Testimony Before the
United States House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Energy
Hearing on Fostering Equity in Energy Innovation
July 16, 2021

Shobita Parthasarathy, Ph.D.
Professor | Director, Science, Technology, and Public Policy Program |
Gerald R. Ford School of Public Policy | University of Michigan

shobita@umich.edu | 734.764.8075

Chairman Bowman, Ranking Member Walker, and members of the Committee, thank you for the invitation to participate in today's hearing. I appreciate the opportunity to discuss the important issue of fostering equity in energy innovation.

We are not accustomed to thinking about equity in the context of innovation. But in recent years, we have begun to recognize that marginalized communities (including those who are low-income and those who come from historically disadvantaged communities of color) are often unable to access the benefits of science and technology, but may be disproportionately subject to the harms.

The key to addressing this is to bring equity considerations into every step of the research and development process, even at the earliest stages.

<u>Inequities in Energy Innovation</u>
It is easy to provide examples of how energy technology can both reflect and reinforce inequalities. The renewable energy transition requires enormous sacrifice from low-income communities that are economically dependent on fossil fuels. People are losing jobs, may have to be retrained and/or move elsewhere to find employment, and manage the pain of watching their hometowns decline.[1] Where large scale deployment of solar and wind energy has begun, local citizens are losing control over land use and community priorities.[2] And, the low-income people around the world who mine the materials needed for solar panels, and those who dismantle and dispose of them, are at greater risk of adverse health impacts including respiratory ailments.[3] They also often fall victim to unsafe labor practices.

At the same time, while low-income households and historically disadvantaged communities of color tend to pay a much larger share of their income on energy bills, often because they live in poorly insulated homes with inefficient heating and cooling equipment, it is

[1] Shannon Elizabeth Bell (2009). "'There Ain't No Bond in Town Like there Used to Be.'" *Sociological Forum*. 24(3): 631-657
[2] Gwen Ottinger (2013). "The Winds of Change: Environmental Justice in Energy Transitions." *Science as Culture*. 22(2): 222-229.
[3] Alastair Iles (2004). "Mapping Environmental Justice in Technology Flows: Computer Waste Impacts in Asia." *Global Environmental Politics*. 4(4): 76-107.; Dustin Mulvaney (2019). *Solar Power: Innovation, Sustainability, and Environmental Justice*. University of California Press.

more difficult and expensive for them to access energy-efficient products.[4] Even energy-efficient lightbulbs, for example, are less available and more expensive in high-poverty areas.[5]

Historically, our research, development, and demonstration funding programs have operated largely oblivious to these impacts. These programs tend to focus on funding projects that seem the most technically feasible, economically viable, and especially now, effective in fighting climate change. Governments then address inequities retrospectively, seeing them as hard, if not impossible to predict and distinct from the innovation process. To compensate, they develop subsidy programs to make it easier for people to access renewable energy technologies, public health interventions to help manage risks, educational programs to convince people of a technology's benefits, and retraining programs for those who lose their jobs.

But these solutions have met with limited success. Historical injustices keep repeating themselves, opportunities to empower marginalized communities are lost, and resentment and distrust seem to grow.

My central point today is that to ensure that energy innovation is equitable and just, and even reduces inequalities, then both government funders and innovators must incorporate this goal much earlier, into the innovation process itself: when they are making choices about which research to fund, which technologies to develop, and even how technologies should be designed. Both policymakers and technologists need to understand that our innovation decisions aren't just technical, they are simultaneously social, organizational, and moral.[6] And the social and equity implications of innovation are much more predictable than we tend to think.[7]

To foster equity, I suggest that the Department of Energy: 1) invest in community-based innovation; 2) consult communities in high-tech projects, and; 3) incorporate social and equity evaluations into its funding apparatus. Central to all of these strategies is the integration of additional expertise—both from affected communities and from social scientists—throughout its research, development, and demonstration funding process

Encouraging Community-Based Innovation

Community-based innovation is, essentially, innovation from the bottom up. Local priorities, knowledge, and context are central to its development, and thus it often leads to small-scale or collective entrepreneurship and grassroots empowerment on a larger scale. It can

[4] American Council for an Energy-Efficient Economy (2020). *How High Are Household Energy Burdens?* An Assessment of National and Metropolitan Energy Burden Across the United States. https://www.aceee.org/energy-burden. Accessed February 22, 2021.

[5] Tony G. Reames, Michael A. Reiner, and M. Ben Stacey (2018). "An incandescent truth: Disparities in energy-efficient lighting availability and prices in an urban U.S. county." *Applied Energy*. 218: 95-103.; Deborah A. Sunter, Sergio Castellanos, and Daniel M. Kammen (2019). "Disparities in rooftop photovoltaics deployment in the United States by race and ethnicity." *Nature Sustainability*. 2: 71-76.

[6] Clark A. Miller, Alastair Iles, and Christopher F. Jones (2013). "The Social Dimensions of Energy Transitions." *Science as Culture*. 22(2): 135-148.; Shobita Parthasarathy (2007). *Building Genetic Medicine: Breast Cancer, Technology, and the Comparative Politics of Health Care*. MIT Press.

[7] Claire Galligan, Hannah Rosenfeld, Molly Kleinman, and Shobita Parthasarathy (2020). *Cameras in the Classroom: Facial Recognition Technology in Schools*. Technology Assessment Project, University of Michigan. http://stpp.fordschool.umich.edu/technology-assessment.; Jack Stilgoe, Richard Owen, and Phil Macnaghten (2013). "Developing a framework for responsible innovation." *Research Policy*. 42(9): 1568-1580.; David Guston and Daniel Sarewitz (2002). "Real-time Technology Assessment." *Technology in Society*. 24: 93-109.

be particularly effective for marginalized communities who may feel ignored and even devalued by large-scale innovation initiatives.

One type of community-based innovation involves equal partnerships between engineers and publics, and we've already seen some of this in the United States.[8] In the wake of Hurricane Maria, community organizations across Puerto Rico began to invest more heavily in local solar power projects.[9] Similarly, Native Renewables, a non-profit organization, provides Navajo families that are "off the grid" in Utah, Arizona, and New Mexico with access to small-scale solar photovoltaic systems so they can power their homes.[10] This organization has also begun to investigate the possibility of revitalizing the land that the Navajo people mined for generations through the development of larger-scale solar projects. This would arrest the environmental and health risks of mining while facilitating economic self-sufficiency.[11] The key is to provide communities with the power and resources to develop and implement energy innovation in ways that are useful for them. To foster these kinds of initiatives, the Department of Energy (DOE) might create programs specifically supporting community organizations engaged in local energy innovation, and reward research and development partnerships between technical experts and marginalized communities.

A second type is often referred to as grassroots innovation, because it fosters low-tech interventions among low-income and otherwise marginalized people. These individuals may lack resources, but they know their needs and circumstances best, and they are innovating all of the time; after all, innovation is often the result of adversity. Proponents argue that supporting this type of innovation often produces useful and inexpensive interventions that the private sector wouldn't generate otherwise, and inspires the community become more engaged in science and technology generally.[12]

To understand how the DOE might support grassroots energy innovation, we can look to the Indian government's National Innovation Foundation (NIF). The NIF was created in 2000 to foster innovation and entrepreneurship among those who are "knowledge rich" but "resource poor". [13] Deliberately inclusive in its approach, NIF's work begins with scouting and identification of new technologies. It sponsors exhibitions and competitions and places local advertisements across the country. In addition, every year a small group of staff and volunteers takes a one- to two- week walk in a different part of the country, to meet with grassroots innovators directly. The idea, as one NIF staff member told me, is to "meet them where they are."

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[8] Mary Finley-Brook and Erica L. Holloman (2016). "Empowering Energy Justice." *International Journal of Environmental Research and Public Health*. 13(926): 1-19.; Shannon Elizabeth Bell, Cara Daggett, Christine Labuski (2020). "Toward feminist energy systems: Why adding women and solar panels is not enough." *Energy Research and Social Science*. 68: 1-13.

[9] Arturo Massol-Deyá, Jennie C. Stephens, and Jorge L. Colón (2018). "Renewable energy for Puerto Rico." *Science*. 362(6410): 7.

[10] Native Renewables (2021). "Our Work." Website. https://www.nativerenewables.org/our-work. Downloaded February 21, 2021.

[11] Mireya Navarro (2010). "Navajos Hope to Shift from Coal to Wind and Sun." *The New York Times*. October 25.

[12] Adrian Smith, Mariano Fressoli, Dinesh Abrol, Elisa Around, and Adrian Ely (2016). *Grassroots Innovation Movements*. Routledge.; Anil Gupta (2012). "Innovations for the poor by the poor." *International Journal of Technological Learning, Innovation and Development*. 5(1-2).

[13] Shobita Parthasarathy (2017). "Grassroots Innovation Systems for the Post-Carbon World: Promoting Economic Democracy, Environmental Sustainability, and the Public Interest." *Brooklyn Law Review*. 82(2): 1-27.

After the initial scoping process, the NIF assesses eligible inventions according to their potential to help the local community, their environmental sustainability, and the feasibility of further development. Based on this assessment, NIF chooses a subset of these technologies to develop further. Its staff then works with the innovators to conduct extensive field-testing to test the technology's effectiveness, and then refine inventions to comply with existing laws and regulations. Consider, for example, NIF's investment in a low-cost windmill. Two farmers from the Indian state of Assam, who have only a high school education, were unsatisfied by the technologies available to irrigate their fields for winter crops. Existing hand pumps required a great deal of time and labor (and had negative health impacts), while pumps powered by a diesel engine were costly and had negative environmental impacts. So, these farmers developed a small, inexpensive windmill made of tin sheets and supported with bamboo rods.[14] NIF helped the farmers secure an Indian patent, develop their technology so that it could be adapted to different types of farming practices, and conduct field trials to gauge the technology's effectiveness.

NIF also works with the innovator to disseminate their technology. In cases where commercialization seems appropriate, NIF helps to secure patents and negotiates, on the innovator's behalf, with companies who have manufacturing and distribution capacity.[15] Because of NIF's focus on equity, licensing agreements invariably include direct benefit-sharing provisions with the local community. The inventors of the low-cost windmill, for example, used a portion of their earnings to donate their windmills to needy farmers.

If the corporate sector decides not to invest, this does not doom the technology. The NIF, committed to the social and sustainability benefits of the technology, usually takes on the dissemination responsibilities instead.[16] They may work with local factories to manufacture the invention on a small scale, or help the innovator disseminate knowledge about their work in surrounding communities so that others can develop it themselves or invent beyond it. Regardless, they always translate information about the inventions into India's many languages and dialects, as a means of continuing to engage a larger and more diverse public in the innovation process. The ultimate goal of this system is to empower the innovative work of the average citizen, in order to encourage technological development that may be more useful to economically disadvantaged communities while also demonstrating the value of grassroots knowledge to the innovation process.

To promote grassroots energy innovation in the United States, the DOE might develop partnerships with community organizations, particularly those that represent rural, low-income, and otherwise marginalized groups. They would work together to find both high and low-tech energy innovations in their communities. DOE could also establish an office that would foster such innovation through prizes, small grants and microloans, and mentorship. As part of this, the DOE would think not just about commercialization, but also alternative pathways to ensure that important ideas and innovation, regardless of their market potential, reach the public and produce social benefit.

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[14] Anil Gupta. "What can we learn from green grassroots innovators: Blending reductionist and holistic perspectives for sustainability science." http://anilg.sristi.org/wp-content/Papers/What%20can%20we%20learn%20from%20green%20grassroots%20innovators.pdf. Accessed July 13, 2021.
[15] National Innovation Foundation (2021). "About Us." https://nif.org.in/aboutnif.php. Accessed July 13, 2021.
[16] Ibid.

Consulting Communities in High-Tech Projects

The DOE can also ensure equity in energy innovation by bringing the perspectives of low-income and marginalized communities into the development, demonstration, and siting of large scale, technically complex interventions. First, it can sponsor deliberative democratic engagement (often called participatory technology assessment). Too frequently, decisions about which science and technology will serve the public good and what investments to make are made without the input of the communities they are most likely to affect, and as a result they may do more harm than good or engender significant opposition that can stymie the project. Deliberative democratic approaches, in which small, representative groups of citizens have the opportunity to learn about a particular issue in detail, question experts, and ultimately offer their insights and recommendations, are designed to ameliorate this.[17] They are particularly useful in generating community insights about highly technical matters; unlike surveys, they provide time and resources for publics to learn and deliberate (they can last anywhere from a few hours to a few weekends).[18] They can also be effective in gathering nuanced information about how particular groups of people—who might be disproportionately affected by a particular technology—might respond.

Researchers have begun to use these methods to assess the social and equity impacts of emerging energy technologies. One project assessed how communities assessed the benefits and risks of large-scale wind energy development in Michigan, Minnesota, and Massachusetts, particularly in terms of their local landscapes.[19] Researchers found that perspectives differed by state: Minnesota participants were much more open to the projects, while Michigan participants worried that large scale development would destroy the "pristine" or "peaceful" qualities of the undeveloped areas of their state (especially for those eager to escape the more urban or suburban areas). Meanwhile, Massachusetts participants opposed all wind energy development, whether large or small scale. Similar deliberative methods to assess public perceptions of solar energy development in Canada uncovered concerns about sustainability across the life cycle including rare earth mining, and the importance of pro-active consumer education and due process.[20]

Thus far, these participatory methods have not been used to understand the perspectives and concerns of marginalized communities vis-à-vis energy innovation. However, their use in other domains suggests they could be useful. In one set of focus groups, African Americans suggested that the community's reluctance to participate in biomedical research was

[17] David Kahane (2016). "Thinking systematically about deliberative democracy and climate change." http://www.fdsd.org/wp-content/uploads/2016/01/Deliberative-democracy-and-climate-change-Kahane.pdf. Accessed July 13, 2021.; Jason Delborne, Jen Schneider, Ravtosh Bal, Susan Cozzens, and Richard Worthington (2013). "Policy pathways, policy networks, and citizen deliberation: Disseminating the results of World Wide Views on Global Warming in the USA." *Science and Public Policy*. 40(3): 378-392.

[18] Daniel Lee Kleinman, Maria Powell, Joshua Grice, Judith Adrian, and Carol Lobes (2007). "A Toolkit for Democratizing Science and Technology Policy: The Practical Mechanics of Organizing a Consensus Conference." *Bulletin of Science, Technology, and Society*. 27(2): 154-169.

[19] Roopali Phadke (2013). "Public Deliberation and the Geographies of Wind Justice." *Science as Culture*. 22(2): 247-255.

[20] Brett D. Dolter and Martin Boucher (2018). "Solar energy justice: A case-study analysis of Saskatchewan, Canada." *Applied Energy*. 225: 221-232.

not simply the result of the Tuskegee Syphilis Study, as many might assume.[21] Rather, it was the result of a long legacy of discrimination and mistreatment in scientific and medical institutions that continues to this day (and suggests impacts beyond biomedicine). Similarly, engaging Native American leaders in democratic deliberation about restoring the ecologically and economically important American chestnut tree through genetic engineering revealed their desire to be consulted much more proactively and expansively.[22]

DOE can also engage community members as advisors in the grantmaking process, a strategy that has worked well in biomedicine. As many of you may know, in the early 1990s breast cancer advocates successfully convinced scientists and policymakers not only to dramatically increase research funding for the disease, but also to integrate the expertise of advocates and patients into the research enterprise.[23] In response, Congress created the Department of Defense's Breast Cancer Research Program, which included women with breast cancer on its scientific peer-review panels. The National Institute for Environmental Health Sciences, in consultation with the National Breast Cancer Coalition, created research centers around the country that pioneered a new partnership model: scientists and women with breast cancer collaborated on research priorities and design.

These collaborations have produced greater community trust as patients felt that scientists saw them as more than just biological samples, data points, or people that needed to be educated or convinced. And it changed research: scientists gained a better understanding of both the breast cancer experience and the realities on the ground and integrated this knowledge into their choices about which research and technology to pursue.[24] In one case, women with breast cancer taught researchers why they should investigate the impact of environmental pollutants by zip code rather than by county. In another, they convinced scientists to assess the impacts of low-level radiation exposure even though it required a different set of measurement tools.

Overall, rather than the customary approach to energy technology development—what scholars call a "decide-announce-defend" model, in which technologists and policymakers determine the solution and then convince communities to accept it—DOE should consider a "consult-consider-modify-proceed" model for research, development, and demonstration programs.[25] That could allow researchers to learn from citizen knowledge and concerns while also minimizing opposition when innovations are deployed.

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[21] Darcell P. Scharff, Katherine J. Mathews, Pamela Jackson, Jonathan Hoffsuemmer, Emeobong Martin, and Dorothy Edwards (2010). "More than Tuskegee: Understanding Mistrust about Research Participation." *Journal of Health Care for the Poor and Underserved*. 21(3): 879-897.

[22] S. Kathleen Barnhill-Dilling, Louie Rivers, and Jason A. Delborne (2019). "Rooted in Recognition: Indigenous Environmental Justice and the Genetically Engineered American Chestnut Tree." *Society & Natural Resources*. 33(1): 83-100.

[23] Janet R. Osuch, Kami Silk, Carole Price, Janice Barlow, Karen Miller, Ann Hernick, and Ann Fonfa (2012). "A Historical Perspective on Breast Cancer Activism in the United States: From Education and Support to Partnership in Scientific Research." *Journal of Women's Health*. 21(3): 355-362.

[24] Sabrina McCormick, Julia Brody, Phil Brown, and Ruth Polk (2004). "Public Involvement in Breast Cancer Research: An Analysis and Model for Future Research." *International Journal of Health Services*. 34(4): 625-646.

[25] Maarten Wolsink (2000). "Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support." *Renewable Energy*. 21: 49-64.; Roopali Phadke (2013). "Public Deliberation and the Geographies of Wind Justice." *Science as Culture*. 22(2): 247-255.

Incorporating Social and Equity Analyses into Grantmaking

The Department of Energy can also incorporate equity analyses into its grantmaking process. When making funding decisions, program officers and peer reviewers customarily focus on the likelihood that a project will advance scientific knowledge, result in a novel or useful technology, and, perhaps, have market potential. But given our growing understanding of the ways that innovation—and energy technologies in particular—can reflect, reinforce, and even exacerbate inequalities, now is the time to incorporate attention to these consequences in our funding and support mechanisms.

DOE could do this in a few ways. In deciding whether to support a particular project, it could require prospective grantees to provide an equity impact assessment of their innovation similar to the National Science Foundation's broader impacts criterion.[26] **The equity impact assessment would gather information about design equity, distributional and siting equity, procedural equity, and historical legacy**, and should be conducted by experts in the social and equity dimensions of innovation. Below, I suggest the types of considerations that would be incorporated into this assessment.

EQUITY IMPACT ASSESSMENT FOR ENERGY INNOVATION	
Theme	**Types of Impacts Considered**
Equity in Design	• To what extent did innovators critically examine the impacts for inequality, and adjust the technology accordingly? • What measures did innovators take to ensure that the technology's design does not reinforce social or economic marginalization, and even ameliorates it?
Equity in Distribution and Siting	• To what extent do innovators try to ensure that the technology is easily accessible to underserved communities? • What additional mechanisms might the public, private, or non-profit sector take to ensure its just distribution?
Equity in Process	• Were potentially affected communities consulted in the technology's development and siting? • To what extent did publics, particularly those who have been historically voiceless in the development of science and technology, influence the innovation?
Historical Legacy	• How have similar previous technologies (in terms of function or predicted implications) influenced inequality? • Have marginalized communities resisted these types of technologies in the past? How? What was the outcome?

DOE could also favor interdisciplinary research proposals that explicitly aim to simultaneously study the technical and equity dimensions of a particular intervention. Consider a recent study funded by the Netherlands Organization for Scientific Research, in which Dutch researchers compared four smart grid systems and found that low-income communities would

[26] Thomas S. Woodson, Elina Hoffman, and Sophia Boutilier (2021). "Evaluating the NSF broader impacts with the Inclusion-Immediacy Criterion: A retrospective analysis of nanotechnology grants." *Technovation*. 101: 1-9.; Michael Davis and Kelly Laas (2014). "'Broader Impacts' or 'Responsible Research and Innovation'? A Comparison of Two Criteria for Funding Research in Science and Engineering." *Science and Engineering Ethics*. 20: 963-983.

experience different impacts depending on the project's design.[27] Equitable smart grid design, they concluded, would ensure that all energy users (not just homeowners) could benefit, that financial profits and costs be fairly distributed, and that users have a voice in the governance of the system including collection and use of household data. To properly evaluate these types of proposals, the DOE must include social scientists and humanists who are experts in equity on its peer review panels and be open to both quantitative and qualitative research.

Regardless, DOE should incorporate staff with expertise in the social and equity dimensions of emerging science and technology throughout its research, development, and demonstration programs. These experts could inform the agency and potential grantees on how to explicitly consider equity in research and development projects, guide peer-review panels, and shape program priorities in terms of the most equitable paths for energy innovation.

In closing, to ensure that energy innovation reduces rather than exacerbates inequities, and does so for the long term, we need to bring these considerations into the research and development process at the earliest stages, through the expertise of both vulnerable communities and social scientists. As you consider policy alternatives with this goal in mind, I am happy to provide whatever assistance I can.

[27] Christine Milchram, Rolf Künneke, Neelke Doorn, Geerten van de Kaa, and Rafaela Hillerbrand (2020). "Designing for justice in electricity systems: A comparison of smart grid experiments in the Netherlands." *Energy Policy*. 147: 1-15.