EPRI

EQUITABLE DECARBONIZATION RESEARCH ROADMAP
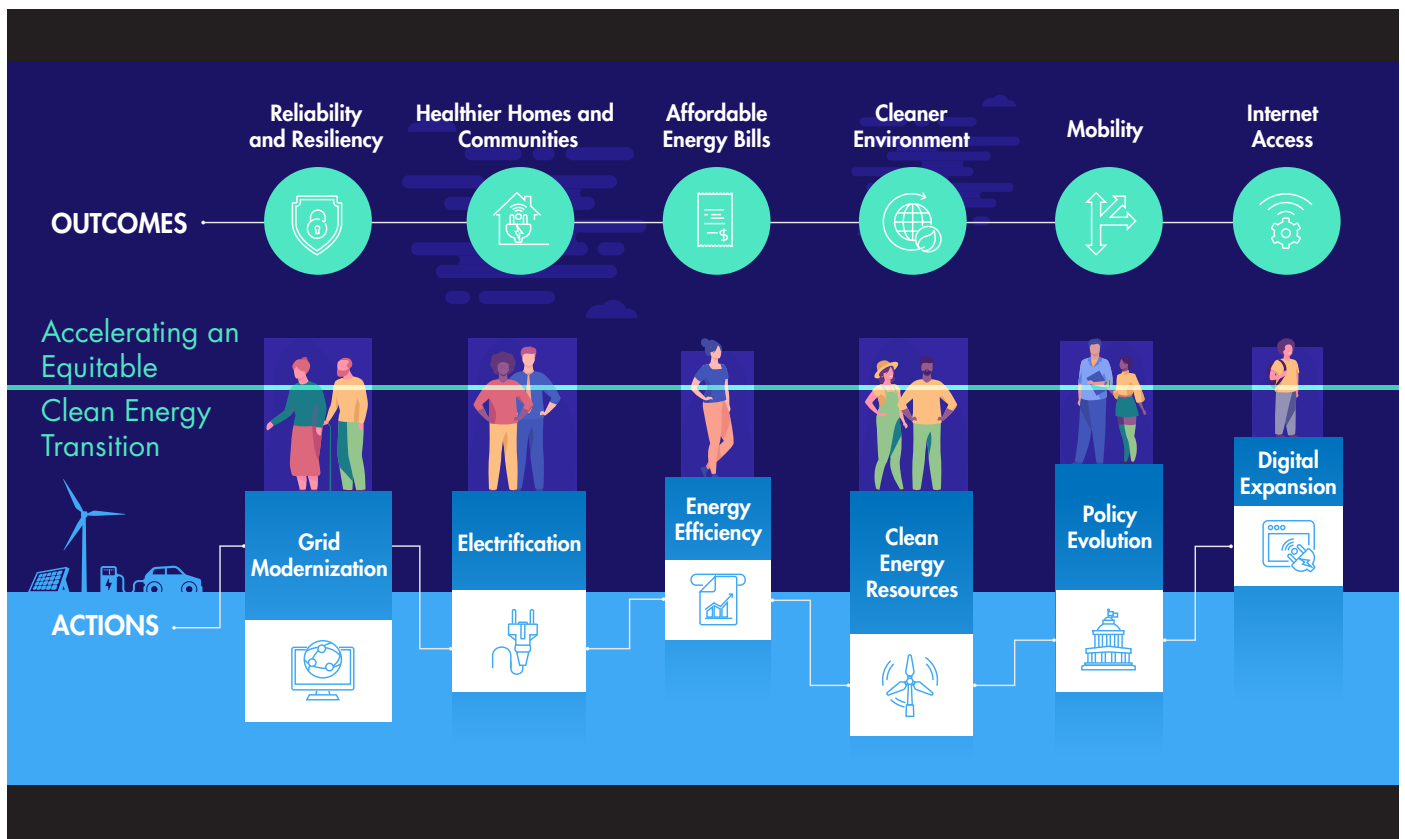

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Table of Contents

Executive Summary

The Electric Power Research Institute (EPRI) developed this Equitable Decarbonization Research Roadmap to provide direction for research on equity issues relating to the clean energy transition. Collaborative R&D is critically important for transitioning to a clean energy economy and meeting decarbonization goals while addressing reliability, affordability, and systemic injustice. Public-private and economy-wide collaboration that brings together a variety of backgrounds, experiences, and perspectives is critical for defining the research agenda, identifying actionable goals, and building tools and technologies that enable a better-informed and inclusive path forward.

Decarbonization presents many opportunities to advance historically marginalized communities that have borne many of the costs and received few of the benefits of the energy system. This could include improving environmental outcomes for communities; addressing racial and other inequities with regards to emissions, pollution, and other environmental risks; alleviating high energy burdens and trade-offs between food, health, and energy that low- and middle-income households confront; involving communities in energy-related decision making; creating high-quality jobs and educational resources; and delivering valuable services to all customers.

The equitable distribution of benefits depends largely on decisions made by energy industry stakeholders and policymakers. Electrification initiatives, energy efficiency projects, financial assistance programs, digital transformation efforts, grid modernization, and power generation transitions are just a few examples of actions the industry may undertake that directly impact conditions within communities.

These opportunities span the sector value chain – from reimagining and repurposing the power generation fleet to designing new energy utilization programming for energy efficiency and electrification. The potential for these opportunities to benefit frontline and historically marginalized communities will depend on strategic collaboration beyond traditional public-private partnerships, including reliance on community organizations. Meeting core community needs while simultaneously driving innovation and technological progress is critical to success. Local community engagement and collaboration are important to an equitable and just clean energy transition.

Over the past year, EPRI's Equitable Decarbonization Interest Group (EDIG) held six technical workshops covering various facets of the clean energy transition to identify fundamental research gaps and opportunities for investigation. This roadmap serves to organize the research questions identified by these workshops with the intention of launching new research addressing energy equity and justice issues at EPRI and beyond. The research gaps and opportunities identified in this roadmap can inform EPRI, universities, national laboratories, and other organizations as well as decision makers and implementers.

EPRI is in a unique position to advance research and analyses, technological innovations, demonstration projects, and program designs. EPRI is currently working to elevate equity across its research portfolio in the areas of nuclear, generation, transmission, distribution, distributed resources such as energy storage, and customer programs. Organizations across EPRI can incorporate equity in their work in a variety of ways. Examples include developing and evaluating innovative methods to integrate equity into energy system modeling for transition planning, developing an economic assessment framework for plant closures and community transitions, and involving local communities throughout the research process.

While this roadmapping process explored a range of research gaps and opportunities, EPRI has identified the following research activities as part of its core equitable decarbonization initiative:

- Develop and deliver awareness training and related education
- Identify leading practices for community and stakeholder engagement
- Develop an equity metrics framework applicable to utility strategies and operations
- Conduct screening and analysis tool demonstrations and evaluations
- Assess equity and environmental justice program development and design

Acknowledgements

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Background

EPRI launched the Equitable Decarbonization Initiative in April 2021 after researching and publishing a white paper titled *Equity and Environmental Justice Considerations for a Clean Energy Transition* (3002021206). The goal was to take on this complex topic and enable information transfer and stakeholder engagement through a collaborative of utility companies and other stakeholders EPRI convened to advance research and cross-sector dialogue on equity and justice during the clean energy transition.

The following key insights drive this research and dialog:

Disadvantaged communities can benefit from the clean energy transition. The transition offers new opportunities to engage with and provide valuable services to frontline and disadvantaged communities by delivering environmental benefits, economic opportunities, and innovation.

Equitably distributing decarbonization costs and benefits requires deliberate planning and program implementation. Disadvantaged communities may be advanced, impacted, or left behind by decarbonization and electrification initiatives, energy efficiency programming, digital transformation, grid modernization, and power generation transitions. New technologies, policies, business models, processes, and programs must be designed, developed, and deployed incorporating the needs of disadvantaged communities in order to reduce carbon emissions and equitably distribute costs, opportunities, impacts, and benefits.

Public and private sector decision making will directly impact equity and environmental justice. Managing the distribution of costs required to achieve decarbonization goals involves critical public and private sector decisions. There are many technical and economic questions to be addressed as the energy sector seeks to reduce regional and global emissions. At the same time, all stakeholders need to understand and manage the transition's implications and opportunities for equity and justice.

Ensuring distributive, procedural, and recognition justice is important to a beneficial transition. Key frameworks for researching and informing decarbonization's equity and justice impacts and opportunities are distributive justice (just allocation of resources), procedural justice (fairness in the processes that allocate resources and resolve disputes), and recognition justice (respecting different values, cultures, opinions, and structures within communities).

New analytical tools and demonstration projects can deliver early benefits. Collaboration with local community organizations and residents can better inform transition efforts to respond to local priorities and cultures.

Roadmap Process

This roadmap is largely a result of six technical workshops held by EPRI in the latter half of 2021. These events were open to the public and drew approximately 370 participants from EPRI, academia, governments, utilities, and non-governmental organizations.

The technical workshops focused on Modeling and Policy, Power Generation, Electrification, Energy Efficiency, the Digital Divide, and Metrics and Tools. Following an expert panel discussion, each workshop featured breakout discussions in which event participants had the opportunity to identify research gaps, challenges, and opportunities relating to just clean energy transition. Following the workshops, these comments were analyzed and synthesized for the creation of this roadmap. Ideas from the panel discussions were also used to supplement the roadmap. In addition, EDIG's external and internal steering committees provided feedback on the roadmap.

This roadmap does not direct whether EPRI, universities, national laboratories, or other organizations should conduct the research discussed in this document, but its content may be informative to any of these entities as well as to decision makers and implementers. Nonetheless, this process serves to inform EPRI's thought leadership as well as its research portfolio and projects.

Common Themes and Key Research Gaps

The following common themes arose from these discussions:

- Challenges arise with definitions, and there is a need for a common understanding of terms and key concepts.
- Availability, collection, and potential bias of data can impact both research and outcomes.
- Both quantitative and qualitative metrics can inform policy and implementation.
- Roles are evolving for utilities, regulators, and others regarding equity.
- Updated screening, assessment, and decision-making tools are needed.
- Evolving market and rate design, rules, and ownership structures can impact equity. As a result, there is a need to investigate how market and rate design can account for equity.
- It is important to understand the distributional impacts of policies and programs and develop strategies for making them equitable.
- Equity issues may be national, regional, local, and sometimes hyperlocal.
- Community engagement and trust are important to both effective research and its application.
- There is a need to understand how the energy transition is impacting workers and communities and develop strategies for ensuring just outcomes for workers and their communities.

More broadly, research into technologies, policies, programs, and strategies accounting for social and economic aspects would need to integrate social sciences to account for equity implications. Such collaborative research could involve disciplines including, but not limited to, public policy and administration, urban planning, geography, sociology, political science, anthropology, and economics along with engineering and technology. Additionally, connecting directly with communities on research topics may involve building relationships and/or partnering with existing organizations or individuals that can facilitate the necessary dialogue and participation. Building partnerships with advocates along with disadvantaged and frontline communities can ensure that this work is connected to community issues and reflects stakeholder needs.

Expanding upon these themes, the table below presents the key research questions identified.

Modeling and Policy
How can stakeholders (including customers, workers, and host communities) be effectively included in energy transition discussions and decision making?
How can modeling and decision making consider present and future equity outcomes in addition to least-cost objectives? How can modeling account for societal and environmental costs and benefits along with return on investment and other financial considerations?
How can the benefits and costs of the energy transition and their distribution be quantified?

Power Generation
How can equity for consumers, communities, and workers be integrated into plant decommissioning processes?
How is the clean energy transition impacting the labor force, and how can the energy industry support and retrain workers in ways that account for the needs of workers and their respective communities?
How can non-utility scale generation (such as rooftop and community solar) impact equity? How can community power generation solutions impact/advance equity, and what types of solutions are needed?

Electrification
How can equity be better integrated into program and rate design?
What technologies and policies increase consumer adoption of electrification?
What systemic barriers prevent people from participating in programs or adopting new technology? What are the institutional barriers and how can they be overcome?
How can electrification respond to community needs and address gentrification and integration issues for public housing and other public infrastructure?

Energy Efficiency
What are the systemic barriers that prevent people from adopting energy efficiency technology, and how can such barriers be overcome? How can the costs of energy efficiency retrofits and upgrades be allocated equitably?
What are existing/potential policies and programs for energy assistance that can ameliorate energy inequities? How have existing policies impacted equity?
What are options for managing the equipment removed during conversions that advance a sustainable and circular economy?

Digital Divide
How can utilities partner with other providers to develop necessary fiber infrastructure to help increase digital equity and access to digital resources? What policies and regulatory actions would enable these partnerships?
How can utilities and regulators account for not only communities unserved digitally, but also generally underserved, and integrate these differentiations and specific demographic groups into data and measurements?

Metrics and Tools
How can qualitative and quantitative equity metrics be used to evaluate the implications of programs and policies for local communities?
How can utilities and regulators better engage directly with communities and build effective paths for communication?
How can researchers involve community members directly in research to better understand their needs?

EPRI's Research Opportunities

EPRI's sectors and research initiatives are advancing their work relative to equity. Common themes and key research gaps along with the suite of challenges and questions identified through the technical workshops are informing EPRI researchers as they consider new projects and initiatives. EPRI's Equitable Decarbonization Internal Steering Committee serves as a key conduit for collaboration, sharing research ideas, progress, and findings. EPRI members and advisory groups also play a role in informing EPRI's research and projects.

The principal effort at EPRI is its EDIG, designed to convene a meaningful dialogue and develop resources, research, and analytical tools supporting decision making and program design that advances equity and environmental justice. Building on EPRI's 2021 Equitable Decarbonization activities and engagement, EDIG plans to collaborate regularly through webcasts, workshops, and participation in steering and working groups that provide shared learning, guidance, and feedback on technical projects. In addition to offering a space for member collaboration, the webcasts and workshops intend to involve guest speakers from diverse organizations such as local, state, and federal governments; community and non-governmental organizations; and academia. EDIG also plans to develop research topics and projects that may include awareness training and related education; community and stakeholder engagement; frameworks for understanding metrics and data, screening and analysis tool demonstration, and evaluation; policy evaluation, updates, and briefings; qualitative program benchmarking; and program design and assessment, such as environmental justice program design.

EPRI is in a unique position to advance research and analyses, technology innovation, demonstration projects, and program designs. EDIG can inform and elevate equity across EPRI's research portfolio in the areas of nuclear, generation, transmission, distribution, distributed resources such as energy storage, and customer programs. Organizations within EPRI can incorporate equity in their work as described by the examples and ideas below:

Nuclear, Generation, and Low-Carbon Resources Initiative (LCRI)
Evaluating worker and community impacts of existing and decommissioning plants and developing potential tools and mitigation strategies
Incorporating equity into workforce development and training
Understanding environmental and energy justice issues through meaningful stakeholder involvement in siting and developing new facilities, repurposing old facilities, and developing other infrastructure
Evaluating environmental impacts of new and existing technologies considering distributional and other equity implications
Assessing equity metrics and environmental justice screening tools, their application, and communication of results
Incorporating equity considerations in net-zero industrial development
Conducting life-cycle and supply chain analyses
Evaluating the development and inclusion of equity and justice goals for rural communities undergoing plant decommissioning and redevelopment
Understanding equity and justice for internal and external stakeholder inclusion during redevelopment planning
Defining metrics to measure the equity and justice of plant redevelopment projects for surrounding communities

Power Delivery and Utilization, Electrification and Sustainable Energy Strategy, and ClimateREADi
Evaluating environmental impacts of energy storage and other distributed energy resources
Evaluating the intersection of equity and resilience, including smart grid innovation to lower costs and burdens for low-income customers while benefiting the grid and lowering overall system costs
Incorporating equity into climate, system, and resource planning modeling
Understanding equity regarding the social cost of carbon and climate risk
Modeling energy system transitions and their associated distributional impacts
Incorporating equity and environmental justice in infrastructure and renewable energy solutions
Defining equity aspects and metrics for electric transportation, costs and services, energy efficiency, electrification, and other customer end-use technologies, programs, and deployment
Identifying solutions for energy transition on the community level rather than on the individual household level
Examining energy equity metrics in use and development
Assessing equity and cost allocation implications for real-time pricing, demand response, prepay, time-of-use, and other dynamic rate structures

Power Delivery and Utilization, Electrification and Sustainable Energy Strategy, and ClimateREADi (continued)
Understanding adoption decision making and developing energy efficiency/advanced building technologies and program design for low-income customers
Conducting life-cycle and supply chain analyses
Investigating opportunities and limitations associated with available demographic and consumer datasets

Discussion of Key Research Areas

EPRI's 2021 technical workshops facilitated rich conversations and contributions to this roadmap. The following section discusses a number of common questions and ideas raised throughout the roadmapping progress.

Recognizing that local community engagement and collaboration are important to an equitable and just clean energy transition, one opportunity spanning these research areas pertains to methodological design and how community involvement can be integrated directly into the research process. This may occur through the involvement of community members in research design throughout the data collection process as "subject matter experts" or by providing feedback to researchers. In addition to community engagement through the research process, there is a question of how to improve data accessibility practices to ensure that equity-related data can be acquired by the community members and organizations that need it.

Data, Metrics, and Modeling

Integration of justice and equity into energy research spurs many questions pertaining to data, methodology, and definitions.

The roadmapping process identified a gap relating to the distinctions and uses of quantitative and qualitative data for equity research. The extent to which equity and inequity can be adequately represented through quantitative data is unclear, begging the question of when and to what extent equity-related research should focus on qualitative research methods. Numerous roadmapping participants noted that there are many aspects of energy and climate justice issues that are not easily quantifiable but are critical to research.

Another area of research gaps and opportunities pertains to modeling design. There is a strong interest in reevaluating the ways in which cost is incorporated and defined in models. More specifically, participants in the roadmapping process emphasized the need for researchers to move past the "compliance at lowest cost"

logic present in current regulatory and modeling design. The aim is to account for present and future social costs and factor equity into modeling. Researchers could also explore ways in which modeling can better account for distributional impacts on communities.

Metrics to quantify the impacts of the energy transition on communities need to be developed and may be standardized. Given that energy justice metrics are in their nascency, metrics research is a major area of opportunity for energy transition researchers to contribute to the creation of tools for decision making and transparency. Knowledge gaps surrounding metrics resemble those mentioned above pertaining to methodology, data, and modeling. Those working to create or expand metrics could explore the incorporation of non-cost elements into metrics, representation of present and future social and economic costs and benefits of the energy transition, and usage of quantitative and/or qualitative data.

Workers and Communities

Based on research gaps identified through the roadmapping process, research opportunities pertaining to workers and communities focus on the impacts of the transition and planning, program, and policy design necessary to ensure just and inclusive mitigation. Research on these topics is needed for understanding obstacles that must be overcome to increase equity and justice and inform solutions for short-and long-term planning.

Uncertainties surround the socioeconomic impacts of the energy transition on both workers and communities. Research exploring the impacts of the energy transition on communities that depend heavily on the oil, gas, and coal industries for employment could investigate not only the effects of the transition on current workers but also the nature of new jobs arising from the transition, regarding both job type and quality. These roadmapping discussions demonstrated a need for research exploring the geographic redistribution of jobs and the nature of new jobs resulting from the transition.

Community-oriented research could investigate the socioeconomic impacts of electrification in both rural and urban areas, particularly the relationship between electrification and gentrification. Examples of investigation relevant to this relationship are the distribution of access to electrified public transportation and the impact of energy modernization on housing costs. Researchers could also investigate 1) how and which communities and demographic groups are adopting new energy efficiency and electrification technologies and 2) systemic barriers that prevent communities from undertaking

such changes. Further research is needed to better understand the distribution of costs and savings of these projects on different communities and across different housing types (ranging from single-family homes to high-density apartment buildings).

Research gaps also pertain to short- and long-term planning for workers and communities. A wide variety of topics are encompassed in this area concerning worker retraining, education, compensation, and involvement in the decommissioning process. There is uncertainty regarding how the energy industry and government can ensure that workers receive training and education necessary for building and maintaining a decarbonized energy system while receiving fair pay, benefits, and good working conditions. Research could consider how direct engagement with workers and labor unions can contribute to equitable employment outcomes. Another uncertainty pertains to how energy stakeholders can drive employment opportunities toward regions that will be most affected socioeconomically by decarbonization.

In addition to direct worker impact, there is other uncertainty regarding the livelihoods of entire communities whose economies are tied closely to the energy industry, particularly given the tax base supported by existing economies. Researchers may investigate potential strategies for preserving workforce opportunities for the entire community in impacted regions. They may also examine how energy industry stakeholders can facilitate lines of communication with communities and include them in decision making regarding the clean energy transition. This effort may entail research regarding partnerships with grassroots community organizations or improvement of access to information about energy programs online. Additional research may include opportunities to advance gender equity through the transition, and how the cultural aspects of resource-based communities can be respected.

Many short- and long-term community planning questions exist regarding electrification and power generation. The roadmapping process demonstrated a need for research on nonutility scale generation and storage opportunities. More specifically, researchers could consider planning approaches for consumers that emphasize community-based solutions and programs rather than focusing exclusively on individual consumer and household technology adoption. Researchers could also investigate strategies for electrification and grid modernization that prevent costs from falling on renters thus exacerbating gentrification.

Consumers and Cost Distribution

The roadmapping process revealed questions about structural changes in energy system decision making to better recognize and incorporate the needs of energy consumers and improve engagement and decision-making processes, including research pertaining to different communities, regions, and cultures. Decarbonization's broader impacts on communities, particularly through electrification, brings up additional concerns to be explored. As noted above, research is needed to explore how to prevent the cost of electrification from falling on low-to-middle income (LMI) residents and exacerbating or encouraging gentrification and other negative impacts for tenants in LMI communities.

Key decision-making processes enabling energy transition include the decommissioning of power plants and siting new facilities. Researchers could investigate how to effectively include community members, workers, grassroots organizations, and labor unions into these projects. As the energy transition progresses, questions also arise relating to the ownership structure and decision-making processes surrounding the creation of new infrastructure.

Another critical knowledge gap pertains to reconsideration of cost and the factors associated with its definition. Similar to research gaps related to modeling, participants in the roadmapping process emphasized the need for the integration of equity into rate, revenue, and market design. Researchers could explore ways in which these changes can occur and how these changes impact historically marginalized communities. Further, researchers could explore equity implications of decoupling revenue from sales.

Many research gaps regarding cost pertain to distribution. Participants emphasized the need for research that explores who bears the costs of technology necessary for energy efficiency and electrification. The aim is to prevent costs from falling on community members, particularly LMI communities and people of color. Questions pertaining to ideas such as shared customer savings, income-based rate design, and incentivization indicate the need for research that explores more systemic changes necessary for cost redistribution.

Policy and Regulation

The roadmapping process highlighted a need for research to explore how policy can play a role in aiding an equitable energy transition. Research areas in this category span nearly all issues and research topics mentioned above. This underscores the opportunity for future energy transition research to identify current and historical inequities relating to the energy system and ways in which modern energy transformations can remedy these inequities. Thus, policy-oriented research opportunities are not limited to the areas specified in this section, as they intersect with many of the topics discussed throughout the roadmap.

One topic pertains to the impacts of having universal equity standards for the energy system vs. having standards that apply specifically to "target communities," or communities recognized as vulnerable or frontline communities. For example, as state and federal governments develop energy equity metrics, metrics may target impacts on specific communities or broader regions. While the existence of both scopes is not mutually exclusive, researchers may consider exploring and comparing the impacts of both in relation to equity.

Participants also identified a need for research investigating electrification and energy efficiency policies and programs and their relation to equity. One knowledge gap pertains to the relationship between electrification and energy efficiency policies and housing justice issues and whether these programs impact or worsen equity and justice issues.

Moreover, there may be opportunities for more systemic or collective solutions to advance equity and transition to clean energy. Policy and related research analyzing alternatives, outcomes, and efficacy spanning these programmatic themes can further illuminate the issues and inform decision making.

Conclusions

EDIG's 2021 technical workshops identified a wide breadth of research gaps and opportunities related to achieving a just and equitable clean energy transition. The roadmapping progress demonstrated the need for energy research to take on new topics concerning how decarbonization impacts consumers, workers, and communities at large in both the present and future. Further, this process highlighted research needs regarding strategies to ensure that historically marginalized and frontline communities are not only protected from bearing the costs of the energy transition but also receive direct benefits from it.

The roadmapping results indicate a particular need for research to explore and improve industry understanding of current and historical injustices related to the energy system as well as avenues for the clean energy transition to directly address and reconsider institutional structures and processes that have contributed to harm. Examples include reevaluation of factors considered in energy models, investigation of the impacts of grid modernization on consumer costs and gentrification, and exploration of direct community and worker involvement in decommissioning processes.

These discussions also demonstrated a need for energy researchers to focus on equity through a systemic lens, rather than solely concentrating on individual actions and solutions. This theme reflects the history of energy, environmental, and climate injustice as part of a larger cycle of marginalization rather than isolated events. Further, energy researchers have the unique opportunity to address contemporary research gaps through interdisciplinary collaboration, particularly with the social sciences, as well as collaboration with community stakeholders through the research process.

In all, this roadmap intends not only to impact EPRI's research portfolio and projects, but also to inform the incorporation and prioritization of equity issues into energy research agendas and energy system modernization. While identifying a wide array of knowledge gaps and research needs, it is important to recognize the evolution of equity issues as well as progression of the clean energy transition. Thus, knowledge gaps surrounding the transition must be continuously monitored and discussed.

Appendix 1: Full Compilation of Research Challenges and Questions

The following sections provide a collection of research challenges and questions compiled from EPRI's EDIG 2021 technical workshops and related discussions that included an array of stakeholders. This section is organized according to Data, Metrics, and Modeling; Workers and Community; Consumers and Cost Distribution; Policy and Regulation; and Digital Technology. These lists of challenges and questions have only been lightly curated to reflect the diverse input received and are intended to inform discussion and research development.

Data, Metrics, and Modeling

KEY RESEARCH CHALLENGES

- Community involvement in research process
- Community access to research outcomes
- Screening tool interpretation and translation for local implications
- Limitations of quantitative methods
- Understanding the human aspects of the energy transition
- Limitations of traditional cost in modeling
- Data accessibility and limitations in using only publicly available data
- Varying definitions for defining metrics and measuring progress
- Incorporating quality of life into research

Research Methods

- How can researchers incorporate procedural justice into their work through direct engagement with communities? How can community members be directly involved in research as subject matter experts?

- How can researchers build relationships with community organizations to identify frontline communities and better understand their needs? How can existing networks be expanded to include workers, community members, and labor unions heavily affected by the transition to review and offer feedback to researchers?

- Under what circumstances might external experts be paid to serve as SMEs rather than (or in addition to) those from various organizations or members from within the community?

- How can community members help co-design both the research and research objectives?

- What can be done to ensure that data collection does not exacerbate injustices? How can data collection preserve privacy so that people do not feel unjustly monitored?

- How should energy justice, equity, and environmental justice be defined?

- How should environmental justice and frontline communities be defined? What are the demographic indicators for identifying these communities?

- How can discrete choice experiments be used to study preferences and willingness to pay for adoption of new technologies?

- How can distributional analysis be better incorporated into research?

Data Availability

- What are the limitations and alternatives to publicly available datasets?

- How can better data for analyzing equity be acquired (including hyperlocal data and data from rural areas)?

- How can access to raw, real-time, and processed data be improved? How can sensors be used to collect more data (such as AMI data)?

- Where can more accurate data on who is being served be found (broadband)? What sources of information could be relied on given data unreliability?

- How can broadband data parse specific demographic groups within communities such as by race and age?

Transparency

- How can consumers be supplied with data to help them understand costs?

- What is the best entity through which public data sharing could occur, especially demographic data?

- How can data and other information produced by research be shared with communities? How can accessibility of data and research be accounted for?

- How can community members be involved as subject matter experts (for example, paying community members to participate)?

Qualitative vs. Quantitative Data

- How can qualitative and quantitative equity metrics be used to evaluate the impacts of policies and programs on frontline communities? When are qualitative data more useful than quantitative data in measuring equity?

- Can equity and inequity be captured with both types of data?

- How can aspects not easily quantifiable such as loss of place, sense of purpose, and sense of belonging be studied?

- How can quality of life impacts be integrated into research?

- How can social burden be used as a metric to inform energy equity?

- Can burden on communities be quantified? If so, how?

- Can climate damages and injustices be quantified? If so, how?

- How can the multifaceted characteristics of energy and environmental justice be accounted for in research?

- How can the benefits derived from a utility program or strategy in a geographic area be measured (including changes in health, air quality, and quality of life, rather than just number of consumers enrolled in a program)?

Modeling

- What are the distributional implications of decarbonization policies and technological change? What data and models are needed to assess differences in household energy burdens?

- How do decarbonization and electrification affect air quality, and how do the associated benefits for human health vary across different communities? What effect does policy design have on these outcomes?

- How can models better account for different communities and demographics rather than simply representing the "average" individual?

- How can social cost (including costs to future generations) be integrated into costs considered in modeling?

- How can models account for other considerations in addition to costs?

- Do some cost models account for equity more robustly than other models? If so, how?

- How can energy modeling better illuminate distributional impacts?

- How does demand response impact energy equity?

- How can equity be integrated into market design and modeling?

- How can demand-side modeling capabilities be expanded?

- How can specific income classes be better incorporated to study impacts of various models in EPRI's U.S. Regional Economy, Greenhouse Gas, and Energy (US-REGEN) Model (especially in terms of demand response)?

- How can impacts of federal, state, and local policies be modeled to study and compare their effect on equity?

- How can equity be incorporated into existing climate resilience modeling capabilities?

- How can equity factors be incorporated into traditional economic analysis and modeling?

- Is there potential for modeling to move past compliance at lowest cost and model equity outcomes? How can modeling better reflect the "stakeholder view of value creation in the utility industry" rather than prioritizing cost?

- How can geographic information system (GIS) capabilities be expanded to accurately map environmental and energy justice communities?

Metrics

- How can energy equity be measured through metrics applicable to utilities?

- What metrics and tools are already in use, and what has their impact been?

- How are success and progress measured within communities?

- How are metrics designed that capture the non-cost benefits of reducing energy burden?

- How can metrics and tools help 1) allocate funding to ensure it reaches disadvantaged communities, 2) manage programs, and 3) track funding for the programs?

- How are economic, environmental, and social community benefits measured?

Workers and Community

KEY RESEARCH CHALLENGES

- Impacts of transition on workers and communities
- Decreased demand for skills held by current workers
- Rise in demand for different skills than those held by current workers
- Unclear how to direct projects toward regions in most need
- Making electrification affordable and accessible for LMI communities
- Understanding impacts of storms and service disruptions to LMI communities
- Limited research on historical impacts and inequities
- Limited community and worker engagement and trust
- Limits to online resources
- Limited community understanding of the clean energy transition

General

- What historical decisions and practices have contributed to injustice, and what can these historical examples reveal about how to better address equity in the future?
- What are the cumulative impacts of pollutants emitted by utility facilities? What are the cumulative impacts of having facilities that emit multiple pollutants?
- What are the opportunities and implications for communities (vs. individual customers) to develop and implement solutions such as community solar and other distributed and new resources (including storage and hydrogen)?
- How can utilities and regulators become better informed on energy and environmental justice issues? Can they facilitate lines of communication to the broader community?
- How can research better account for major stakeholder groups – including workers, consumers, and community members – impacted by infrastructure and its performance?
- How can the implications of state, federal, and utility policies be effectively communicated to communities?
- How can access to programs online be simplified?
- How can the benefits of electrification be communicated and provided to communities?
- How can utilities partner with communities to address inequity?
- How can providers work with established community organizations and institutions to ensure equity?

- How can utilities and regulators expand collaboration and communication with remote communities?
- How can utilities and regulators better engage directly with communities?

Workforce Trends

- How is decarbonization impacting the workforce? How many workers from the energy sector are retiring? How many workers will remain in the workforce?
- Which communities are/are not receiving the benefits of economic opportunities related to the clean energy transition?
- Where do the jobs/workers go after decommissioning? What are the related economic and social impacts?
- Which communities will be most impacted by these changes? Which geographic areas need the most jobs due to the transition?
- How is the energy transition affecting salaries, working conditions, and economic resources of workers in the energy/utility industry and fossil fuel communities?
- What is the overlap or disparity between the skills needed from workers before and after the clean energy transition? What skills are missing from the workforce that are needed for decarbonization?
- How has the workforce already changed in the energy industry in areas such as automation and contracting?
- How can workforce issues be examined through a macro lens rather than through individual group perspectives?

Worker Retraining and Compensation

- What are the options for workers who require either retraining or early retirement options? What are opportunities for addressing the needs of workers impacted by plant retirements/changes?
- How can employers/governments help the workforce and labor unions to prioritize equity and prevent workers from being left behind?
- How can new energy projects be driven towards regions in need of more jobs?
- How can jobs be kept within a community or region?
- How can worker retraining target local communities and provide the workforce skills needed for decarbonization?
- Can apprenticeships provide a possible avenue for worker retraining assistance?

- How can the energy industry better support and retrain workers?

- How can worker needs be integrated into the decommissioning process?

- How can stakeholders address labor shortage issues?

- How can data on labor shifts be integrated into planning and siting decisions?

- How is the cultural integrity of resource-based communities, particularly in rural areas, impacted by the clean energy transition, and how can such integrity be respected throughout the transition?

Housing

- What is the relationship between electrification and gentrification? How can communities be electrified while mitigating gentrification and its consequences?

- What are the socioeconomic impacts of electrification on neighborhoods?

- How can building decarbonization projects be completed while preventing costs from falling on renters? How can the split incentive obstacle be overcome?

- How do emissions, energy burden, and other outcomes compare across upgrades for single-family homes and large apartment buildings?

- How do both the costs and savings associated with building conversions and energy efficiency projects compare across single-family homes or to high-density large apartment buildings?

- What are the barriers for homeowners and renters to undertake electrification and energy efficiency projects?

Decommissioning

- What are the second life use possibilities for power plants? How can these sites be used for community purposes such as recreation centers, schools, or indoor agriculture?

- What are the challenges and mitigation strategies to repurposing sites?

- How can/does engaging external stakeholders in decommissioning impact equity? Does involving all stakeholders from the beginning and giving them more authority over redevelopment plans make a difference in equity?

Infrastructure

- How can nonutility scale generation (such as rooftop and community solar) impact equity?

- What systemic barriers prevent people from participating in programs or adopting technology related to energy efficiency and electrification? What are the institutional barriers?

- What is the distribution of access to electrified public transportation? How does access to electric public transportation impact equity outcomes?

- What are the opportunities and impacts associated with electrification of public transportation systems relative to equity? How can energy justice concerns be addressed through the buildout of public transit electrification?

- What are the impacts of natural gas and alternative fuels emissions on energy and environmental equity? What are the present and future equity-related costs and benefits of using natural gas and alternative fuels?

- How can the electrification of neighborhood infrastructure consider community needs?

- How can community member concerns be incorporated into infrastructure planning?

- How does population growth create new needs for grid modernization? How can grid modernization consider population growth and migration?

- How can the buildout of new transmission lines and other infrastructure account for equity?

- How can a sustainable/circular economy be achieved for equipment removed during conversions?

- How can building electrification address long-term needs and issues? What are the follow-up challenges for buildings after conversions?

- What pre-conversion repairs or upgrades are necessary to transform buildings?

- How can new infrastructure help mitigate heat risk?

- How is equity impacted or advanced through the development of new clean energy infrastructure?

- What are lessons learned regarding repurposing sites for decarbonized technology?

- What issues are associated with implementation of hydrogen technologies?

- How can vulnerable communities benefit or at least not be compromised through the adoption of early/higher-risk technology?
- How can strategies for electrification take into account community preferences related to specific geographical elements and cultures?
- How can equity for consumers, communities, and workers be integrated into life-cycle impacts, particularly in terms of pollution and waste disposal?

Resilience

- What are alternative approaches to building a resilient electricity supply?
- What are the impacts of storms when broken down by zip code and geographic area to understand equity implications/impacts vs. total economic cost of a storm?
- What time and resources are required to fulfill basic needs during an outage, including food, medications, access to transportation, and home insulation?
- What resources do households lose in a storm? What is the burden of storms on households?
- What are the effects of increasing storms and natural disasters on energy efficiency infrastructure and dependent communities?

Consumers and Cost Distribution

KEY RESEARCH CHALLENGES

- Engagement of communities in decision-making processes
- Equity/inequity, social costs, and future costs in cost definition
- Cost burden on LMI and communities of color (black, indigenous, and people of color or BIPOC)
- Understanding how costs of new technologies are distributed/borne
- Incorporating equity into rate and revenue requirements design

Decision Making

- How can equity be included in decarbonization strategies?
- How can costs of projects and community benefits be calculated? How can projects that are not necessarily economical (but offer resources to the community) be measured in terms of equity?
- How can community voices be integrated directly into the decommissioning and siting processes?

- How can decision making in the energy system allow for involvement from communities? How does community involvement in the energy system impact energy equity?
- What is the relationship between energy democracy and the buildout of an equitable decarbonized energy system?
- What do various ownership models and distribution of distributed energy resources look like? How do they impact equity?
- How can historically disadvantaged communities be included in the discussions around affordability, energy justice, environmental justice, and energy efficiency improvements?
- How can consumers, workers, and people affected by infrastructure changes be involved in resource planning?
- How can communities participate in the ownership, buildout, and development of new systems?

Costs

- How does electricity price carry through to equity in cost of services such as heating or cooling?
- How can cost be defined to include societal needs? How can equity and inequity be accounted for as forms of cost in areas such as social cost?
- What are possible community implications of decoupling revenue from sales? What is the relationship between decoupling revenue and equity?
- How can equity be integrated into rate and revenue design? How do these impact LMI and BIPOC community members?
- Whom do the costs of electrifying homes, net metering/rooftop solar, and gas infrastructure fall on? What are the costs? What are mechanisms to mitigate the costs of new technologies and appliances impacting low-income communities?
- What can make electrification and new technology more affordable?
- How can incentives play a role in accelerating electrification in communities?
- How do costs for smart technologies impact LMI communities, and how are such costs addressed?
- What are more equitable means of distributing funds and costs for energy efficiency upgrades?
- How can costs be allocated/mitigated for LMI consumers?
- How can energy efficiency upgrades effectively address affordability/energy burden?

- How might shared savings with other customers impact or reduce the burden on low-income customers?

- What are the costs to consumers when developing infrastructure? How can the share of their income that it takes to access these services be accounted for in evaluating equity impacts of these services?

- How does real-time pricing compare with demand response pricing in their impact on equity?

- What is the relationship between rate/price standardization and equity? How might alternatives to price standardization such as income-based pricing lead to different equity outcomes?

- Can smart grid innovation lower costs and burdens for low-income customers?

Programs

- What types of utility programs worsen or create systemic barriers to consumer adoption of new technologies?

- What are effective utility programs for eliminating systemic barriers to electrification and energy efficiency technology adoption?

- What type of utility programs would allow for a broader, faster effort to help households participate in and benefit from the clean energy transition? What are alternatives to programs that focus on individual household choice and adoption?

- How can investments for equity be measured to achieve equity goals?

- What prevents customers from participating in energy efficiency programs?

Policy and Regulation

> ### KEY RESEARCH CHALLENGES
> - Lack of research on how to incentivize rapid and equitable plant closures
> - Unclear how to fund Just Transition projects
> - Unclear how policy can support transmission buildout
> - Unclear relationship between housing policy and electrification

General

- How can regulation and policy consider equity rather than specifically focusing on lowest reasonable cost solutions?

- What systemic policy changes can help increase equity in the energy system?

- What are collectively focused policy solutions to electrification and energy efficiency?

- What questions/lessons learned can be derived from preexisting government policies that have required utilities to create programs for historically marginalized communities, for example, programs in California?

- Rather than focusing on defining disadvantaged vulnerable communities (DVCs) and target communities, how do systems with universal standards for all communities impact equity?

- What are the equity outcomes of programs that are based on targeted involvements vs. those that are universal?

- What are the advantages and disadvantages to moving towards universal equity programs, and how might they impact the overall cost and distribution of investment?

- How can improving the universal standard to include aspects of affordability and access to clean energy serve as a method for increasing equity?

- What/how can tax policy help raise funding needed for electrification?

- How could tax policy play a role in lowering the burden on frontline and BIPOC communities?

- What policies help ensure electrification in both new-build and existing housing stock?

- What policies can address cumulative impacts of power generation and other sources of pollution?

Decarbonization Timeline

- How do incentives influence plant closures?

- How has policy been advanced historically during other crises such as the Great Depression or COVID-19? What are the lessons learned to apply to the present urgency of decarbonization?

- What lessons can be learned from the policies of countries, particularly those that are considering equity issues while increasing renewables more quickly than the United States?

- What influences timing and schedules for decommissioning in terms of the various discussion, proposal, development, regulatory approval, and rollout phases?

Community Issues

- How should worker and economic equity issues related to plant retirement be characterized? What policies might address these issues and how?

- How can decarbonization policy achieve job creation in a way that considers the needs of frontline communities, labor unions, and workers?

- How do siting and permitting impact surrounding communities and what are mitigation options?

- How can public investments mitigate the impacts of maladaptation through the energy transition?

Electrification and Energy Efficiency

- How can housing policies such as rent caps and anti-displacement measures impact energy equity?

- What policies and regulations create or worsen systemic barriers to consumer adoption of new technology?

- What are effective policies for eliminating barriers to electrification and energy efficiency technology adoption?

- What type of policies would allow for a broader, faster effort to help households participate in and benefit from the energy transition? For example, what are alternatives to policies that focus on individuals?

- How can electrification be integrated into the development of public housing?

- What types of energy efficiency assistance programs are currently in place, and have they been successful in increasing equity? How can energy efficiency assistance be more equitable?

- What are the policy and regulatory barriers to the buildout of transmission? What policies and regulatory decisions accelerate transmission buildout?

- What policies help historically marginalized communities adopt electrification?

- What population segments qualify for assistance and other program funding, and how does this compare to where funding is actually going?

- How do differences in seasonal peak and demand profiles of various regions impact the investments and programs required for energy efficiency?

- How can electrification policy help equitably redistribute heat risk?

Digital Technology

KEY RESEARCH CHALLENGES
- Assessing broadband transmission, quality, and access
- Data on broadband equity

Digital Divide

- How can right of way (ROW) easements be updated to include fiber optic communications use?

- How can policies or regulatory action designed to address issues regarding private easements and ROWs preventing shared fiber projects avoid conflicting with private property rights?

- What types of policies may impact upselling and down-selling of broadband/internet services?

- How can mutual needs be aligned between fiber broadband providers and utilities that need the same transmission medium for different purposes?

- Is it possible to colocate broadband network with electric infrastructure if/as both are expanding?

- How should costs be distributed and attributed to utility and broadband partners?

- What incentivizes the use of existing lines and ROWs to provide broadband access?

- How can easements be updated to include fiber optic communications use?

- What emergency response planning and backup power are necessary so that broadband can operate during storms and disasters?

- Are there cybersecurity concerns if internet service providers use dark fiber?

- What are effective methods to attach fiber to distribution poles?

- How can grid modernization bring fiber to rural areas?

- What levels of broadband access and quality are needed to increase equity? How can those being underserved, rather than unserved, be quantified/taken into account?

Appendix 2: Compilation of Past and Current EPRI Research Projects

The following verbatim lists were originally compiled in July 2021 through a voluntary survey of employees and updated with input from EPRI's Internal Equitable Decarbonization Workshop in February 2022. As such, this listing is indicative but not comprehensive.

Past Projects

- Research on environmental Justice, electrification, and low-carbon initiatives with the Federal Energy Regulatory Commission (FERC) and Biden administration

- EPRI deliverable, *Site Investigation and Restoration of a Former Power Plant Property* (EPRI report 1023742) on environmental considerations for power plant redevelopment

- EPRI Washington Seminar on Electric Utilities and Trees exploring community engagement and related equity and justice issues: https://assets.ctfassets.net/ucu418cgcnau/5fkSQVVmwe5bNGKdAuC1Vu/c18a77e77d372c91b308fcf8100542e4/Electric_Utilities_and_Tree_Cover.pdf

- Supplemental project with Tri-State G&T working with their irrigation customers to provide irrigation pumping resources in collaboration with the Irrigation Innovation Consortium

- Deployment of low-cost air quality sensors and evaluation of previously collected air data from ground-based vehicle platforms to provide hyperlocal environmental information. These high-density data ameliorate bias in federal/state monitoring network design and better represent energy justice neighborhoods, especially when deployed in tandem with community groups.

- P198 Just Transition report evaluates lessons learned from other industries that have undergone substantial transformation.

- P198 context metrics pilot identifies appropriate metrics in the energy affordability space. This is significant as "affordability" has a number of meanings including "access" and "burden," and current metrics may not be technically appropriate.

Current Projects

- Incubatenergy project on window retrofit technologies to improve building thermal performance

- Planning to include equity and environmental justice concerns in thought leadership pieces (not main focus of this paper)

- Current government project, funded by the CA Strategic Growth Council: https://smartercooler.homes

- Context-based Metrics Pilot for Energy Affordability – examining how energy affordability is defined and reviewing potential new metrics to inform utility strategy and performance measurement over time

- Tracking upstream large-format lithium ion battery supply chain social issues, which are concentrated in developing countries without worker and environmental protections; more in *Sustainability Aspects of the Lithium Ion Battery Supply Chain* (EPRI report 3002019811)

- Collaborating on a Technical Innovation project to formally incorporate Emissions Estimation in Microgrid Planning and Valuation Tools such as EPRI's Distributed Energy Resources Value Estimation Tool (DER-VET™), which can be applied for installations in energy justice communities

- Economic Impacts of Energy Transition – a collaborative project with University of Michigan focused on assessment of the economic impacts of plant-closure on the community

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