Environmental Justice and Geothermal Energy Networks

In this report we present the environmental justice (EJ) considerations that should be taken into account when developing Geothermal Energy Networks (GENs). This study was developed as part of the Budget Period 1 (BP1) “Planning and Design” of the Community Geothermal Heating and Cooling (CGHC) grant awarded by the Department of Energy (DOE) to HEET. The partner organizations of this project are: Eversource Energy- the Deployment Partner; the City of Framingham - the Municipal Partner, Salas O’Brien - the Design Partner, and HEET, the main recipient. HEET is a non-profit with a mission to drive systems change through an ethical and efficient thermal energy transition.

Preface

Fossil fuel-based traditional energy systems have disproportionately harmed marginalized communities while accelerating climate change and environmental degradation.
A transition to renewable energy systems presents an opportunity to address historical environmental injustices. Thus, it is crucial to prioritize environmental justice (EJ) principles to ensure equitable access to clean energy and mitigate climate change impacts.

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Every community is different. To understand equity and access in each community where a geothermal network is planned, the current state of equity and access should be assessed by reviewing barriers and opportunities in residential demographics, building characteristics, energy efficiency, and social inclusion. This assessment allows us to understand where the project is succeeding in terms of equitable access and where it faces challenges, such as uneven energy burdens or community outreach issues. This review can happen in the project siting phase before construction and should evaluate what's effective and identify areas for improvement.

An analysis should be guided by three environmental justice principles:

1. Equitable Development: Addressing disparities and promoting inclusive development, recognizing historical redlining and gentrification impacts.
2. Inclusive Decision-Making: Ensuring community participation in energy decision-making, prioritizing marginalized voices.
3. Preventive Action: Preventing environmental hazards and financial hardships by promoting proactive solutions.

Geothermal networks lend themselves to these principles.

- Adopting a traditionally single-owner model to a multi-owner model accelerates the distribution of benefits, offering a stark contrast to the current status quo.
- Deploying this solution through a gas utility ensures that the installation, operation and maintenance of a system benefits from continuity. A single entity can effectively manage expectations and outcomes and provide clear communication across the lifespan of the project.
- Gas utilities must exercise prudent spending in designing and installing infrastructure, while ensuring reliability and rates that will ultimately benefit consumers.

To continually improve equity, this analysis should focus on reducing inequities that arise from the implementation of energy projects. By gathering key demographic, economic, and residential data, we can make informed decisions to ensure equitable distribution of benefits and mitigate negative impacts.

Environmental Justice Framework: **Equity Metrics and Data**

Table 1. General Demographics and Residential Economics

Metric	Description	Data Source
Income	Median household income	American Community Survey
Energy Burden	Household energy costs/income	Energy Information Administration
Residential Characteristics	Ownership, property type, years living at residence	American Community Survey
Household Demographics	Age, children, seniors, multigenerational	American Community Survey
Race/Ethnicity	Population demographics	American Community Survey
Language	Language spoken at home	American Community Survey
Disability	Persons living with disabilities	American Community Survey

Table 2. Residential Building Characteristics

Metric	Description	Data Source
Building Type	Single family, 2-4 family, multi-family 5+	American Community Survey
Building Height	Single story, 2-3 story, 4-6 story, 6-10 story, 10+ story	Building department data
Age of Building	Year built	Building department data
Square Footage	Residential square footage	Mass Save energy assessments
Exterior Walls	Material (stone, plaster, brick, etc.)	Mass Save energy assessments

Table 3. Weatherization and Energy Efficiency

Metric	Description	Data Source
Weatherization Improvements	Air sealing, insulation, blower door test	Mass Save energy assessments
Identified Barriers	Knob and tube, combustion safety, mold, asbestos	Mass Save energy assessments
Remediation Options	Asbestos, vermiculite	Mass Save energy assessments
Cost of Remediation	Cost of asbestos remediation	Mass Save energy assessments

Table 4. Social Access and Community Support

Metric	Description	Data Source
Education	% some college or less, % Bachelor's degree or higher	American Community Survey
English Language Learner	Language proficiency	American Community Survey
Length of Residency	Years living in residence	American Community Survey
Age	Population demographics	American Community Survey
Race/Ethnicity	Population demographics	American Community Survey
Living with Disability	Persons living with disabilities	American Community Survey
Designated Environmental Justice Community	EPA designation	EPA

Table 5. Health and Environmental Impacts

Metric	Description	Data Source
Asthma Rates	Asthma prevalence in disadvantaged communities	Centers for Disease Control and Prevention
Cancer Rates	Cancer incidence in disadvantaged communities	National Cancer Institute
Urban Heat Island Effect	Temperature increases in urban areas	National Oceanic and Atmospheric Administration

Table 6. Equity Approach for Outreach

Metric	Description	Data Source
Community Outreach	Mailing, phone, flyers, social media, door knocking	Community outreach data
Community Engagement	Partnerships with local organizations, language support	Community engagement data
Demographic Economic Development	Data describing potential participants	Economic development data

Table 7. Participant Data and Feedback

Metric	Description	Data Source
Demographic Data	Income, race/ethnicity, language, energy burden	Participant data
Participant Feedback	Surveys, experience	Participant feedback data
Non-Participant Feedback	Opted out, community feedback	Non-participant feedback data

Note: Data for evaluating these metrics can often be sourced through Home Energy Assessments. However, in Massachusetts, inconsistencies in these assessments present challenges for reliable and comparable data collection, complicating efforts to assess community energy needs.

Integrating Geothermal Networks for Community-Centered Energy Solutions

Geothermal networks are inherently hyper-local technologies that require a deep understanding of the unique needs, challenges, and strengths of the communities they serve. Ensuring that equity metrics are rigorously evaluated is essential for deploying these technologies in a way that promotes inclusivity and addresses systemic inequities. By focusing on community-centered deployment, we can create equitable access to geothermal networks and other clean energy initiatives.

The integration of environmental justice principles within geothermal energy systems holds immense potential to alleviate energy burdens, improve public health, and promote equity. Addressing longstanding disparities and fostering inclusive development paves the way for a more just and sustainable energy future.

Key Considerations:

1. Prioritize community-centered planning in energy development.
2. Ensure equitable access to energy efficiency programs, across all communities, prior to energy project siting.
3. Invest in energy storage solutions, such as geothermal borehole energy storage (BHES), to reduce reliance on fossil fuels and provide resilience to every network.

By prioritizing equity and environmental justice, we can ensure a more sustainable and just energy future that centers the needs of marginalized communities. Future research should focus on evaluating the potential benefits of Geothermal Networks for Environmental Justice and community well-being, during installation and operation of a system.

Potential Benefits of Geothermal Energy Networks for Environmental Justice

Energy Efficiency & Security: Geothermal networks use minimal electricity compared to other electrification methos for heating and cooling buildings, and they do not rely on fuel. The bidirectional single ambient temperature loop allows for synchronous cancellation or matching of thermal loads between buildings, optimizing energy use even before tapping into boreholes.

Sustainable Development: Geothermal networks have the potential to improve energy efficiency compared to fossil fuel systems, which could lead to lower projected energy bills. Additionally, for regulated utilities, costs may be spread out over ratepayers, making energy more affordable and accessible for low-income households, promoting equity in energy access.

Addressing Energy Poverty: Energy efficiency measures in concert with geothermal network deployment can lower energy costs for heating and cooling, particularly benefiting low-income households. By improving access to reliable energy with more-consistent pricing, geothermal networks can help alleviate energy poverty and ensure equitable energy access.

Thermal Storage & Affordability: The capability of geothermal networks to redistribute excess heat to locations where it is needed enhances overall energy efficiency. A managed transition from gas to geothermal can mitigate the risks associated with an unmanaged shift that may leave renters and low- to moderate-income populations unable to afford necessary equipment and building retrofits to transition one household at a time.

Scalability & Flexibility: Geothermal networks can be deployed in areas with existing natural gas infrastructure, as well as in urban and rural settings. They can utilize various thermal resources, including geothermal boreholes, aquifers, and thermal reservoirs (e.g. lakes, rivers), providing adaptability to different contexts.

Public Health & Environmental Impact: By reducing reliance on fossil fuels, geothermal networks can decrease harmful air pollutants and greenhouse gas emissions, improving air quality and reducing pollution-related health issues in communities. As fossil fuel use declines, emissions of harmful pollutants linked to respiratory and cardiovascular diseases may also decrease.

Low Emissions: Building energy use accounts for 40% of total energy demand in the U.S. Transitioning to geothermal networks, which primarily use electricity to power pumps, could reduce energy demand and curb emissions from fossil fuel combustion. This transition may improve both outdoor and indoor air quality, benefiting overall public health.

Energy Resilience & Reliability: Geothermal networks provide a consistent and reliable energy source, unaffected by weather conditions or disruptions in fuel supply. They can also store excess heat during high demand, offering a sustainable alternative to traditional fossil fuel peaker plants. Tapping into borehole energy storages (BHES) could shave peak demand, which is the most costly.