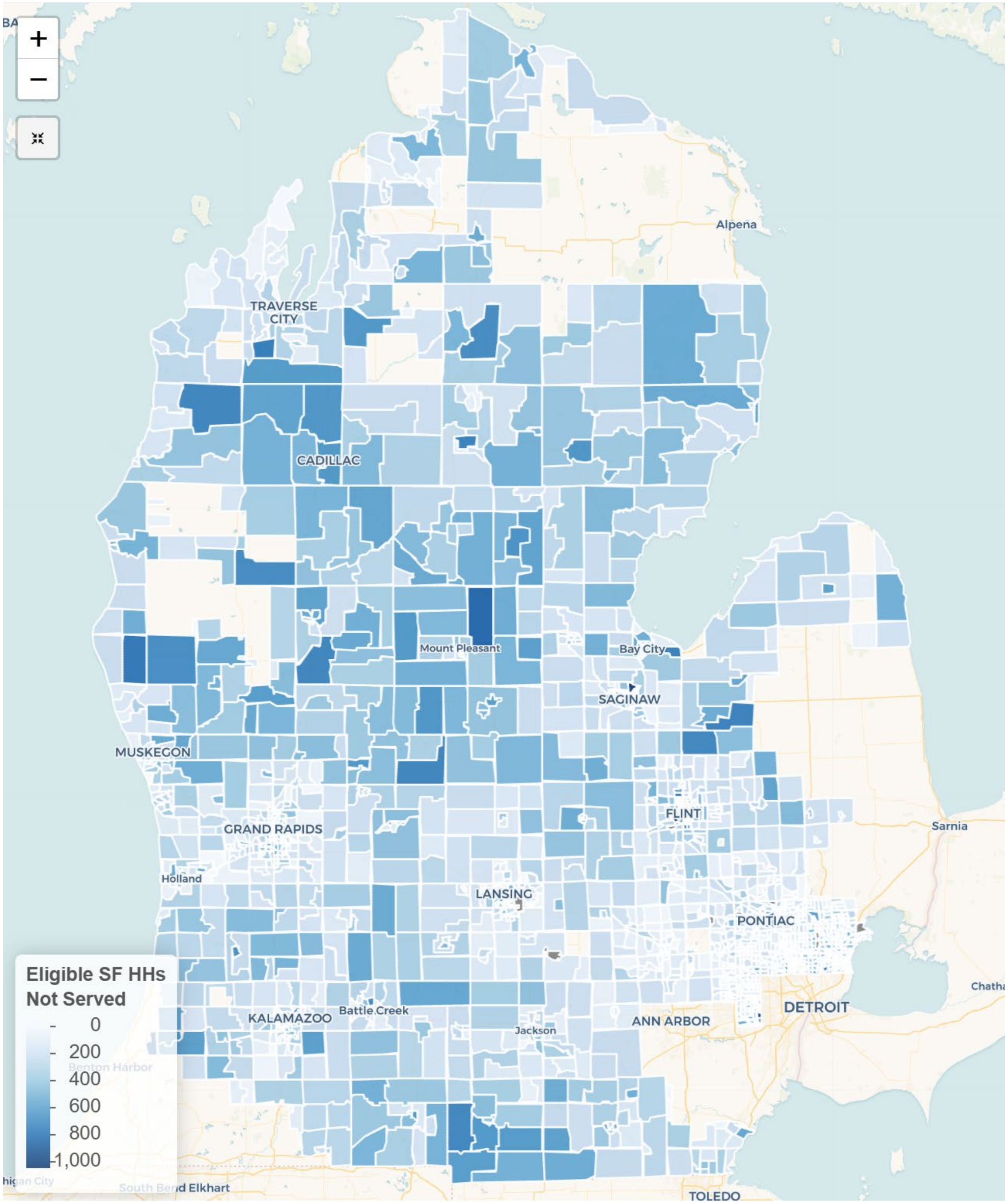


Figure 2. Estimated unserved single-family household counts across Consumers Energy's service territory.

One Centralized Tool

Data Integration

The gap analysis served as the contextual base for the following dynamic need mapping. Once we had assessed the gap in program eligibility and participation, we then built an interactive need scoring tool to investigate how population characteristics and environmental risk factors overlapped with participation trends. In addition to the gap analysis, we layered in demographic data from the ACS, energy cost burden from the LEAD Tool, environmental justice data from the MiEJScreen, and DAC indicators from the CEJST (Table 1).

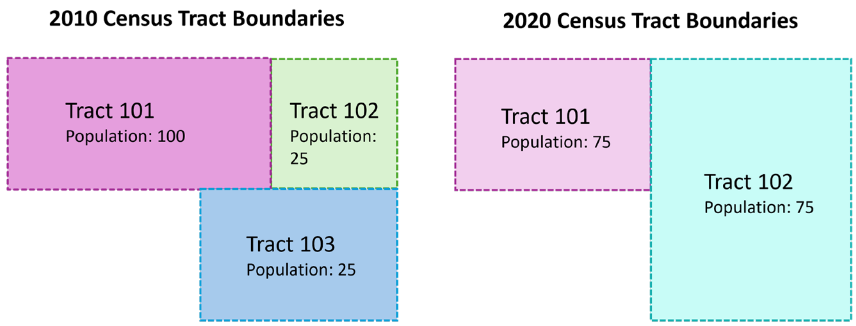
The LINA tool includes a function to combine user-selected metrics from these data and estimate an overall “need score” for each utility-served census tract. To maximize accessibility to the gap analysis and enable dynamic mapping of user-defined needs, we built a web-based dashboard application using R Shiny. We created multi-layered, interactive maps using the R leaflet package to enable easy comparisons between variables (such as eligible, served, and unserved customers; need scores) on a dynamic scale. Users can pan and zoom in and out to quickly alternate between comparisons of the entire service territory, regions, cities, or specific neighborhoods. Figure 2 shows a view of the entire Consumers Energy service territory.

Table 1. Contextual data integrated into the LINA tool

Variable	Levels	Description	Source
Household heating fuel	Utility gas Electricity	Occupied housing units with specified type of heating fuel	ACS 2023 5-year estimates
Household tenure	Owner Renter	Occupied housing units occupied by owners or renters	ACS 2023 5-year estimates
SNAP benefits	Receiving SNAP Not receiving SNAP	Households receiving cash public assistance or Food Stamps/SNAP	ACS 2023 5-year estimates
Federal Poverty Level (FPL)	Under 50% FPL Under 100% FPL Under 125% FPL Under 150% FPL Under 185% FPL Under 200% FPL	Ratio of household income to the Federal Poverty Level in the last 12 months	ACS 2023 5-year estimates
Age	18 and under 19 to 34 35 to 64 65 and over	Civilian noninstitutionalized population in each age bin	ACS 2023 5-year estimates
Language spoken at home	English Not English Non-English Indo-European language Asian language Other language	Language spoken at home and English proficiency for the population 5 years and older	ACS 2023 5-year estimates
English proficiency	English proficient Not English proficient Primary language Spanish, English proficient Primary language Spanish, not English proficient	Language spoken at home and English proficiency for the population 5 years and older	ACS 2023 5-year estimates
Race and Ethnicity	White Non-white Black American Indian Asian Pacific islander Other race Multiple races Hispanic Non-Hispanic	Population for each race or ethnicity	ACS 2023 5-year estimates
Education	Less than high school High school Bachelor’s degree Master’s degree	Educational attainment for the population 25 years and older	ACS 2023 5-year estimates

	Doctorate degree		
Employment	Employed Unemployed Armed forces	Employment status for the population 16 years and older	ACS 2023 5-year estimates
Veteran	Veteran Not veteran	Veteran status for the population 18 years and older	ACS 2023 5-year estimates
Disability	Disability No disability	Disability status for the civilian noninstitutionalized population	ACS 2023 5-year estimates
Energy burden	Continuous numeric scale, 0-100%	Percent of income spent on energy	LEAD Tool
MiEJ environmental conditions sub score	Continuous numeric scale, 0-100%	See Figure 1	MiEJScreen Tool
MiEJ population characteristics sub score	Continuous numeric scale, 0-100%	See Figure 1	MiEJScreen Tool
MiEJ overall score	Continuous numeric scale, 0-100%	See Figure 1	MiEJScreen Tool
EJ40 DAC	True/false flag; percent of 2020 tract that came from a EJ40 DAC 2010 tract	EJ40 DAC = True if the majority (>=50%) of the 2020 census tract came from a 2010 census tract flagged as a DAC by the MiEJScren	MiEJScreen Tool
CEJST DAC	True/false flag; percent of 2020 tract that came from a CEJST DAC 2010 tract	CEJST DAC = True if the majority (>=50%) of the 2020 census tract came from a 2010 census tract flagged as a DAC by the CEJST	CEJST
Low-income program participation	Discrete numeric scale, 0-total household population	Historically participating households in Consumers Energy low-income programs, single- and multifamily	Gap analysis
Low-income program eligibility	Discrete numeric scale, 0-total household population	Households income-eligible for Consumers Energy low-income programs, single- and multifamily	Gap analysis
Low-income program participation gap	Discrete numeric scale, 0-total household population	Households income-eligible for Consumers Energy low-income programs that have not yet participated, single- and multifamily	Gap analysis

Census geography boundaries are updated with each decennial census, but many datasets that use data collected before 2020 continue to report data at the 2010 census geographies. This is true for the MiEJScreen and CEJST, which both only report their data for 2010 census geographies. To combine those data with the ACS and LEAD data reported at 2020 census geographies, we used IPUMS NHGIS crosswalks to convert the MiEJ and CEJST data from 2010 census tracts to 2020 census tracts (IPUMS 2024). We took a weighted average of each variable based on the population proportions of the deprecated 2010 tracts within each 2020 tract, as diagrammed in Figure 3 below.



Calculating values for 2020 geographies that changed from 2010 geographies:

For variable A, A^{101}_{2010} denotes the value of A for Tract 101 of the 2010 Census geographies

$$A^{101}_{2020} = (A^{101}_{2010} * \frac{75}{75})$$

$$A^{102}_{2020} = (A^{101}_{2010} * \frac{25}{75}) + (A^{102}_{2010} * \frac{25}{75}) + (A^{103}_{2010} * \frac{25}{75})$$

Figure 3. Example of converting data from 2010 census tracts to 2020 census tracts.

Similar to the methods used in our gap analysis, this population redistribution relies on an ecological fallacy that assumes the population characteristics within the tracts are evenly distributed and that the sub-population that moves from one tract to another when the geographies change will maintain the original tract-level proportions of characteristics. This introduces inaccuracies but provides the best estimate possible with the data available to align geographies across different data sources.

Dynamic Need Scoring

The LINA tool allows the user to select up to five variables at a time (including the gap analysis components) and then calculates a percentile-based "need score" for each utility census tract by comparing the value of each selected variable in each census tract to the values of the same variables across all utility-served census tracts. The percentile rank of each variable is a numerical value ranging from 0 to 100; these rankings are summed to create the composite need score. Therefore, each additional variable selected increases the scaling range by 100—scores comprising two variables will be scaled from 0-200, three variables from 0-300, and so on. The MiEJScreen employs a similar composite scoring system for its percentile-ranked overall score, although it applies a weight to its component variables and the total is normalized to a 0-100 scale.[2] We decided against normalization to maintain visibility on how many component variables each need score contains.

Once the scores have been calculated, the tool populates a heat map of the service territory with the need scores by census tract (Figure 4). The user can view the entire territory at once or zoom in and out on specific areas. Clicking on individual tracts pops up information such as the GEOID, overlapping zip codes, EJ40/CEJST designation, and specific need score (Figure 5). These results can also be exported in tabular format from the tool, allowing additional score weighting or analysis outside of the dashboard. The process of selecting variables and calculating the associated need takes only a few seconds, so it is easily repeatable with different components to assess numerous scenarios.

[2] The methodology of MiEJScreen score calculations is detailed in Figure 1.

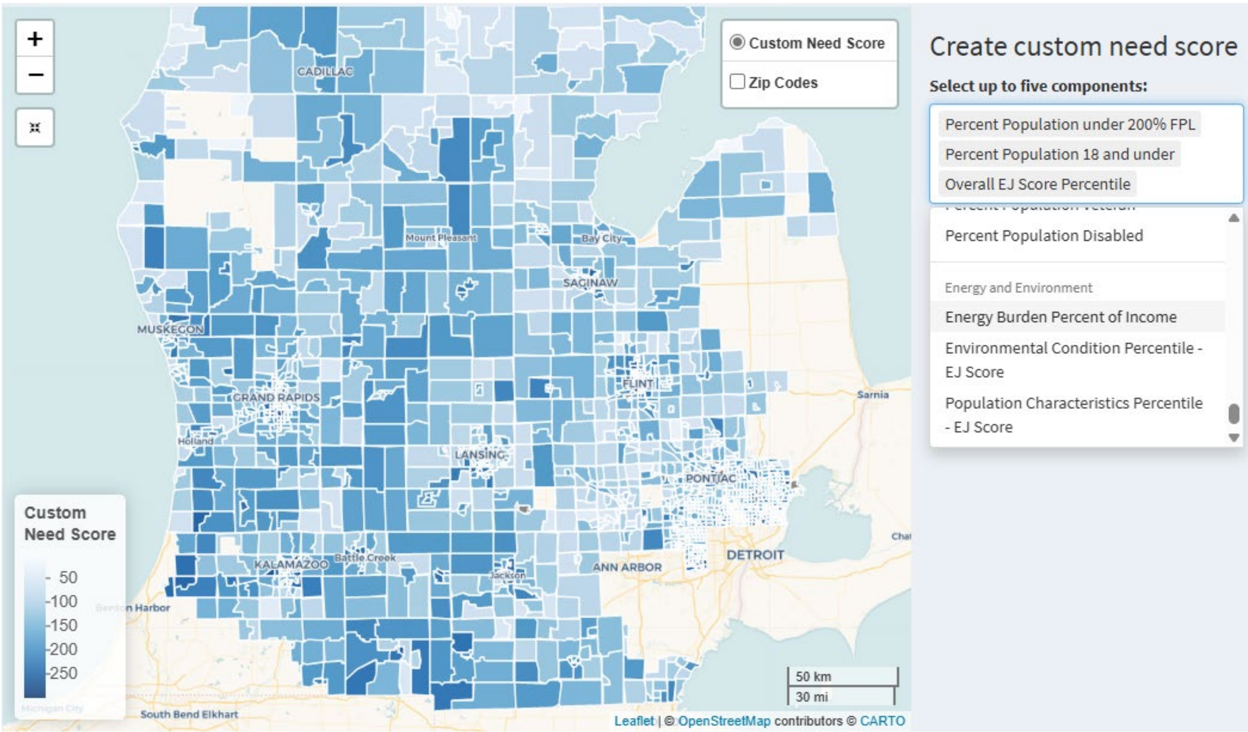


Figure 4. An example prioritization scenario in the dynamic need scoring page of the LINA tool.

Conclusions: Dynamic Targeting at Work

To identify subsequent target areas after the Flint Initiative, Consumers Energy developed a uniform geotargeting protocol to pair with the LINA tool's need scoring system that standardizes outreach and coordination planning with stakeholders, CBOs such as Community Action Agencies, local government leaders, and other key community leaders. Consumers Energy also identified a few key metrics to focus on when identifying underserved communities, shown in Table 2. Combining the insights from the LINA tool with this new geotargeting protocol is facilitating collaboration towards addressing community needs and customizing the geotargeting initiative to best serve disadvantaged customers within those communities.

Table 2. Primary foci of the Consumers Energy geotargeting initiatives

Category	Focus	Source
Environmental Justice	MiEJScreen overall score	MiEJScreen Tool
Energy accessibility	Energy cost burden as a percent of income	LEAD Tool
Demographic	Poverty, renters, children, seniors	ACS
Building characteristic	Electric heating	ACS
Program engagement	Communities historically underserved by Consumers Energy low-income programs	LINA gap analysis

Using the insights from the LINA tool on the community characteristics listed above, Consumers Energy identified Kalamazoo as the next focus of its geotargeting efforts. Kalamazoo has a high density of census tracts with high need scores based on multiple prioritization scenarios investigating Consumers Energy's areas of focus, such as the one shown in Figure 5. These scenarios included also gap analysis metrics, such as eligible and unserved households, indicating areas of opportunity that overlap with environmental justice and demographic characteristics of interest. Consumers Energy is currently developing its *Count on Us* campaign with CBOs in Kalamazoo to connect customers to program services and build partnerships in the communities identified in the LINA tool.

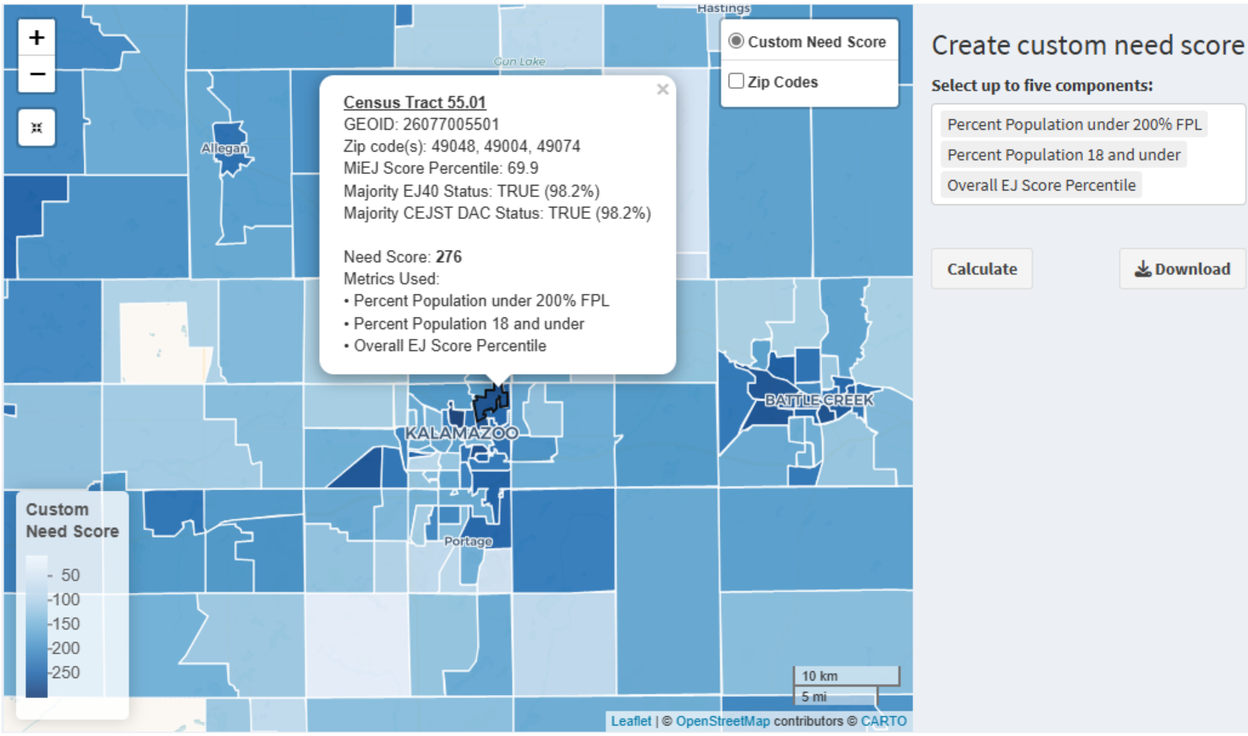


Figure 5. A zoomed in view of the same scenario shown in Figure 4 with a Kalamazoo census tract highlighted.

Based on its work in DACs throughout its service territory identifying what program offerings increase access to EWR services, Consumers Energy is also expanding its EWR Health & Safety Initiative. This program pairs EWR upgrades with repairs to the foundation, roof, and windows and doors of customers' homes, in addition to offering services such as pest control and mold removal. It aims to maximize energy bill savings and home comfort for homes that may not otherwise qualify for energy upgrade programs without these additional repairs.

The LINA tool provides a baseline picture of community needs that has been helping start conversations with local community groups who can then help further explain community barriers and needs and assist with engagement strategies to enhance success. Consumers Energy and Cadmus are updating the LINA tool on an annual basis to further gauge gaps in services provided to DACs and support additional geotargeting initiatives.

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