ENVIRONMENTAL LAW & POLICY CENTER

March 9, 2023

Ms. Lisa Felice
Michigan Public Service Commission
7109 W. Saginaw Hwy.
P. O. Box 30221
Lansing, MI 48909

RE: MPSC Case No. U-21193

Dear Ms. Felice:

The following is attached for paperless electronic filing:

Testimony on Behalf of Environmental Law & Policy Center, The Ecology Center, Union of Concerned Scientists and Vote Solar:

William D. Kenworthy
Chelsea Hotaling
James Gignac
Boris Lukanov

Proof of Service

Sincerely,

Daniel Abrams
Environmental Law & Policy Center
dabrams@elpc.org

cc: Service List, Case No. U-21193

STATE OF MICHIGAN
BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief.	)))))	Docket No. U-21193 Administrative Law Judge Sharon Feldman

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EXHIBIT LIST

ON BEHALF OF

THE ECOLOGY CENTER,
THE ENVIRONMENTAL LAW & POLICY CENTER, UNION OF CONCERNED SCIENTISTS,
AND VOTE SOLAR

March 9, 2023

MPSC Witness	Ex. #	Exhibit Description
William D. Kenworthy	CEO-1	Resume of William D. Kenworthy
	CEO-2	Testimony and Comments of William D. Kenworthy
	CEO-3	Comments of Vote Solar on the Draft MI Healthy Climate Plan: Modeling the Benefits of Electrification and Decarbonization in the Power Sector in Michigan, February 23, 2022
	CEO-4	MIACDE-4.1a
	CEO-5	U-21193 MNSCDE-2.11d 2017-2021 Capacity Factor
Chelsea Hotaling	CEO-6	Resume of Chelsea Hotaling
	CEO-7	DTE Supplemental response to CEODE 2.33a
James Gignac	CEO-8	Resume of James Gignac
	CEO-9	*Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan*
	CEO-10	*Designing a Neighborhood Microgrid: Envisioning a Microgrid for the Parker Village Neighborhood in Highland Park, Michigan*
	CEO-11	*On the Road to 100 Percent Renewables: States Can Lead an Equitable Energy Transition*
	CEO-12	*On the Road to 100 Percent Renewables for Michigan: Strengthening the State's Energy Transition*
Boris Lukanov	CEO-13	Resume of Boris Lukanov
Kelsey Bilsback	CEO-14	Curriculum Vitae of Kelsey Bilsback
	CEO-15	CEO Emissions Analysis
	CEO-16	CEO Health Analysis
	CEO-17	CEO Equity Analysis

Boratha Tan	CEO-18	Resume of Boratha Tan
	CEO-19	dGen Step-by-Step Process
	CEO-20	dGen Results
	CEO-21	Community Solar and Storage Resilience
Kevin Lucas	CEO-22	Kevin M. Lucas CV
	CEO-23	*Carbon Capture and Sequestration (CCS) in the United States*, Congressional Research Service, October 2022
	CEO-24	MNSCDE-1
	CEO-25	*NETL's Updated Performance and Cost Estimates for Power Generation Facilities Equipped with Carbon Capture*, National Energy Technology Laboratory, U.S. Department of Energy, October 2022
	CEO-26	*Winter Storm Elliott Overview*, PJM, January 2023
	CEO-27	*Michigan Hosting Capacity Study*, ITC Michigan, 2021
	CEO-28	*Beyond Wires: Using Advanced Transmission Technologies to Accelerate the Transition to Clean Energy*, Environmental Law & Policy Center, May 2021
	CEO-29	*Interconnection Cost Analysis in the Midcontinent Independent System Operator (MISO) Territory*, Lawrence Berkeley National Laboratory, October 2022
	CEO-30	*Lessons from the Front Line: Principles and Recommendations for Large-scale and Distributed Energy Interconnection Reform*, SEIA, June 14, 2022
	CEO-31	*Comments of the Solar Energy Industries Association*, Docket No. RM22-14-000, October 13, 2022

STATE OF MICHIGAN
MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief.	)))))	Docket No. U-21193 Administrative Law Judge Sharon Feldman

DIRECT TESTIMONY OF
WILLIAM D. KENWORTHY

March 9, 2023

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I. Introduction and Summary

Q: Please state for the record your name, position, and business address.

A: My name is William D. Kenworthy (he/him). My business address is 1 South Dearborn Street, 20th Floor, Chicago, Illinois 60603.

Q. By whom are you employed and in what capacity?

A. I serve as Regulatory Director, Midwest for Vote Solar. I oversee policy development and implementation related to large scale and distributed solar generation in the region. I also review regulatory filings, perform technical analyses, and testify in commission proceedings on issues relating to solar generation.

Vote Solar is an independent 501(c)(3) nonprofit working to repower the U.S. with clean energy by making solar power more accessible and affordable through effective policy advocacy. Vote Solar seeks to promote the development of solar at every scale, from distributed rooftop solar to large utility-scale plants. Vote Solar has over 90,000 members nationally, including over 2,700 members in Michigan. Vote Solar is not a trade organization nor does it have corporate members.

Q. On whose behalf are you submitting this direct testimony?

A. I appear here in my capacity as an expert witness on behalf of the Ecology Center, the Environmental Law & Policy Center, the Union of Concerned Scientists and Vote Solar. I refer to these parties collectively in this case as the Clean Energy Organizations, or “CEO.”

Q. Please summarize your qualifications, experience, and education.

A. I have nearly 30 years of experience in the energy industry in both the public and private sectors working in the renewable energy business and in energy policy. Of that experience, I spent eight years in solar energy project development working primarily on commercial and industrial distributed solar projects in the Midwest. A copy of my resume is attached as Exhibit CEO-1.

I received a Master of Public & Private Management degree from the Yale University School of Management with a concentration in Regulation and Competitive Strategy. My research in graduate school focused on regulatory theory and practice. I also have a Bachelor of Science in Foreign Service from Georgetown University.

Q. Have you testified before the Michigan Public Service Commission previously?

A. Yes. I provided testimony in the following proceedings before the MPSC:

- U-20162 – DTE Electric Co. Electric Rate Case
- U-20359 – Indiana Michigan Power Co. Electric Rate Case
- U-20471 – DTE Electric Co. Integrated Resource Plan
- U-20561 – DTE Electric Co. Electric Rate Case
- U-20697 – Consumers Energy Co. Electric Rate Case
- U-20649 – Consumers Energy Co. Voluntary Green Pricing Case
- U-20713/U-20851 – DTE Electric Co. Consolidated Voluntary Green Pricing and Renewable Energy Plan Amendment cases
- U-21090 – Consumers Energy Co. Integrated Resource Plan
- U-21134 – Consumers Energy Co. Voluntary Green Pricing Case
- U-20836 – DTE Electric Co. Electric Rate Case

Q: Have you testified or provided comments in similar state regulatory proceedings?

A: Yes. I have provided testimony in rate cases before the Iowa Utilities Board and the Wisconsin Public Service Commission. I have provided testimony on community solar services, the value of distributed energy resources, and the calculation of distributed generation penetration before the Illinois Commerce Commission and the Indiana Utility Regulatory Commission. I have provided comments in numerous other proceedings before the Illinois Commerce Commission, the Illinois Power Agency, the Minnesota Public Utility Commission, and the Wisconsin Public Service Commission. A list of testimony and comments that I have filed is included as Exhibit CEO-2.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibits:

- Exhibit CEO-1: Resume of William D. Kenworthy
- Exhibit CEO-2: Testimony and Comments of William D. Kenworthy
- Exhibit CEO-3: Comments of Vote Solar on the Draft MI Healthy Climate Plan: Modeling the Benefits of Electrification and Decarbonization in the Power Sector in Michigan, February 23, 2022.
- Exhibit CEO-4: U-21193 MIACDE-4.1a Current Distributed Generation Penetration
- Exhibit CEO-5 - U-21193 MNSCDE-2.11d 2017-2021 Capacity Factor

Q: What is the purpose of your testimony?

A: I will review the Integrated Resource Plan ("IRP") submitted by DTE Electric Company ("DTE" or the "Company") in this case, introduce the other witnesses for the Clean Energy Organizations, summarize the strategic vision that underpins the analysis that the CEO undertook of DTE's plan, and recommend changes to DTE's plan in the form of a proposed alternative plan for the Commission's consideration. In addition, I will discuss the

Company's proposed cost recovery mechanism for the accelerated retirement of its coal assets.

II. <u>CEO Witnesses</u>

Q: Who are the other witnesses appearing on behalf of the Clean Energy Organizations?

A: In addition to myself, the CEO submit testimony from six other witnesses:

- **Chelsea Hotaling**, Consultant, Energy Futures Group. Witness Hotaling is the CEO modeler-in-chief. Witness Hotaling discussed the CEO view of the DTE PCA, the changes made in the CEO preferred plans, the CEO modeling process, and the CEO modeling results, including the CEO preferred plan.
- **James Gignac**, Midwest Senior Policy Manager for the Climate & Energy Program, Union of Concerned Scientists. Witness Gignac testified regarding the concepts of energy justice and equitable grid transition in the context of an integrated resource plan and the Energy Equity package of targeted investment in low- and moderate-income communities developed in conjunction with the Detroit Area Advocacy Organizations ("DAAO").
- **Boris Lukanov**, PhD., Senior Scientist, Physicians, Scientists & Engineers for Healthy Energy. Witness Lukanov analyzed the energy cost burdens for DTE customers, particularly low- and moderate-income ratepayers. Building off of this analysis, Witness Lukanov testified regarding eliminating the "affordability gap" in DTE's service territory, using sustainable and long-lasting solutions such as energy waste reduction ("EWR") and distributed energy resources ("DER").

- **Kelsey Bilsback**, PhD., Senior Scientist, Physicians, Scientists & Engineers for Healthy Energy. Witness Bilsback testified regarding the Company's environmental justice analysis. Witness Bilsback also conducted an environmental justice analysis and quantified and monetized public health impacts from the continued operation of DTE's fossil fuel resources.
- **Boratha Tan**, Regulatory Manager-Midwest, Vote Solar. Witness Tan testified regarding the input assumptions the CEO group made in building out its dGEN model. The National Renewable Energy Laboratory's dGen software models the adoption of distributed generation taking into consideration a number of variables, such as energy cost, resource cost, solar resource potential, and other relevant inputs. In addition, Witness Tan testified regarding the input assumptions and scoping that led to the Energy Equity package which the CEO modeled in conjunction with DAAO.
- **Kevin Lucas**, Senior Director of Utility Regulation & Policy, Solar Energy Industries Association. Witness Lucas testified regarding the need for an accelerated, "no regrets" renewable buildout to avoid a future capacity constraint.

III. <u>DTE's Proposed Course of Action and the Clean Energy Organizations' Alternative Plan</u>

A. DTE's Proposed Course of Action

Q: Have you reviewed the Integrated Resource Plan and accompanying testimony and exhibits filed by DTE Electric in this case?

A: Yes.

Q: What are your findings about the plan submitted by DTE?

A: DTE's Proposed Course of Action ("PCA") finally marks a significant shift toward clean energy, and the plan includes a number of elements that our analysis shows will improve public health and affordability while maintaining reliability. However, the CEO have identified a number of important opportunities to improve the plan that further accelerate the clean energy transition, advance energy equity & environmental justice, increase affordability, and improve public health. The CEO recommend that the Commission adopt the CEO Alternative Plan as the "most reasonable and prudent plan" for meeting DTE's resource needs over the next 20 years. MCL 460.6t(8)(a).

Q: What are the highlights of DTE's Proposed Course of Action?

A: In its Application, DTE highlights the following elements of its proposed 15-year plan (through 2042):

a. Develops 6,500 MW of solar;

b. Develops 8,900 MW of wind;

c. Develops 1,810 MW of battery storage;

d. Ceases coal-fired generation operations at Belle River and converts it from a 1,270 MW coal-fired baseload power plant to a 1,270 MW natural gas peaking resource in 2025 (Unit 1) and 2026 (Unit 2), with the converted Belle River peaking resource retiring by 2040;

e. Retires Monroe Power Plant Units 3 and 4, a total of 1,535 MW of coal-fired generation in 2028 – nearly 12 years earlier than previously announced - and retires Units 1 and 2, 1,531 MW of coal-fired generation, in 2035 – nearly 5 years earlier than previously announced;

f. Incorporates the maximum amount of achievable EWR potential identified in the 2021 Michigan EWR Statewide Potential Study (Statewide Potential Study), an average of 1.5% per year over the study period;

g. Deploys 38 MW of conservation voltage reduction/volt-var optimization (CVR/VVO);

h. Incorporates a 946 MW low or zero carbon, dispatchable resource in 2035 when the final two units (Units 1 and 2) of the Monroe Power Plant retire. While low and zero carbon dispatchable technologies to support net zero goals are still emerging and require further development, the technology currently selected in the IRP is a natural gas combined cycle turbine with carbon capture and sequestration (CCGT with CCS).[1]

Taken as a whole, the PCA that DTE has proposed represents an important recognition of the opportunities to accelerate a clean energy transition. In particular, DTE's proposal to accelerate the retirements of the Belle River and Monroe coal-fired power plants are in the best interests of customers and the State. Likewise, DTE's recognition of the opportunities to replace fossil generation with a clean energy portfolio is an important step in the right direction.[2] Importantly, however, as will be discussed below and in the testimony of CEO witnesses, there are a number of revisions to the plan that are needed to ensure that it is the most reasonable and prudent means to meet the Company's customers energy and capacity need through 2042. The CEOs Alternative Plan is presented in the following section.

B. The Clean Energy Organizations' Alternative Plan

Q: Please Summarize the Clean Energy Organizations Alternative Plan.

A: The CEO Alternative Plan has been prepared by Vote Solar, the Union of Concerned Scientists, the Environmental Law & Policy Center, and the Ecology Center with the assistance of experts in capacity expansion and production cost modeling, renewable energy development, public health impact analysis, environmental justice impact analysis, and energy affordability. In addition, we collaborated closely with the Detroit Area

[1] *Application of DTE Electric Company for Approval of Its Integrated Resource Plan Pursuant to MCL 460.6t and for Other Relief*, Case No. U-21193, November 3, 2022, pages 2-3.

[2] For purposes of this testimony, a clean energy portfolio refers to a resource portfolio that includes solar, wind, energy storage, EWR, and load management.

Advocacy Organizations to develop a package of energy resources that would take meaningful steps toward addressing energy equity and reducing energy burden. The CEO Alternative Plan improves on DTE's Plan and represents the most prudent and reasonable path to meeting DTE customers' needs through 2042.

During the course of evaluating DTE's PCA, the CEO identified a number of important missed opportunities in the Company's approach. The CEO Alternative Plan moves faster toward a clean energy transition, reduces system costs, and advances the interests of energy equity. And, through modeling with the same software used by the Company, the CEO quantitatively demonstrate the feasibility and value of our proposed modifications.

The key elements of the CEO Alternative Plan include:

- Accelerate retirement of polluting fossil fuel generating assets where feasible
    - Retire Monroe Units 3 and 4 in 2028 as proposed by DTE;
    - Retire Monroe Units 1 and 2 in 2030 (as opposed to 2035 as proposed by the Company);
    - Retire one unit of the Greenwood Peaker (Units 12) and replace with energy storage;
- Adds 1,307 MW more solar, 115 MW more wind, and 827 MW more energy storage to Michigan's energy grid by 2030 than DTE's preferred plan.

- Adds 540 MW of rooftop solar on customer sites by 2030 (1,411 MW by 2042) by treating distributed generation as a resource through an innovative model that pays customers for the value they provide to the grid.
- Adds 539 MW of community solar by 2042 to reduce the energy burden of low-to-moderate-income renters and energy storage batteries for medically vulnerable populations (the "Energy Equity Package" developed in conjunction with DAAO).
- Includes a more robust public health, environmental justice and energy equity analysis.
- Saves more lives and prevents more negative health outcomes.

C. Planning for a Just and Equitable Clean Energy Transition

Q: What is the CEO vision for DTE's resource portfolio and its service territory?

A: Broadly stated, the goal of the CEO is a just and equitable clean energy transition for DTE. The foundational objective for the energy system remains a clean, safe, reliable, affordable, and just energy system. The desired future grid that we advocate achieves those goals while advancing toward a decarbonized and just energy system.

Q: How can the Commission, DTE, and Intervenors move closer to that goal in this proceeding?

A: Integrated Resource Plans provide an important opportunity for utilities, regulators, customers, and other stakeholders to take a holistic, long-term approach to identifying the most reasonable and prudent means of meeting customers' long-term energy needs. As discussed below, the IRP statute provides a venue for strategic thinking about the system as a whole and requires the Company to consider not only what is the least-cost approach but one that is the "most reasonable and prudent" path forward, simultaneously balancing seven factors.

Q: What is the statutory standard for Commission approval of an IRP?

A: MCL 460.6t provides that the Commission may only approve an IRP if it is "the most reasonable and prudent means of meeting energy and capacity needs."[3] The statute further requires the Commission to balance all of the following seven factors in determining whether the plan is "the most reasonable and prudent:"

> (i) Resource adequacy and capacity to serve anticipated peak electric load, applicable planning reserve margin, and local clearing requirement.
> (ii) Compliance with applicable state and federal environmental regulations.
> (iii) Competitive pricing.
> (iv) Reliability.
> (v) Commodity price risks.
> (vi) Diversity of generation supply.
> (vii) Whether the proposed levels of peak load reduction and energy waste reduction are reasonable and cost effective. Exceeding the renewable energy resources and energy waste reduction goal in section 1 of the clean and renewable energy and energy waste reduction act, 2008 PA 295, MCL 460.1001, by a utility shall not, in and of itself, be grounds for determining that the proposed levels of peak load reduction, renewable energy, and energy waste reduction are not reasonable and cost effective. [4]

Q: What is the CEO's approach to examining the DTE plan?

A: The CEO approach to the plan is informed by the goal of an equitable clean energy transition. Specifically, the CEO Alternative Plan is the "most reasonable and prudent" way to balance the seven factors in a way that advances energy and environmental justice goals. In the following section, I will clarify what I mean by energy and environmental justice and how they pertain to resource planning.

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[3] MCL 460.6t(8)

[4] MCL 460.6t(8)(a)(i-vii).

Q: How does the CEOs vision of an equitable, democratic, and distributed future square with the requirements in MCL 460.6t(8)?

A: The statutory standard for plan approval defines factors that must be balanced but does not define the future state, i.e., how should the energy system should look in 2042. That vision is left to the IRP itself to define and for the Commission to determine whether it is the most reasonable and prudent means to achieve that end point.

The goals of decarbonization, equity, and democratization of the energy system are in the public interest and should inform the Commission's evaluation of whether the proposed plan balances the seven factors in the "most reasonable and prudent" fashion. A plan that does not advance decarbonization, equity, and energy democratization is not "reasonable and prudent." Not only are energy equity and environmental justice inherently part of the reasonable and prudent standard from a policy standpoint, but the CEOs legal briefing in this case will demonstrate that equity is inherently part of the public interest standard that the Commission not only can consider, but must consider, in evaluating the Company's plan and the CEO's Alternative Plan.

D. Energy and Environmental Justice in Resource Planning

Q: What is the difference between energy equity and environmental justice?

A: Energy equity and environmental justice are related concepts, but they focus on different aspects of social and environmental equity.

Environmental justice is a broader concept that aims to address the unequal distribution of environmental benefits and burdens, including air and water pollution, toxic waste, and climate change impacts. Environmental justice recognizes that marginalized communities, such as low-income, minority, and indigenous populations, often bear a disproportionate share of environmental risks and harms, while enjoying fewer environmental benefits and protections.

Energy equity, on the other hand, is a more specific concept that focuses on the energy sector's inequities. It addresses the allocation of benefits and costs associated with energy production, distribution, and consumption, including access to affordable and clean energy, energy efficiency, and renewable energy technologies. Energy equity recognizes that energy policies and practices can have significant social, economic, and environmental impacts on communities and emphasizes the need to ensure equitable and sustainable energy systems.

In summary, while environmental justice seeks to address broader environmental equity issues, including those related to energy, energy equity is a more specific concept that focuses on equity in the energy sector specifically. CEO Witness James Gignac provides additional discussion and analysis of the requirement to incorporate energy and environmental justice into the planning process itself and into the Commission's evaluation of whether the Plan is the most reasonable and prudent means of meeting customers' energy and capacity needs throughout the term of the plan.

Q: What has the Commission said in other DTE cases about how environmental justice should factor into the Company's planning processes?

A: In DTE's most recently completed electric rate case, U-20836, there was considerable discussion by parties, including by the MPSC Staff, DTE, the Detroit Area Advocacy Organizations, and the CEO about the definition and role of energy equity, and in particular how it applies to DTE's distribution system planning and investment decisions.

In its November 18, 2022, Final Order in that case, the Commission declared its intent to continue holding the Company accountable for incorporating equity into its planning and decision-making processes:

> As such, the Commission will continue to hold DTE Electric to its commitments to more fully incorporate equity considerations into its decision-making processes.[5]

While this section of the Order related specifically to distribution system spending and investment, the Commission referred to planning generally, suggesting that such accountability pertains to the resource planning dockets.

In addition, in the same Order, the Commission directed the Energy Affordability and Accessibility Collaborative ("EAAC") to define energy equity as it relates to distribution system planning. Citing to the CEO briefing on this topic, the Commission observed:

> The Commission agrees with the ALJ that the Staff's recommendation is reasonable. The Commission finds that adopting a shared definition of equity and creating energy infrastructure related metrics are important issues to consider in the context of 4.8 kV conversion and are not limited to DTE Electric. The Commission also notes that several additional terms have been utilized in the context of equity discussions in this case such as environmental justice, energy justice, and grid equity. In addition to equity, these additional terms should be explored and potentially defined as well.[6]

While the EAAC is developing a shared definition of energy justice, the CEO testimony is intended to provide a framework based on best practices from which the Commission and other stakeholders can draw. CEO Witness Gignac will further expand on this topic.

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[5] Order, U-20836, pg. 459.

[6] Order, *In the matter of the application of DTE ELECTRIC COMPANY for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority*, Case No. U-20836, pg. 462.

Q: How has the Commission required Michigan utilities filing IRPs to consider environmental justice?

A: In its October 27, 2022, Order in U-18461, the Commission updated the filing requirements to include a more robust environmental justice analysis.[7] The new filing requirements include:

> XXII. Environmental Considerations and Environmental Justice: Describe how the utility's resource plan and any alternative resource plans presented in the application will comply with all applicable local, state, and federal environmental regulations, laws, and rules.
>
> a) Include a list of all environmental regulations that are applicable to the utility fleet. Identify which regulations apply to which resources;
>
> b) Include all capital costs for compliance with new and reasonably expected environmental regulations for existing fleet assets in the utility IRP;
>
> c) Include a chart that compares the total projected carbon emissions under each scenario analyzed (no sensitivities applied), including quantifying the carbon emissions projected in each sensitivity as a percentage of the carbon emissions presented in the base scenario associated with that sensitivity. The utility shall identify and justify its use of a carbon accounting methodology identified in Electric Power Research Institute, Methods to account for Greenhouse Gas Emissions Embedded in Wholesale Power Purchases or other Commission approved methodology;
>
> d) If the Company is proposing retirement of an existing resource due to an environmental regulation, clearly identify the future capital cost for environmental regulations and other capital investments in the facility. If costs are identified as avoided capital costs, provide sufficient detail to support the capital cost as avoidable, meaning dollars will never be spent, or capital cost will simply be transferred to another cost category. For example, becoming cost of removal, or fully avoidable capital costs;
>
> e) Hold a technical conference with MPSC and Department of Environment, Great Lakes, and Energy (EGLE) staff within 30 days after the filing to discuss the environmental and emission related data included in the filing testimony, exhibits, and workpapers; and

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[7] Order, *In the matter, on the Commission's own motion to implement the provisions of Section 6t of 2016 PA 341*, Docket No. U-18461, October 27, 2022.

> f) Identify, quantify, and provide evidence in the filing that shows progress in meeting any state, federal or utility announced carbon reduction goals. Illustrate how each optimized build plan for each MIRPP scenario (no sensitivities applied), the proposed resource plan, and the previously approved plan perform in meeting those goals throughout the planning period.[8]

The new filing requirements became effective on November 21, 2022; as such, they were not binding on this IRP which was filed by DTE on November 8, 2022. Nevertheless, DTE did conduct an environmental justice analysis. CEO Witness Kelsey Bilsback critiques DTE's environmental justice analysis and provides additional analysis to support the CEO proposed Alternative Plan.

Q: Does the environmental justice analysis done by DTE provide a full scope analysis of energy equity and environmental justice that is needed to fully evaluate the plan proposed by DTE?

A: No. As described in more depth by CEO witness Bilsback, DTE's energy equity analysis falls short on several dimensions. Dr. Bilsback explains gaps in the EJ analysis and expresses her professional opinion that the results of the public health and impact analysis were not used to inform the most important decision points in the Company's PCA. In contrast, the development of the CEO Alternative Plan was informed by an analysis of the energy and environmental justice impacts that it would have on all customers. The CEO developed an Alternative Plan to advance energy and environmental justice goals, recognizing that we have a starting point portfolio of existing assets and balancing the other priorities of providing safe, reliable, and affordable power. Improving public health,

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[8] Michigan Public Service Commission, Revised Integrated Resource Plan Filing Requirements Pursuant to Public Act 341 of 2016, Section 6t, October 27, 2022. (Attachment A to the October 27, 2022 Order in Docket No. U-18461).

advancing energy equity, and addressing environmental justice concerns was and is incorporated into the decision-making criteria in developing the plan rather than being included as an adjunct in parallel with but not affecting the most important decisions.

Q: How should energy equity factor into integrated resource planning?

A: Energy equity considerations must be an important factor in integrated resource planning. In particular, electric utilities should consider the potential impacts of their resource planning decisions on marginalized communities, including low-income, minority, and indigenous populations. I am not an attorney, but as a policy matter, I find that energy equity and environmental justice are integral to the Commission's authority to ensure "just and reasonable" rates and that resource plans are the "most reasonable and prudent" means of meeting energy and capacity needs.

Here are some specific ways that the Commission should require utilities to analyze energy equity in resource planning for electric utilities:

- Assessing Environmental Impacts: Electric utilities should conduct environmental impact assessments for new power generation and transmission projects to evaluate the potential impacts on air and water quality, natural resources, and local communities. They should also consider the cumulative impacts of multiple projects in the same area, as well as the potential health impacts on vulnerable populations.
- Public Participation: Electric utilities should engage with communities, including marginalized populations, early and often in the planning process. This should include opportunities for public comment, information sharing, and meaningful participation in decision-making. The results of this

process, and how the feedback is incorporated into a utility's plan should be a requirement of the application.

- Distributed Energy Resources: Electric utilities should consider the potential of distributed energy resources, such as rooftop solar, battery storage, and energy efficiency, to provide benefits to marginalized communities. These resources can provide access to affordable and clean energy, reduce energy bills, and improve resilience in the face of power outages.
- Energy Burden and Affordability: Keeping overall system costs low is one of the key objectives of resource planning. It is not the only objective, but energy supply is a significant component of overall rates that customers face. Therefore, net present value of revenue requirements ("NPVRR") is an important metric in identifying the preferred plan. Additionally, however, there are different resource options or programs that can affect the resource mix and have implications for the distribution of energy burden. For example, as discussed by myself and other CEO witnesses, targeted energy efficiency or distributed energy resources programs can help to address energy burden while also having grid beneficial effects on the resource mix.
- Reliability: Reliability is a core function of the electric utility. While most outages result from distribution system failures, it is important to keep in mind resource adequacy and to protect the reliability of the bulk power system.

- Equitable Access: Electric utilities must ensure equitable access to energy services, including renewable resources, for all customers, regardless of their income or geographic location. This may require targeted investments in low-income and minority communities.

Overall, energy equity and environmental justice considerations should be integrated into every stage of the resource planning process for electric utilities to ensure that the energy system is equitable, sustainable, and just.

Q: How does the CEO Alternative Plan put these principles into action?

A: The CEOs developed their Alternative Plan with mindful consideration of each of the principles of energy equity and environmental justice. The Commission should evaluate all aspects of the current energy system through an environmental and energy justice lens. We seek to identify through quantitative analysis where systematic EJ disparities exist. In addition, we collaborated with the Detroit Area Advocacy Organizations to propose specific programs that directly address a subset of the problems we have identified. Finally, we look forward to and anticipate the opportunity to hear from frontline communities and individual stakeholders through a public hearing process before briefing begins. The CEO also support the focus group process initiated by DAAO Witness Koeppel, described in detail in his testimony. The Commission must seek to understand the lived experience of all customers, not just intervenors.

E. Earlier Retirement of Monroe Unites 1 &2

Q: What do the CEO propose with regard to retirement of the Monroe units?

A: The CEO Alternative Plan adopts the proposed retirement of Monroe Units 3 and 4 in 2028 but would accelerate the retirement of Monroe Units 1 and 2 to 2030. Accelerated retirement of Units 1 and 2 provides significant financial, public health, and environmental benefits.

Q: Why did the CEO prioritize an earlier closure of Monroe units 1 and 2 in modeling?

A: The Monroe plant is one of the largest remaining coal plants in the Midwest and the fourth largest in the country.[9] As demonstrated by CEO Witness Bilsback, accelerating the retirement of any single unit by one year has significant and measurable public health and EJ benefits. Closing Monroe units 1 and 2 in 2030 rather than 2035, will avoid between $777-$1.75 billion dollars in total health costs and between 68-154 premature mortalities. For more detailed analysis, see the testimony of CEO Witness Bilsback.

In addition, as demonstrated by the modeling conducted by CEO Witness Hotaling, accelerating the retirement of Monroe Units 1 and 2 even earlier than what was proposed by DTE reduces the overall cost of the system by replacing that energy and capacity with renewables and energy storage. In fact, without the Energy Equity Package, the CEO Alternative Plan which features the 2030 retirement of Monroe units 1 and 2 (as opposed to 2035 as proposed by DTE) has a comparable NPVRR to DTE's Revised PCA.[10] [11]

Q: How does DTE propose to replace the energy and capacity deficit created by the retirement of Monroe Units 1 and 2 in 2035?

[9] Direct Testimony of Joyce Leslie, *In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief,* Case No. U-21193, November 3, 2022. Page JEL-14.

[10] Witness Hotaling describes the adjustments that were made to the assumptions in DTE's PCA in order to provide a basis of comparison to the CEO Alternative Plan.

[11] With the Energy Equity Package, the NPVRR of the CEO Alternative Plan is $18,444 million compared to $17,772 million for the DTE Revised PCA. The difference between the NPVRR of CEO Alternative Plan with and without the Energy Equity Package is $671.8 million, although the NPV of the gross cost of the Energy Equity Package is $883.3 million.

A: DTE proposes to build a combined cycle gas turbine with carbon capture and storage ("CCGT w/CCS") in 2035.[12]

Q: Did the CEO allow EnCompass to select the CCGT w/CCS?

A: No. As discussed previously, MCL 460.6t requires consideration of seven factors in evaluating whether the PCA is the most prudent and reasonable plan to meet the Company's future energy and capacity needs, including the consideration of "diversity of supply" and "commodity price risks." MCL 460.6t(8)(v, vi). The proposed CCGT with CCS is too risky on several dimensions:

- High capital and operating costs create a significant risk of stranded assets. Just as ratepayers are faced with continuing to pay for the unrecovered book value of retiring assets in this case, the CEO are concerned with paying too much for a new fossil fuel resource that will not be economical to operate.
- There have been no successful large-scale deployments of carbon capture and storage technology, particularly with such ambitious recovery goals. While the technology may evolve, the Company should not pin its hopes on risky and unproven technology when proven clean energy portfolios are available and can meet the same energy and capacity requirements at a lower total cost. CEO Witness Kevin Lucas addresses more about the technology readiness and feasibility of CCS.
- The Blue Water Energy Center, which came online in June 2022 already provides the Company with a significant new natural gas capacity. Adding another increment of natural gas capacity would significantly increase the

[12] Leslie Direct, page JEL-17.

Company's exposure to commodity price risk, especially for a high-capacity factor combined cycle unit. The recent gas supply volatility and uncertainty that resulted from the Russian invasion of the Ukraine in February 2022 have served as a potent reminder of natural gas volatility. In contrast, new renewables projects have exceptionally low marginal costs that provides a significant hedge against commodity fuel price risk. Moreover, adding a second CCGT onto of BWEC both of which carry significant risks does not advance the "diversity of supply" IRP statutory factor.

F. Distributed Generation as a Resource

1. Why Distributed Generation?

Q: What does Michigan law say about the use of private investment in cost-effective renewable energy assets?

A: Public Act 342 makes it clear that it is the policy of the state to "encourage private investment in renewable energy and energy waste reduction."[13] In addition, the cost-effectiveness of renewable energy is specifically cited in the goal:

> (3) As a goal, not less than 35% of this state's electric needs should be met through a combination of energy waste reduction and renewable energy by 2025, if the investments in energy waste reduction and renewable energy are the most reasonable means of meeting an electric utility's energy and capacity needs relative to other resource options. Both of the following count toward achievement of the goal:
>
> (a) All renewable energy, including renewable energy credits purchased or otherwise acquired with or without the associated renewable energy, and any banked renewable energy credits, that counted toward the renewable energy standard on the effective date of the 2016 amendatory act that added this subsection, as well as renewable energy credits granted as a result of

[13] Public Act 342, Section 1(1)(c)

> any investments made in renewable energy by the utility or a utility customer after that effective date.
>
> (b) The sum of the annual electricity savings since October 6, 2008, as recognized by the commission through annual reconciliation proceedings, that resulted from energy waste reduction measures implemented under an energy optimization plan or energy waste reduction plan approved under section 73.[14]

Q: Please explain how distributed energy resources, including distributed storage, can be leveraged to reduce total system costs and provide non-resource benefits.

A: Recent studies are bringing to light the value that distributed energy resources can bring to the grid. A study by Vibrant Clean Energy ("VCE") submitted by Vote Solar on the draft MI Healthy Climate Plan found that accelerating the growth of local solar-plus-battery storage on Michigan's electric grid can save residential and commercial utility customers $773 per year, compared to resource plans proposed by Michigan utilities. Vote Solar's Comments and the VCE study are attached as Exhibit CEO-3. VCE's research also shows that leveraging the precision and flexibility of local clean energy can reduce overall system costs and, therefore, costs to all customers. Co-optimization of distribution-connected resources with utility scale investments provides even greater benefits in the form of reduced cumulative costs.[15]

In addition to the efficiencies resulting from co-optimization and avoided transmission system costs, the VCE modeling work shows that distributed generation also provides several categories of benefits to both the bulk power system and the distribution

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[14] Public Act 342, Section 1(3)

[15] Vote Solar, *Comments of Vote Solar on the Draft MI Healthy Climate Plan: Modeling the Benefits of Electrification and Decarbonization in the Power Sector in Michigan*, February 23, 2022.

grid; these benefits include capacity avoidance/deferral, ancillary services, line loss reduction, and resilience.

- **Capacity**: DERs reduce distribution system peak demand and can thereby defer or avoid distribution system capital investments and capacity planning reserves in the short and long run;
- **Ancillary services**: DERs reduce the need for operating reserves, such as spinning reserves, and frequency regulation, and reduce the need for voltage regulation;
- **Line loss reduction**: DERs inject power close to load, reducing the line losses inherent in the displaced electricity that must be transmitted over long-distance transmission lines and distribution wires; and
- **Resilience**: DERs diversify the energy supply mix, which can increase energy surety, or uninterrupted service by reducing vulnerabilities associated with the loss of fuels, in addition to enhancing resilience.

The degree to which DERs provide these benefits will depend on the operating profile of the distributed generation asset (including any storage paired with solar), the timing of production, and the location (within the distribution system) of the asset. However, distributed generation assets also provide long-run value to the distribution grid no matter where the asset is located.

Q: What obligation does the Company have to adopt distributed generation if it is found to contribute to achieving the most reasonable and prudent means of meeting energy and capacity needs?

A: The minimum distributed generation program participation levels established in MCL 460.1173 (often described as the DG "cap") do not somehow limit the Commission's authority to require a higher level of DG if it is the most reasonable and prudent course of action under the IRP statute. The distributed generation program and the resource planning process are two different statutory programs aimed at two different goals. The DG program is intended to provide support to stimulate the distributed market through the widespread availability of net metering. On the other hand, the purpose of integrated resource planning is to identify the "most reasonable and prudent means of meeting the electric utility's energy and capacity needs." MCL 460.6t(8). In light of the demonstrated value of distributed generation to reducing total system cost, the Commission can (and should) only approve a plan that selects it as part of its PCA in the IRP process. It would artificially constrain the IRP and lead to less optimal programs if the Commission interprets the DG statute to somehow constrain the Commission's choices under an IRP.

2. DG can directly address equity concerns.

Q: How is distributed generation uniquely situated to directly address equity concerns while addressing utility resource needs?

A: Unlike other supply side resources available in conventional resource planning, distributed generation can be used to directly address equitable access to clean energy through programs designed to reduce energy burden and increase energy independence. On September 23, 2020, Governor Gretchen Whitmer issued Executive Directive 2020-10 on Building a Carbon-Neutral Michigan.[16] Executive Directive 2020-10 expands the scope of

[16] Governor Gretchen Whitmer, Executive Directive 2020-10, September 23, 2020. https://www.michigan.gov/whitmer/0,9309,7-387-90499_90704-540278--,00.html

EGLE's environmental advisory opinion filed in IRP dockets to include climate and environmental justice considerations:

> The Department must expand its environmental advisory opinion filed by the Department in the Michigan Public Service Commission's ("Commission") Integrated Resource Plan (IRP) process under MCL sections 460.6t and also file environmental advisory opinions in IRPs filed under MCL 460.6s. The Department must evaluate the potential impacts of proposed energy generation resources and alternatives to those resources, and also evaluate whether the IRPs filed by the utilities are consistent with the emission reduction goals included in this Directive. For advisory opinions relating to IRPs under both MCL 460.6s and MCL 460.6t, the Department must include considerations of environmental justice and health impacts under the Michigan Environmental Protection Act. The Commission's analysis of that evidence must be conducted in accordance with the standards of the IRP statute and the filing requirements and planning parameters established thereto.[17]

Q: What are some of the other benefits of distributed generation to customers and communities?

A: Distributed generation allows energy users to own and control the long-term revenue from future energy sources, allowing individuals and families to share in wealth that historically has been limited to utility investors (for utility-owned assets) and bankers (for energy assets operating under Power Purchase Agreements with utilities). This opportunity is further expanded through community solar and other forms of shared renewables that allow renters and low-income households and businesses who otherwise lack sufficient capital or physical space to share in the returns from renewable generation.

Customer-owned or sponsored distributed generation provides increased value by distributing the profits from renewable generation as direct customer bill savings. The value of a megawatt of solar owned by customers produces returns as direct bill savings to

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[17] *Ibid.*

individual customers, whereas the value of a megawatt of utility-scale clean energy must be split between shareholders and customers, leaving less value for ratepayers. Utility-scale generation also requires transmission and results in increased line losses, further reducing the value to customers. In addition to less overall savings for ratepayers, the savings that do occur from utility-owned generation are not equally shared by those historically shut out of the economy. Instead, the savings flow through cost of service rules to predominantly the largest energy users.

Job creation and local business development opportunities are inherently greater for community-based renewable energy than for large, centralized energy systems for multiple reasons:

- A larger number of smaller projects create more jobs, both during construction and long-term during operations, than a single large project of the same total size. This creates a much more stable and sustainable long-term workforce opportunity.
- Distributed generation development also disperses business development and job creation opportunities, making jobs and enterprises more accessible to a wider range of Michiganders. Financing is also more feasible locally for relatively smaller sized projects.

Finally, distributed energy resources can provide a number of reliability and resilience benefits to communities. DERs, such as solar panels and small-scale wind turbines, can reduce the reliance on the centralized power grid, lower the risk of power outages caused by grid failures or natural disasters, and improve system reliability and resilience. DERs can also provide local power generation, which can help to ensure a more reliable and resilient power supply. For instance, a community with its own solar panels can continue to generate power during a blackout, providing a local source of energy.

DERs also improve energy efficiency, reducing the overall demand for power and making the grid more resilient. For example, a building equipped with solar panels and battery storage can generate and store its own power, reducing the overall demand on the grid. Additionally, DERs can help to enhance grid stability by providing a more diverse mix of power sources, preventing power disruptions caused by sudden changes in demand or supply.

DERs can speed up the recovery process after a power outage or natural disaster as well. For example, a microgrid equipped with DERs can quickly restore power to critical facilities, such as hospitals and emergency services.

All of these examples relate to any DER adopter, but in this context, are intended to illustrate that the benefits of DER can be used to directly address individuals or vulnerable customer segments in a granular and targeted fashion.

Q. Are there particular benefits of DERs to disadvantaged communities?

A. Yes. Disadvantaged communities can particularly benefit from DERs. DERs can help to reduce energy costs and provide a more affordable and reliable source of power. Disadvantaged communities are often more vulnerable to power outages caused by natural disasters or other disruptions, and DERs can provide a more resilient source of power, helping to ensure that critical services and facilities, such as hospitals and emergency services, remain operational during outages.

The deployment of DERs can also create local jobs in disadvantaged communities, providing employment opportunities and economic benefits. DERs can help to reduce greenhouse gas emissions and improve air quality, providing important health and environmental benefits for disadvantaged communities, which are often disproportionately affected by pollution and other environmental hazards. DERs can provide a sense of community empowerment by giving residents greater control over their energy supply. This can help to build community resilience and promote social and economic equity.

CEO Witness James Gignac provides an example of a recent report by Soulardarity and the Union of Concerned Scientists that describes the benefits that can be realized through the adoption of multiple clean energy strategies and DER deployment in Highland Park, Michigan.

3. Distributed Generation in DTE's Plan

Q: What types of solar generation did the Company consider in its planning process?

A: The Company included two different types of solar in its modeling: distribution-connected solar and transmission-connected solar. The Company's "distribution-connected" resource recognizes the different cost and performance characteristics of solar connected to the distribution grid. In addition, as will be discussed below, the Company considered, but did not model, distributed generation as a resource.

Q: How did the Company estimate distributed generation adoption in its load forecast?

A: The Company hired ICF to do a DG adoption model that was then incorporated into the load forecast prepared by the Company to create a net load forecast that was subsequently used in EnCompass. In the Reference case, DTE Witness Markus Leuker presented the base case DG adoption rate in Table 2b of their testimony, recreated here:

Table 1: Distributed Generation Outlook (Cumulative capacity in MW)

	2021	2025	2030	2035	2040
Residential Installed Capacity	35	64	119	195	266
C&I Installed Capacity	25	41	73	112	147
Total Service Area Installed Capacity	60	106	192	307	413

Q: Is the Company's DG forecast consistent with the current Distributed Generation caps?

A: No. In response to a discovery request by the Michigan Energy Innovation Business Council, Institute for Energy Innovation, Advanced Energy Economy, and Clean Grid Alliance, MIACDE-4.1a (attached as Exhibit CEO-4), the Company indicated that it is actually very near the cap for Category 1 (if it has not already exceeded it by the time this testimony is submitted). According to the discovery response (attached as Exhibit CEO-4), as of January 31, 2023, the Company had the following distributed generation penetration:

Table 2: Current Distributed Generation Penetration as of January 31, 2023

	Current Penetration	Current Cap (kW)
Category 1	51,477	54,599
Category 2	9,370	27,300
Category 3	0	27,300

There is an obvious inconsistency between the current "cap" on DG participating in the DG program and the levels of DG implicit in the load forecast used by DTE in the EnCompass model. This inconsistency highlights the gap between the DG cap penetration levels (set in under a previous DG compensation regime prior to the 2016 energy laws and the Commission's adoption of the DG Tariff) and the optimal levels of DG adoption, which are discussed below.

Q: What do you recommend with regard to the DG Cap?

A: The Company has the ability to unilaterally expand participation in the distributed generation program. As I have previously recommended in a number of cases involving DTE, and as the Commission has found, the current DG program resolves concerns related to alleged adverse cost shifting to non-participating customers. In fact, as I have explained in previous testimony in other cases, the current program under-compensates distributed generation for the value that it can provide to the grid. As such, in order to achieve the goals of the program explained here, the Company should voluntarily remove the caps on participation in the DG Program. At a minimum, it should adjust the allowed participation level (the "cap") to be consistent with the projected adoption forecast as a result of adopting the DG as a Resource program detailed below.

Q: Did the Company consider distributed generation as a supply-side resource in its preferred course of action in this IRP?

A: DTE Witness Manning explains that the Company did model customer-owned residential and commercial distributed solar:

> Additionally, the IRP team modeled customer-owned residential and commercial distributed solar and batteries as supply side resources and offered these resources to the model as capacity expansion resource alternatives. The cost and operating characteristics of these resources came from NREL Annual Technology Baseline as discussed by Witness Cejas Goyanes in his testimony.[18]

Q: What costs did the Company model for distribution-connected solar resources?

A: The Company modeled distribution connected solar resources as a supply-side resource at the full capital expenditure cost ("capex"). Appendix B to DTE's Plan, *Master Technology*

[18] Manning Direct, page SDM-26.

Inputs, shows the Capital Costs for DG Solar Commercial ($1,471.47) and DG Solar Residential ($2,198.32).[19]

Q: Why is the Company's methodology flawed?

A: The Company modeled distributed generation assuming that 100% of the cost of the resources would be incurred as capital costs, as if the utility were purchasing the systems installed on customer sites. In fact, customers, not the Company, bear the full cost of the investment in distributed generation on their premises.

Q: Did the Company perform analysis to determine the impact of higher adoption of distributed generation than was included in their forecast?

A: Yes. The Company performed two sensitivities that assumed increased adoption which adjusted the load forecast (which required EnCompass to solve for a lower energy and capacity need).

- **Aggressive DG**: This sensitivity: The aggressive customer owned DG sensitivity begins with the Reference DG adoption case provided by ICF but assumed capital costs for BTMG would align with NREL's 2021 Annual Technology Baseline aggressive scenario, thus resulting in higher adoption rates.[20]
- **Stakeholder High Distributed Generation Portfolio**: This sensitivity – developed with stakeholder input – is intended to "assess the impacts of both aggressive DG adoption and increased penetration of EVs. The

[19] Exhibit A-3.2, Page 4 of 73, Witness S.D. Manning.
[20] Leuker Direct, page MBL-43.

Stakeholder scenario was used as the basis for this sensitivity and included 25% annual growth of DG from 2023-2030 and 15% annual growth from 2031-2042."[21]

Q: Did the Company's high DG sensitivities show that increasing adoption of Distributed Generation would save customers money?

A: Yes. The NPV of revenue requirement for Aggressive DG Load Forecast sensitivity was $20 million less than the Reference Base case.[22] Likewise, the Stakeholder 25% DG sensitivity was $149 million less than the Stakeholder Base case.[23] DTE Witness Shayla D. Manning correctly summarizes the impact of these sensitivities:

> The model does not select DG in the optimization, unlike utility scale solar and utility scale storage. However, when there is an assumed increase in the adoption of DG in the load forecast, there is an apparent benefit. The higher levels of DG indirectly reduce the energy and capacity demands of customers, which in turn displaces the utility-scale solar build.[24]

These two sensitivities clearly demonstrate the value of distributed generation on the system for all customers.

4. DG as a Resource (DGR) Concept

Q: Please expand on your discussion of the conventional approach to modeling distributed generation in resource planning.

A: The conventional utility planning approach for DERs (to the extent they account for DERs at all) is to treat them as an exogenous variable to their capacity expansion modeling. Like

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[21] Leuker Direct, page MBL-44.

[22] Manning Workpaper "WP SDM 151 - REF_Other Sensitivity Analysis Results.xlsx"

[23] Manning Workpaper "WP SDM 157- STAKE_ Sensitivity Analysis Results.xlsx". Case Name: STAKE_25%_DG compared to STAKE_BASE.

[24] Direct Testimony of Shayla D. Manning, *In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief, Case No. U-21193*, November 3, 2022. Page SDM-59.

weather, or the economy, DER growth is something that "happens to" the utility and needs to be planned around, rather than something that the utility can affect through its own actions and can utilize to meet its customers' requirements. In fact, DERs have unique characteristics, as identified above, which could increase the diversity of the Company's supply portfolio. The conventional approach typically forecasts energy efficiency and distributed solar adoption and then subtracts them from the utility's gross load forecast to establish a net load forecast. The net load forecast is then used, either as the base case or a sensitivity, to model system capacity expansion through supply-side resources offered to the model, subject to user-defined constraints.

5. DGR Model Specification

Q: Please describe the methodology you propose to evaluate Distributed Generation as a Resource in the EnCompass model.

A: I propose a Distributed Generation as a Resource ("DGR") model that has been modeled in testimony submitted by CEO Witness Chelsea Hotaling. The DGR model applies the National Renewable Energy Laboratory's Distributed Generation Market Demand ("dGen") model to estimate the incremental increased demand that would be expected if an incentive of $500/kilowatt were offered for new distributed generation. The application of the dGen model to estimate increased adoption based on the assumed incentive was done by CEO Witness Boratha Tan. Witness Tan provides details of the dGen model in his testimony.

Q: Why did the CEO select the $500/kilowatt value?

A: The $500/kW value was selected to test the hypothesis that spurring the adoption of incremental distributed generation at the utility's cost to incentivize such incremental adoption lowers the net present value of revenue requirements (NPVRR) thus providing benefits to all customers

Q: How do the CEO propose the incentive is paid?

A: The CEO have not proposed a specific program to implement this incentive should the DGR model be adopted by DTE and the Commission. There are a number of incentive models that could be adopted, such as establishing a customer rebate for smart inverters (see, e.g., the Illinois Distributed Generation Rebate) that could be treated as a regulatory asset for the Company.

Q: How does the inclusion of a $500/kilowatt incentive in the CEO's Alternative Plan comport with the statutory requirements of an IRP?

A: MCL 460.6t requires the Commission to approve the "most reasonable and prudent" plan to meet the Company's energy and capacity needs through the plan horizon. As even DTE's own higher penetration DG sensitivities demonstrate, distributed generation lowers system costs in addition to providing benefits to individual customers. DG is a critical part of a reasonable and prudent IRP. Wider adoption of distributed generation also helps achieve two specific IRP statutory factors, diversity of supply and reliability. Increased DG helps diversify the Company's generation portfolio because it is distinct from utility, transmission-connected renewables. DG also helps shore up grid-wide reliability, because it is connected directly to the distribution grid, closer to load.

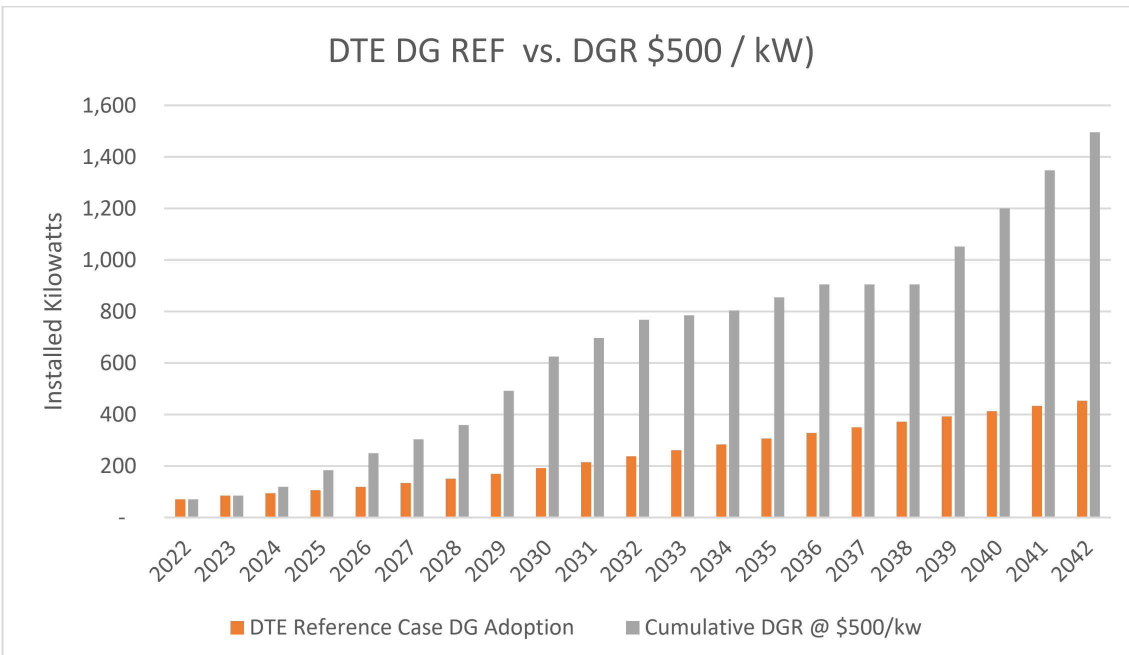
Q: Does the DGR model assume that all adopters of distributed generation will be paid the same incentive?

A: Yes. Similar to the way that energy waste reduction is modeled, because it would be impossible to discriminate between customers that would have adopted new DG in the absence of the incentive, it is assumed that all customers would receive the incentive.

6. DGR Results

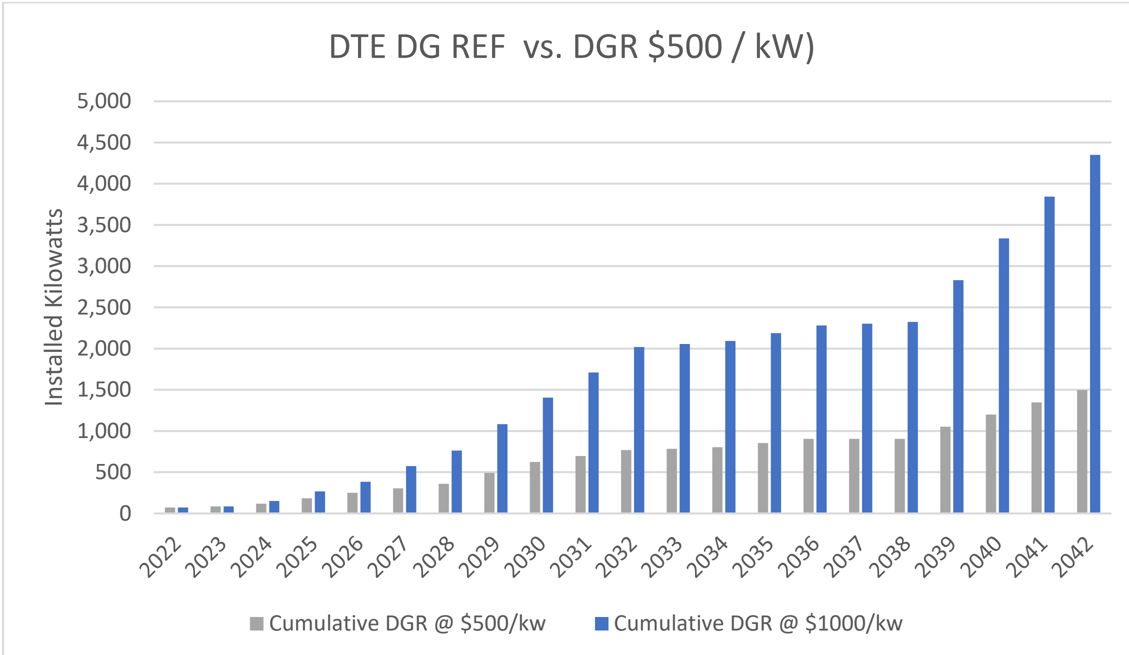
Q: How much additional distributed generation would be adopted with an incentive of $500/kW?

A: As explained by CEO Witness Boratha Tan, the results of the dGen model show a significant increase in the adoption of distributed generation compared to DTE's forecast.



Q: Did the CEO model any other incentive values for distributed generation?

A: Yes. In order to better understand the dynamic nature of the model, Mr. Tan also tested an incentive at $1,000/kW. The following chart shows the increase adoption that would be expected to result from a $1,000/kW incentive:



Q: Why wasn't $1,000/kW selected?

A: The $1,000/kW incentive was not selected by the EnCompass model as the lowest cost resource available. Since the goal was to provide a resource that is beneficial to all customers, we did not pursue the $1,000/kW resource. However, I would note that there are values of distributed generation not reflected in the resource model that could contribute to increasing the overall value of the incremental distributed generation, such as avoided transmission and distribution costs as well as grid services that advanced DER can provide.

Q: Please describe the results of offering the DGR model to EnCompass.

A: To summarize the results of the modeling by CEO Witness Chelsea Hotaling, preliminary modeling runs indicated that the model was optimally selecting some of the DG solar that was offered as a selectable resource. Upon further testing with the full set of DG solar resources included in the model as a fixed decision, the resulting PVRRs of the plans were comparable. Since the costs were comparable and given the additional benefits of DG solar that are difficult to capture in a capacity expansion model, we decided to include the DG solar resource as a fixed decision in the CEO Alternative Plan. Put simply, the initial selection of DG solar in the preliminary of the CEO Alternative Plan runs suggests that incentivizing additional customers to adopt distributed generation lowers total system cost and saves all customers money.

Q: What do you recommend based on the results of the DGR model?

A: In light of the findings of this modeling exercise, there are sufficient grounds for the Commission to direct DTE to modify its IRP to adopt the DG as a Resource model and to test the DG adoption at the $500/kW incentive rate in order to benefit all customers.

G. Accelerate Renewables

Q: How much more new wind, solar, and energy storage is selected in the CEO's Alternative Plan?

A: The CEO Alternative Plan adds 1,307 MW more solar, 115 MW more wind, and 827 MW more energy storage to Michigan's energy grid by 2030 than DTE's preferred plan. The table below summarizes the renewables building of the CEO Alternative Plan compared to DTEs PCA through 2030:

Table 3: Comparison of CEO Alternative Plan and DTE Revised Plan through 2030 (as re-optimized using CEO assumptions)

	CEO Alternative Plan (Megawatts)	**DTE Revised Plan (Megawatts)**
Capacity Additions through 2030		
Utility Scale Solar	2,000	1,700
Solar Hybrid	800	300
DG Solar (DTE from Load Forecast)	540	192
Low Income Community Solar	159	0
Subtotal, Solar	3,499	2,192
Storage (Battery/Hybrid/Ancillary)	1,884	1,056
Wind	3,000	2,885

Energy Waste Reduction	1,048	810

The next table summarizes the renewables buildout of the CEO Alternative Plan compared to the DTE Revised PCA through 2042:

Table 4: Comparison of CEO Alternative Plan and DTE Revised Plan through 2042 (as re-optimized using CEO assumptions)

Capacity Expansions through 2042	**CEO Alternative Plan (Megawatts)**	**DTE Revised Plan (Megawatts)**
Utility Scale Solar	4,542	5,238
Solar Hybrid	2,400	2,300
DG Solar	1,411	453
Low Income Community Solar	539	
Subtotal, Solar	8,353	7,991
Storage (Battery/Hybrid/Ancillary)	5,761	4,563
Wind	4,808	4,886
Energy Waste Reduction	1,576	1,441

Q: Why do the CEO propose a significant acceleration of renewables, above and beyond the Company's PCA?

A: As discussed, the CEO goal is to explore whether an alternative plan to the Company's PCA could improve equity and economic outcomes for the Company and its customers. CEO Witness Hoteling tested a portfolio that better aligned with the public health, environmental justice, and economic values discussed above. Witness Hotaling found that the CEO Alternative Plan selected a mix of renewables and energy storage when allowed to optimize to solve the energy and capacity needs created by the retirement of polluting, uneconomic assets.

Q: What changes to the EnCompass model led to the selection of additional clean energy resources?

A: As detailed by Witness Hotaling, the CEO made several adjustments to DTE's assumptions that resulted in EnCompass selecting considerably more solar, wind, and storage than appears in the DTE PCA. The main drivers of the accelerated clean energy adoption were:

- Relaxed constraints to solar and wind buildout. DTE constrained EnCompass to select no more than 200 MW per of wind (beginning in 2028) up to 1, 000 MW total and 400 MW of solar per year through 2028 and then increased to 800 MW per year between 2029 and 2034.
- Accelerated retirement of Monroe Units 1 and 2. As discussed above, accelerating the retirement of Monroe Units 1 and 2 creates an energy and capacity needs for which EnCompass in optimization mode selects a combination of solar, wind, and energy storage.

Q: How does DTE justify the limits imposed on new wind and solar?

A: DTE claims the new wind, in particular, is difficult to site in Michigan.[25]

Q: Do you agree?

[25] Direct Testimony of Vielka M. Hernandez, *In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief, Case No. U-21193*, November 3, 2022. Page VMH-23.

A: Yes. That is manifestly true. However, it is important to understand the opportunity cost that such limits impose on ratepayers and the Company. By not taking advantage of attractive resources, the Company and ratepayers are foregoing economic and public health benefits. The CEO findings reflect the urgency of addressing siting reform, and we stand ready to work with the Company, the Commission, and others to address the issue.[26]

Part of the role of IRP is to demonstrate the most reasonable and prudent way to meet demand—if the IRP selects more wind, it is up to policymakers to find ways to solve the issues that make wind more difficult. The value of long term planning is that we now have several years to enact those changes. We must not shy away from an optimal plan because of artificial barriers which can be addressed through collective effort. And the Commission should insist on understanding the optimal plan mindful of the opportunities and benefits available as well as the addressable challenges that are barriers to realizing an optimized plan.

Q: Should the Company accelerate the buildout of renewables in anticipation of future capacity needs?

A: Because of the savings in energy costs available from renewables, the CEO recommend that DTE accelerate the buildout of renewables in anticipation of a capacity need rather than waiting for an urgent need to manifest that may not provide sufficient time for the development of renewables. CEO Witness Kevin Lucas explains why an accelerated renewables buildout is a "no regrets" policy that will situate the Company to replace

[26] The current perceived constraints on siting renewables, whether we are able to resolve them together or not, also highlights the importance of accelerating adoption of distributed generation, which does not generally suffer from the same limitations.

dispatchable fossil with a clean energy portfolio that provides equal or greater reliability on the schedule proposed in the CEO Alternative Plan.

Q: Does DTE's PCA adequately anticipate capacity needs?

A: DTE's approach to meeting capacity needs in the PCA is to build assets when needed in anticipation of capacity needs created by retiring assets. However, as discussed by CEO Witness Kevin Lucas, by proposing relatively near-term retirements or alterations in this plan, the Company has foreclosed consideration of alternative capacity solutions that may have been more beneficial had they been implemented previously. For example, by proposing to repower the Belle River units with natural gas in 2025 and 2026, the potential capacity solution set is limited because of the infeasibility of replacing the capacity being removed from service by a clean energy portfolio within the next two or three years. DTE's proposed solution (repowering with gas) thus becomes the only reasonably feasible solution within the time frame proposed. Had DTE begun developing or procuring other clean energy portfolio assets as a result of the previous IRP (as recommended by multiple parties), other potentially cleaner and more cost-effective alternatives could be considered.

I urge the Commission not to allow the Company, ratepayers, and stakeholders to be caught in the same trap again. The Commission should therefore direct DTE to instead accelerate clean energy portfolio alternatives, especially where no-regrets projects can be realized that deliver energy savings even when there is no immediate capacity need. This will serve customers in two way—by reducing overall plan costs, and by avoiding the need for a combined cycle gas plant in 2035.

H. Programs to Advance Energy Equity and Improve Public Health and Safety

1. Overview of Energy Equity Package

Q: What additional programs to address energy equity and environmental justice did the CEO model in developing its Alternative Plan?

A: The CEO worked closely with the Detroit Area Advocacy Organizations to develop two programs, referred to as the Energy Equity package, that would advance energy equity interests for vulnerable customers while providing valuable resources to meet the Company's energy and capacity requirements:

- Energy storage for customers with life-critical medical devices.
- Low Income Community Solar (LICS) for renters.

A number of witnesses will provide support for the design and modeling of these two proposals:

- CEO Witness James Gignac will explain the origin and policy basis for the Energy Equity Package, as well as the coordination with DAAO in developing the models.
- CEO Witness Boratha Tan provides support for the assumptions underlying the models.
- CEO Witness Chelsea Hotaling explains how the modeled Energy Equity package was offered to EnCompass and the economic impact it had.
- In addition, DAAO Witness Jackson Koeppel discusses the need for and basis of the proposed programs. Mr. Koeppel will also elaborate on the collaboration that lead to this joint proposal

The CEO endorse the Energy Equity Package jointly developed with DAAO. As described by CEO and DAAO witnesses, the programs are designed to provide a significant beneficial impact to the vulnerable populations they serve while reducing the net cost to customers by contributing to the resource value of the DTE's overall portfolio. For example, the battery storage for customers with life critical medical devices is designed to provide some energy and capacity value of the energy storage devices installed on these customers' premises to reduce the cost compared to directly purchasing the devices.

2. Modeling of Low Income Community Solar

Q: How did the CEO model the Low-Income Community Solar part of the Energy Equity Package?

A: The first step was to determine the size of the program needed to meet the policy goals identified in collaboration with DAAO. CEO Witness Boratha Tan explains the estimate of the number of low-income renters in DTE's service territory and estimates the size of program subscription that would be necessary to achieve the desired policy objective of alleviating the excess energy burden (above 6%) for that subset of customers. The second step in specifying the LICS for renters resource was to model a resource representative of the cost of representative projects that are envisioned for this program. We envision projects with the following characteristics:

- Third party owned,
- Distribution connected,
- 5 megawatts or less (to qualify for the IRA programs listed below)

- Eligible for and able to take advantage of the following Investment Recovery Act[27] incentives to total a 50% ITC:
    - Base Investment Tax Credit (30%)
    - Energy Community bonus tax credit (10%)[28]
    - Low-Income Community bonus tax credit (10%)[29]
- Capex estimated using the NREL Annual Technology Baseline for distributed commercial solar.[30]
- To maintain consistency, the CEO modeled the same capacity factor as the Company.

CEO Witness Hotaling included the modeled LICS resource as part of the Energy Equity Package.

3. Energy Storage for Medically Vulnerable Customers

Q: Why is the energy storage for medically vulnerable customers part of the Energy Equity Package?

A: As discussed in more detail by CEO Witness Gignac and DAAO Witness Koeppel, low-income customers suffer from poor reliability. These customers face more frequent and more prolonged outages. The CEO and DAAO chose to scope this program to meet the needs of Medicaid customers with essential medical devices. The program serves the dual

[27] Inflation Reduction Act of 2022, Pub. L. No. 117-99, 136 Stat. 1234 (2022).

[28] 26 U.S. Code § 48E

[29] 26 U.S. Code § 48(e) and 26 U.S. Code § 48E(h).

[30] National Renewable Energy Laboratory. (2021). 2021 Annual Technology Baseline (ATB) Cost and Performance Data for Electricity Generation Technologies [Data set]. U.S. Department of Energy. https://doi.org/10.7799/1599440

purpose of providing a clean energy resilience backup for those devices, as well as serving a grid service in these areas plagued by poor reliability.

Q: What are the characteristics of the Energy Storage Program?

A: The Energy Storage for medically vulnerable customers program is intended to provide a 20 kWh energy storage device to all customers who depend on electric service to power life-critical medical devices. CEO Witness Boratha Tan discusses the rationale behind the size of the device and the number estimated eligible customers. The details of the program would have to be determined but in general, it would reimburse eligible customer (possible through a rebate that could be recorded as a regulatory asset) for the full value of an energy storage device to be installed at the customers premise that would be able to operate life-critical devices for some period of time, as described by Witness Tan.

I. Early Retirement of Peaker Plants in Environmental Justice Communities

Q: Why are peaker plants in EJ communities a part of the CEO case?

A: There at least three reasons the CEO addressed the Company's peaker fleet. First, DTE's peaker fleet contains a number of facilities in some of the most vulnerable communities in the Company's service territory. CEO Witness Dr. Kelsey Bilsback explains her findings that River Rouge Power, Delray, Northeast, and Superior peakers are all located in environmental justice communities as defined by at least one indicator in the Department of Environment, Great Lakes and Energy's MIEJScreen Draft map.[31] Second, DTE's peakers have low capacity factors and a history of poor performance when called upon (See

[31] Office of Environmental Justice Public Advocate. https://www.arcgis.com/apps/webappviewer/index.html?id=0c6f9a4d8b7c4b5f9d1a0f6c8a2b3c7e. Accessed 9 Mar. 2023.

CEO Witness Kevin Lucas's testimony in the 2019 IRP, discussed below). Finally, because these facilities operate at very low capacity factors, they can easily be replaced by existing battery storage, which is now eligible for the federal Investment Tax Credit. The example replacement of the Greenwood peaker 12 on an economic basis is discussed by CEO Witness Hotaling.

Q: What do you propose with respect to the accelerated retirement of peaker plants in environmental justice communities?

A: To illustrate the public health and economic benefits of replacing inefficient peakers with energy storage, the CEO modeled retiring the Greenwood peaker 12 and replacing them with battery storage as soon as feasible. This analysis follows on analysis provided in the last DTE IRP by CEO Witness Kevin Lucas. Mr. Lucas analyzed the DTE peaker fleet as part of his testimony in the 2019 DTE IRP and found that it generally suffers from poor reliability and economics.[32] Witness Lucas found in 2019 that DTE's fleet of peakers was already aging and in need of scrutiny:

> DTE should have taken a closer look at its peaker fleet in this IRP. Its filing contains zero analysis on the fleet and assumes that all units – even those that are already among the oldest in the nation of their type – will continue to operate for another 20 years. Further, its failure to track fixed and variable costs limits the ability to perform robust financial analyses on the units to determine whether they remain economic to operate.[33]

Partially, as a result of that analysis, the Commission directed DTE to conduct a retirement analysis. DTE Witness Morren explains the retirement analysis that the

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[32] Direct Testimony of Kevin Lucas on behalf of the Environmental Law & Policy Center, the Ecology Center, the Solar Energy Industries Association, the Union of Concerned Scientists, and Vote Solar, *In the matter of the application of DTE Electric Company for approval of its integrated resource plan pursuant to MCL 460.6t, and for other relief.* U-20471, August 21, 2019, pages 70-121.

[33] *Ibid*, Lucas Direct, 2019, pg. 70.

Company undertook. The Company proposes to retire several units, including those included in the retirement analysis. However, the Company chose not to conduct the entire analysis directed by the Commission:

> The Company's large gas turbine peakers are newer, have lower energy and fuel costs, and are expected to continue to run through the study period. For these reasons, they were not included in this analysis.[34]

This is tautological: the Company chose not to do a retirement analysis partly because they expect the large, gas units to run through the study period.

An additional reason to recommend retirement of the Greenwood peakers and the further evaluation of the opportunity to consider retirement and replacement of additional units, especially in environmental justice communities, is the opportunity to improve public health and environmental justice outcomes. There are significant public health and environmental justice benefits of retiring those units and replacing them with energy storage to serve the 483 of hours per year on average that they operate without compromising reliability or resource adequacy.[35] In addition, because of the operational flexibility of energy storage, the operational value of the site is increased.

IV. Regulatory Asset Treatment for the retiring Monroe Units and the Coal Handling Equipment at Belle River.

Q: What does the Company propose with regard to recovery of the remaining net book value of the retired of the Monroe units and the Belle River coal handing equipment that will no longer be used when the units are repowered to gas?

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[34] Direct Testimony of Justin L. Morren, In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief, Case No. U-21193, November 3, 2022. Pg. JLM-31

[35] Exhibit CEO-5 - U-21193 MNSCDE-2.11d 2017-2021 Capacity Factor

A: The Company proposes to recover the remaining net book value ("NBV") and decommissioning costs of the retired Monroe units and the Belle River coal handing equipment that will no longer be used when the units are repowered to gas through a regulatory asset. DTE Witness Timothy J. Lepczyk proposes to recover the costs by classifying them as regulatory assets and then recovering those assets through amortization in base rates.[36]

The Company argues that the full recovery at the Company's approved return on equity (ROE) is justified since the assets are currently used and useful:

> The PCA calls for the cessation of coal (and the subsequent 1 conversion to a natural gas peaking resource at the Belle River Power Plant in 2025 and 2026. In addition, it proposes the early retirement of the Monroe Power Plant, with units 3 and 4 retiring in 2028 before units 1 and 2 are retired in 2035. This acceleration, if approved as part of the PCA, would result in unrecovered NBV at time of retirement because the depreciation schedules reflected in existing rates have been based on the previously determined remaining useful lives for these facilities (i.e., 2041 through 2044 for Monroe Power Plant and 2030 for Belle River Power Plant). The NBV amounts included in rate base derive from reasonable and prudent investments to maintain the facilities properly and have been reviewed and approved in rate cases. Absent regulatory action, the remaining NBV at the time of the plant retirements would be considered unrecovered. Without resolution of this issue and an appropriate recovery mechanism, the Company would not be able to implement the PCA and proceed with the early retirements given the significant financial consequences.[37]

Q: What is the amount that the Company proposes to include in the regulatory asset?

A: At the end of 2024, the remaining NBV associated with coal-fired assets proposed for retirement is estimated at \$3.3 billion (\$3.1 billion associated with total plant at Monroe Power Plant; \$0.2 billion at Belle River for coal-handling assets; see Exhibit A-15.1).

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[36] Direct Testimony of Timothy J. Lepczyk, *In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief,* Case No. U-21193, November 3, 2022. Page TJL-4.

[37] Lepczyk Direct, page TJL-12.

Furthermore, as described by Witness Morren and shown in Exhibit 6.1, the Company anticipates an incremental $0.7 billion of maintenance capital will be required to support ongoing operations at the Monroe Power Plant during 2025 through its planned retirement in 2035.

Q: Did the Company consider securitization?

A: Yes, but it dismissed securitization for policy reasons related to the impact on the Company's balance sheet and did not conduct an analysis of benefits it could provide to ratepayers.

Witness Lepczyk explains that the Company considered three alternative ways to recover the NBV: (1) regulatory asset treatment, (2) securitization, and (3) accelerated depreciation.

Q: Did the Company consider just writing off the NBV?

A: No.

Q: What should the Commission order with respect to the recovery of the unrecovered book value of retired fossil assets?

A: The Commission should consider some combination of requiring the write off of imprudently incurred, uneconomic assets and securitization of uneconomic but prudently incurred capital costs.

The Company's ROE reflects risk. But if they never have to bear the cost of uneconomic assets, they have no incentive not to make decisions that create future stranded assets.

Q: Why securitization as opposed to regulatory asset?

A: Creating a regulatory asset to recover the remaining book value of a retiring fossil fuel power plant is one option that utilities can consider. However, securitization may be a more attractive option for two reasons.

First, securitization can provide more certainty around the recovery of costs for both the utility and ratepayers. By securitizing the remaining debt on the retiring power plant, the utility can lock in a lower interest rate and reduce the overall cost of the debt. This can provide more predictability around the utility's financial position and help to stabilize rates for ratepayers.

Second, securitization can provide a more equitable solution for ratepayers. By securitizing the debt, the cost of retiring the power plant can be spread out over a longer period of time, reducing the immediate impact on ratepayers. This can help to avoid large rate increases in the short-term and provide a more gradual transition to cleaner energy sources.

In summary, while creating a regulatory asset to recover the remaining book value of a retiring power plant is one option, securitization may offer a more streamlined, predictable, and equitable solution for both the utility and ratepayers. It was unreasonable for the Company to eliminate securitization as an option prior to analyzing the relative benefit it could provide ratepayers.

Q: What does the Company say about the impact that securitization would have on its balance sheet?

A: Witness Lepcyzk conducted an analysis of the impact of securitization of the Monroe and Belle River assets which suggests that it would increase long-term debt from $8,442,000,000 (before the $230 million River Rouge/Tree trim securitization) to

$9,895,000,000 and would shift the Debt/Equity percentage ratio from a 50:50 to 58.6: 41.4 debt to equity ratio.

Q: What do you recommend?

A: I recommend the Commission reject the regulatory asset treatment and direct the Company to securitize the NBV of the assets upon retirement. In any event, there does not seem to be a rationale for converting the assets to regulatory assets prior to their retirement, so the decision should at least be deferred until the retirement dates for the plants.

V. <u>Conclusion and Recommendations</u>

Q: Please summarize your recommendations.

A: Recommendations

- Adopt CEO Alternative Plan with
  - Accelerated retirement of Monroe Units 1 and 2
  - Distributed Generation as a Resource model
  - Accelerated Clean Energy Build Plan
  - Early retirements of Greenwood peaker 12 and replacement with energy storage.
  - Adoption of the Energy Equity Package
- Reject proposal for regulatory asset treatment prior to actual retirement.
- Require the Company to securitize the NBV of coal assets when they are retired.

Q: Does this conclude your testimony?

A: Yes

William D. Kenworthy

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Summary:

Energy industry advocate and executive with deep knowledge and experience in electric industry structure, energy economics and energy policy. Specific experience in renewable energy project development, energy optimization, machine learning for process optimization, financial analysis of distributed generation, economics and energy policy.

Experience

Vote Solar

Regulatory Director, Midwest | July 2018 - Present

Manage regulatory policy development and implementation related to large scale and distributed solar generation in the Midwest. Advocate for policies to ensure equitable and fair access to solar. Review regulatory filings, perform technical analyses, and testify in commission proceedings on issues relating to solar generation.

Microgrid Energy

Managing Director, Midwest | October 2017-June 2018 and October 2014-April 2016

Managed operations of Chicago office for solar energy project development and EPC (engineering, procurement, and construction) company. Coordinated business development, market development, state and local policy efforts. Leveraged industry experience, strategic industry insight and market knowledge to enter new markets.
October 2017-June 2018 and October 2014-April 2016

Infer Energy / Root3 Technologies

President | April 2016 – October 2017

Primary responsibility for marketing & business development for startup technology firm focused on providing energy optimization services to large industrial energy users. Successfully expanded business to the point at which was folded into the customer equipment health and maintenance offering of a large on-site energy generation provider.

Tipping Point Renewable Energy

Executive Vice President, Marketing & Business Development | January 2010 – April 2016

Led sales, marketing and business development process for startup solar energy project development and installation company

Governmental Strategies Incorporated

Vice President / Partner | October 1996 – December 2007

Senior partner in governmental affairs consulting practice. Developed and implemented strategic plans and marketing campaigns to affect public policy on behalf of Fortune 100 electric utility companies.

Nuclear Energy Institute

Director, Federal Legislative Affairs | May 1992 – October 1996

Developed and implemented strategic plans affecting public policy related to the ownership and operation of the nation's nuclear power plants and over 200 companies involved in the industry. Provided technical assistance to legislators and their staffs in the development of energy policy, including facilitating cross-functional communications between technical personnel and legislative staff.

House Energy & Commerce Committee, U. S. House of Representatives
Professional Staff Member
May 1987 - August 1990
Represented Chairman John D. Dingell (D-MI) and Members of the Committee in dealings with other Members of Congress, the Executive Branch, private interests, and public organizations on energy & environmental policy. Professional staff team during the negotiation and drafting of the Clean Air Act Amendments of 1990.

Education

Yale University, School of Management
MBA / MPPM, Regulation and Competitive Strategies | May 1992

Georgetown University
BSFS, International Politics | May 1987

Community and Volunteer Activities

Jackalope Theater Company

Erie Family Health Foundation
Board Member, 2018 - 2021

Jefferson Avenue Center
President, Board of Trustees & Member | May 2012 – Present

Georgetown University
Alumni Interviewer | June 2014 – Present

Columbus Academy
Member of Board of Trustees and Parent's Association President | June 2013 - December 2013

City of Upper Arlington Cultural Arts Commission
Commissioner and Chairman June 2012 – December 2013

CareRing of Charlotte
Member, Board of Trustees April 2004 - May 2008

Boy Scouts of America,
Assistant Scoutmaster, Cubmaster, Den Leader | September 2002 – September 2014

Skills / Software

Energy Modeling: NREL System Advisor Model (SAM), Encompass
Productivity: Microsoft Office Suite
Business Intelligence / Data Visualization: Tableau, Tableau Prep, Python, NumPy
Adobe Creative Suite

Testimony and Comments of William D. Kenworthy

Regulatory Director, Midwest
Vote Solar
March 9, 2023

Testimony

Surrebuttal, Testimony of William D. Kenworthy on behalf of Vote Solar, *Verified Petition of Vote Solar of Distributed Energy Resource Systems in Wisconsin*, Wisconsin Public Service Commission, Docket No. 9300-DR-106, October 21, 2022

Direct Testimony of William D. Kenworthy on behalf Vote Solar, *Verified Petition of Vote Solar of Distributed Energy Resource Systems in Wisconsin*, Wisconsin Public Service Commission, Docket No. 9300-DR-106, September 16, 2022.

Direct Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar, *In the matter of the application of Consumers Energy Company for authority to increase its rates for the generation and distribution of electricity and for other relief.*, Michigan Public Service Commission, Case No. U-21224, August 24, 2022.

Rebuttal Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center and Vote Solar, *Petition of for Approval of Performance and Tracking Metrics pursuant to 220 ILCS 5/16-108.18(e): Ameren Illinois Company d/b/a Ameren Illinois*. Illinois Commerce Commission, Case No. 22-0063, June 6, 2022.

Direct Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar, *In the matter of the application of DTE ELECTRIC COMPANY for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority*, Michigan Public Service Commission, Case No. U-20836, May 19, 2022.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center and Vote Solar, *Petition of for Approval of Performance and Tracking Metrics pursuant to 220 ILCS 5/16-108.18(e): Commonwealth Edison Company*. Illinois Commerce Commission, Case No. 22-0067, April 6, 2022.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center and Vote Solar, *Petition of for Approval of Performance and Tracking Metrics pursuant to 220 ILCS 5/16-108.18(e): Ameren Illinois Company d/b/a Ameren Illinois*. Illinois Commerce Commission, Case No. 22-0063, March 30, 2022.

Direct Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar, *In the matter, of the application of CONSUMERS ENERGY COMPANY For approval of Voluntary Green Pricing programs pursuant to Section 61 of 2016 PA 342.*, Michigan Public Service Commission, Case No. U-21134, March 17, 2022.

Direct Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar, *In the matter of the application of Consumers Energy Company for Approval of an Integrated Resource Plan under MCL 460.6t, certain accounting* *approvals, and for other relief.*, Michigan Public Service Commission, Case No. U-21090, October 28, 2021.

Direct Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar, *In the matter of the application of Consumers Energy Company for authority to increase its rates for the generation and distribution of electricity and for other relief*, Michigan Public Service Commission, Case No. U-20963, June 22, 2021.

Rebuttal Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar *In the matter, on the Commission's own motion, regarding the regulatory reviews, revisions, determinations and/or approvals necessary for DTE ELECTRIC COMPANY to comply with Section 61 of 2016 PA 342*, Michigan Public Service Commission, Case No. U-20713, and *In the matter of DTE ELECTRIC COMPANY'S application for the regulatory reviews, revisions, determinations, and/or approvals to fully comply with Public Act 295 of 2008*, Michigan Public Service Commission, Case No. U-20851, May 4, 2021.

Direct Testimony of William D. Kenworthy on behalf of the Ecology Center, the Environmental Law & Policy Center, and Vote Solar *In the matter, on the Commission's own motion, regarding the regulatory reviews, revisions, determinations and/or approvals necessary for DTE ELECTRIC COMPANY to comply with Section 61 of 2016 PA 342*, Michigan Public Service Commission, Case No. U-20713, and *In the matter of DTE ELECTRIC COMPANY'S application for the regulatory reviews, revisions, determinations, and/or approvals to fully comply with Public Act 295 of 2008*, Michigan Public Service Commission, Case No. U-20851, December 23, 2020.

Rebuttal Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center, Vote Solar, and the Natural Resources Defense Council, *Investigation under Section 10-101 of the Public Utilities Act to determine whether Rider Net Metering requires amendment to comport with Section 16-107.5 of the Public Utilities Ac*t. Illinois Commerce Commission, Case No. 20-0738, October 26, 2020

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center, Vote Solar, and the Natural Resources Defense Council, *Investigation under Section 10-101 of the Public Utilities Act to determine whether Rider Net Metering requires amendment to comport with Section 16-107.5 of the Public Utilities Ac*t. Illinois Commerce Commission, Case No. 20-0738, October 23, 2020.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center, Vote Solar, and the Natural Resources Defense Council, *Investigation under Section 16-107.6(e) of the Public Utilities Act into an annual process and formula for the calculation of distributed generation rebates,* Illinois Commerce Commission Case No. 20-0389, October 2, 2020.

Direct Testimony of William D. Kenworthy on behalf of the Citizens Action Coalition of Indiana, the Environmental Law & Policy Center, Solar United Neighbors, and Vote Solar on the *Petition of Southern Indiana Gas and Electric Company D/B/A Vectren Energy Delivery of Indiana, Inc. for Approval of a Tariff Rate for the Procurement of Excess Distributed Generation Pursuant to Indiana Code § 8-1.40 Et. Seq.*, Indiana Utility Regulatory Commission, Case No. 45378, August 20, 2020.

Rebuttal Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of the application of CONSUMERS ENERGY COMPANY for approval of Voluntary Green Pricing programs pursuant to Section 61 of 2016 PA 342*, Michigan Public Service Commission, Case No. U-20649, June 25, 2020.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Great Lakes Renewable Energy Association, the Solar Energy Industries Association, and Vote Solar. *In the matter of the application of CONSUMERS ENERGY COMPANY for authority to increase its rates for the generation and distribution of electricity and for other relief*, Michigan Public Service Commission, Case No. U-20697, June 24, 2020.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of the application of CONSUMERS ENERGY COMPANY for approval of Voluntary Green Pricing programs pursuant to Section 61 of 2016 PA 342*, Michigan Public Service Commission, Case No. U-20649, May 28, 2020.

Rebuttal Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center and Vote Solar, *In the matter of Proposed Revisions to Rider Parallel Operation of Retail Customer Generating Facilities Community Supply*, Illinois Commerce Commission, Docket No. 19-1121, April 23, 2020.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law & Policy Center and Vote Solar, *In the matter of Proposed Revisions to Rider Parallel Operation of Retail Customer Generating Facilities Community Supply*, Illinois Commerce Commission, Docket No. 19-1121, February 21, 2020.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of the Application of DTE Electric Company for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority.* Michigan Public Service Commission, Case No. U-20561, November 6, 2019.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of the Application of Indiana Michigan Power Company for authority to increase its rates for the sale of electric energy and for approval of depreciation rates and other related matters,* Michigan Public Service Commission, Case No. U-20359, October 17, 2019.

Rebuttal Testimony of William D. Kenworthy on Behalf of the Environmental Law and Policy Center and Vote Solar*, In the Matter of the Joint Application of Wisconsin Power Company, Wisconsin Gas LLC, and Wisconsin Public Service Corporation to Adjust Electric, Natural Gas and Steam Rates,* Wisconsin Public Service Commission, Docket No. 5-UR-109, October 4, 2019.

Rebuttal Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center and the Iowa Environmental Council*, In re: Interstate Power & Light Compan*y, Iowa Utilities Board, Docket No. RPU-2019-001, September 10, 2019.

Direct Testimony of William D. Kenworthy on Behalf of the Environmental Law and Policy Center and Vote Solar*, In the Matter of the Joint Application of Wisconsin Power Company, Wisconsin Gas LLC, and Wisconsin Public Service Corporation to Adjust Electric, Natural Gas and Steam Rates,* Wisconsin Public Service Commission, Docket No. 5-UR-109, August 23, 2019.

Rebuttal Testimony of Will Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of Application of DTE ELECTRIC COMPANY for approval of its integrated resource plan pursuant to MCL 460.6t and for other relief*, Michigan Public Service Commission, Case No. U-20471, August 21, 2019.

Direct Testimony of William D. Kenworthy on behalf of the Environmental Law and Policy Center and the Iowa Environmental Council, *In re: Interstate Power & Light Company*, Iowa Utilities Board, Docket No. RPU-2019-001, August 1, 2019.

Rebuttal Testimony of Will Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of the Application of DTE Electric Company for authority to increase its rate schedules and rules governing the distribution and supply of electric energy, and for other relief,* Michigan Public Service Commission, Case No. U-20162, November 28, 2018.

Direct Testimony of Will Kenworthy on behalf of the Environmental Law and Policy Center, the Ecology Center, the Solar Energy Industries Association, and Vote Solar, *In the matter of the Application of DTE Electric Company for authority to increase its rate schedules and rules governing the distribution and supply of electric energy, and for other relief,* Michigan Public Service Commission, Case No. U-20162, November 7, 2018.

Comments

Comments of the Environmental Law & Policy Center, and Vote Solar on Locational Reliability/Equity Metric, *In the Matter of a Commission Investigation to Identify and Develop Performance Metrics and, Potentially, Incentives for Xcel Energy's Electric Utility Operations*, Docket No. E002/CI-17-401, and *In the Matter of Xcel Energy's Annual Report on Safety, Reliability, and Service Quality and Petition for Approval of Electric Reliability Standards*, Docket No. E002/M-20-406, January 6, 2023.

Comments of The Ecology Center, Environmental Law & Policy Center, Union Of Concerned Scientists And Vote Solar, *In the matter, on the Commission's own motion, to open a docket for certain regulated electric utilities to file their distribution investment and maintenance plans and for other related, uncontested matters*, Michigan Public Service Commission, Docket No. U-20147, November 1, 2022.

Responses to Objections of the Environmental Law & Policy Center, the Natural Resources Defense Council, and Vote Solar to The Illinois Power Agency's 2022 Long-Term Renewable Resources Procurement Plan, *Petition for Approval of the IPA's 2022 Long-Term Renewable Resources Procurement Plan pursuant to Section 16-111.5(b)(5)(ii) of the Public Utilities Act*, Illinois Commerce Commission, Case No. 22-0231, May 11, 2022.

Reply Comments of Community Power, Environmental Law & Policy Center, and Vote Solar, *In the Matter of Xcel Energy's 2021 Integrated Distribution System Plan and Request for Certification of Distributed Intelligence and the Resilient Minneapolis Project*, PUC Docket No. E002/M-21-694, April 12, 2022.

Verified Objections of the Joint Non-Governmental Organizations to The Illinois Power Agency's 2022 Long-Term Renewable Resources Procurement Plan, *Petition for Approval of the IPA's 2022 Long-Term Renewable Resources Procurement Plan pursuant to Section 16-111.5(b)(5)(ii) of the Public Utilities Act*, Illinois Commerce Commission, Case No. 22-0231, April 4, 2022.

Initial Comments of Community Power, Environmental Law & Policy Center, and Vote Solar, *In the Matter of Xcel Energy's 2021 Integrated Distribution System Plan and Request for Certification of Distributed Intelligence and the Resilient Minneapolis Project*, PUC Docket No. E002/M-21-694, February 25, 2022.

Comments of Vote Solar on the Draft MI Healthy Climate Plan: Modeling the Benefits of Electrification and Decarbonization in the Power Sector in Michigan, February 23, 2022.

Verified Reply Comments of the Joint Non-Governmental Organizations on Amendment of 83 Ill.Adm. Code Parts 466 and 467, Illinois Commerce Commission, Docket No 20-0700, April 29, 2021.

Joint Comments of Vote Solar, the Institute for Local Self Reliance, the Environmental Law & Policy Center, and Cooperative Energy Futures, *In the Matter of Xcel Energy's 2020-2034 Upper Midwest Resource Plan*, PUC Docket No. E002/RP-19-368, February 11, 2021.

Verified Initial Comments of the Joint Non-Governmental Organizations on Amendment of 83 Ill.Adm. Code Parts 466 and 467, Illinois Commerce Commission, Docket No 20-0700, February 4, 2021.

Comments of Vote Solar in the Matter of Updating Generic Standards for Utility Tariffs for Interconnection and Operation of Distributed Generation Facilities Established Under Minn. Stat. § 216B.1611, Minnesota Public Service Commission Docket No: E-999/CI-16-521, September 19, 2018.

Comments of Vote Solar, the Environmental Law and Policy Center, Natural Resources Defense Council, and Plugged In Strategies on the Michigan Distributed Planning Framework: MPSC Report. *In the matter, on the Commission's own motion, to open a docket for certain regulated electric utilities to file their five-year distribution investment and maintenance plans and for other related, uncontested matters.* Case No. U-20147, October 5, 2018.

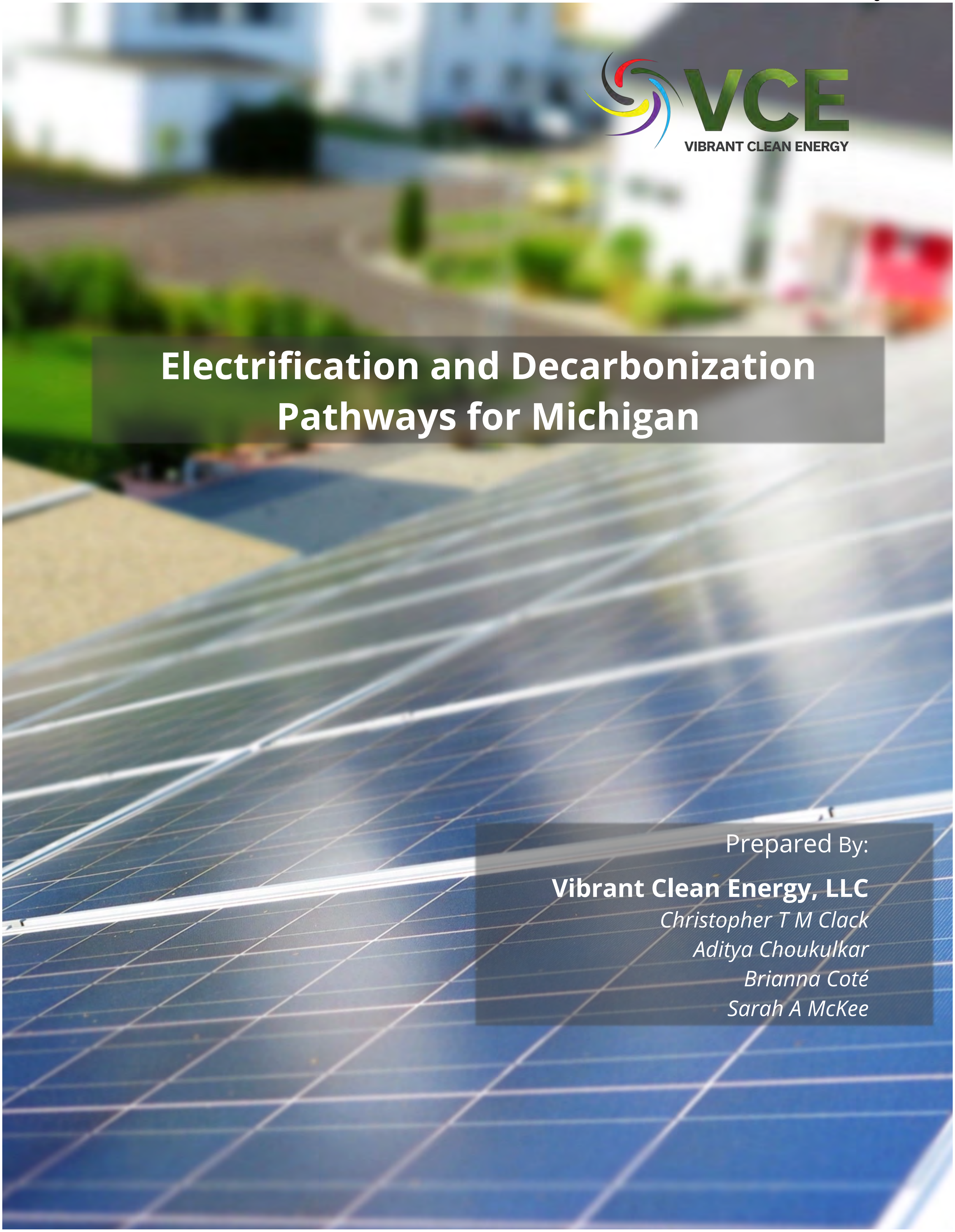
Comments of Vote Solar, the Environmental Law and Policy Center, Natural Resources Defense Council, and Plugged In Strategies on the Indiana Michigan Power Company's draft *Michigan Five Year Distribution Plan for 2019-2023* per the Commission's November 21, 2018 Order in Case No. U-20147, December 21, 2018.

Comments of Vote Solar in the Matter of the Commission's Inquiry into Standby Service Tariffs, Minnesota Public Service Commission Docket No: E999/CI-15-115, February 19, 2019.

Comments of Vote Solar in the Matter of a Commission Investigation to Identify and Develop Performance Metrics, and Potentially, Incentives for Xcel Energy's Electric Utility Operations, , Minnesota Public Service Commission Docket No: E002/CI-17-401, May 6, 2019.

Reply Comments of Vote Solar in the Matter of a Commission Investigation to Identify and Develop Performance Metrics, and Potentially, Incentives for Xcel Energy's Electric Utility Operations, , Minnesota Public Service Commission Docket No: E002/CI-17-401, June 6, 2019.

Supplemental Comments of Vote Solar in the Matter of the Commission's Inquiry into Standby Service Tariffs, Minnesota Public Service Commission Docket No: E999/CI-15-115, September 23, 2019.



VCE
VIBRANT CLEAN ENERGY

Electrification and Decarbonization Pathways for Michigan

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Aditya Choukulkar
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1 Study Description

Major utilities in the state of Michigan have released their Integrated Resource Plans (IRPs) outlining their projections for meeting demand out to 2050. The Governor of Michigan, in the meantime, signed an Executive Directive for Michigan to become carbon neutral economy-wide by 2050. In the present study, Vibrant Clean Energy, LLC (VCE®) was commissioned by Vote Solar to study the IRPs released by the major utilities in the lower peninsula of Michigan and compare them against scenarios that achieve the Governor's carbon neutrality goal for the state. The modeling in this study was performed through 2050 using WIS:dom®-P, a state-of-the-art model capable of performing detailed capacity expansion and production cost while co-optimizing utility-scale generation, storage, transmission, and distributed energy resources (DERs). The modeled scenarios use the National Renewable Energy Laboratory (NREL) Annual Technology Baseline (ATB) 2020 "advanced" cost projections for installed capital and Operation and Maintenance (O&M) costs. For fuel costs, projections from the Annual Energy Outlook (AEO) 2020 High Oil and Gas supply scenario are used.[1]

The scenarios modeled in the present study are as follows:

(1) **Business-as-usual with major utilities in Michigan following their respective IRPs ("IRP"):** In this scenario, major utilities in Michigan follow their respective IRPs for capacity additions or retirements. The portions of Michigan not covered by the IRPs undergo optimal capacity expansion. The model does not co-optimize the distribution system with the utility-scale generation (as this is not included in the IRPs released by the utilities in Michigan). The model follows all existing RPS and greenhouse gas mandates passed into law. In addition, the model enforces Consumers Energy to reduce its electricity sector emission by 90% as declared by the utility in a recent announcement.[2] WIS:dom-P is constrained to follow the capacity changes in the IRP unless additional capacity is needed for reliability or to meet emission reduction goals or mandates. In this scenario, Michigan does not undergo economy-wide electrification.

(2) **Electrify and decarbonize Michigan in line with the Governor's Executive Directive without distribution co-optimization ("Decarb+nonOptDER"):** In this scenario, Michigan undergoes economy-wide electrification of energy related activities and completely decarbonizes the electricity sector by 2050. In addition, the scenario must meet 30% of demand from renewable electricity by 2025. In this scenario the distribution system is not co-optimized with the utility-scale grid. Natural gas fired power plants with carbon capture and sequestration (CCS) and advanced nuclear power plants [small modular reactors (SMR) and molten salt reactors (MSR)] are allowed to be installed after 2025 and 2035, respectively, if determined cost-optimal by WIS:dom-P.

[1] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2020&region=1-0&cases=highogs&start=2018&end=2050&f=A&linechart=highogs-d112619a.3-3-AEO2020.1-0~highogs-d112619a.36-3-AEO2020.1-0~highogs-d112619a.37-3-AEO2020.1-0~highogs-d112619a.38-3-AEO2020.1-0~highogs-d112619a.39-3-AEO2020.1-0~highogs-d112619a.40-3-AEO2020.1-0&map=highogs-d112619a.4-3-AEO2020.1-0&sourcekey=0
[2] https://www.usnews.com/news/best-states/michigan/articles/2021-06-23/consumers-energy-plans-to-complete-coal-phaseout-by-2025

(3) **Electrify and decarbonize Michigan in line with the Governor's Executive Directive with distribution co-optimization ("Decarb+optDER"):** This scenario is identical to "Decarb+nonOptDER" scenario with the single exception that the distribution system grids are co-optimized with the utility-scale grid.

The scenarios are initialized and calibrated with 2018 generator, generation, and transmission topology datasets. The model then determines a pathway from 2020 through 2050 with results outputted every 5 years. As part of the optimal capacity expansion, WIS:dom-P must ensure each grid meets reliability constraints through enforcing the planning reserve margins specified by the North American Electric Reliability Corporation (NERC) and having a 7% load following reserve available at all times. Detailed technical documentation describes the mathematics and formulation of the WIS:dom-P software along with input datasets and assumptions.[3]

[3] https://vibrantcleanenergy.com/wp-content/uploads/2020/08/WISdomP-Model_Description(August2020).pdf

1.1 WIS:dom®-P Model Setup

To investigate the various scenarios, as described in the previous section, WIS:dom-P modeled the state of Michigan (upper and lower peninsula) with its existing generator topology, transmission, and weather inputs obtained from National Oceanic and Atmospheric Administration (NOAA) High Resolution Rapid Refresh (HRRR) model[4] at 3-km horizontal resolution and 5-minute time resolution. The initialized generator dataset is created by aligning the Energy Information Administration Form 860 (EIA-860) dataset[5] with the 3-km HRRR model grid. The existing generator topology in Michigan in 2018 along with existing transmission at 3-km resolution is shown in Figure 1.1.

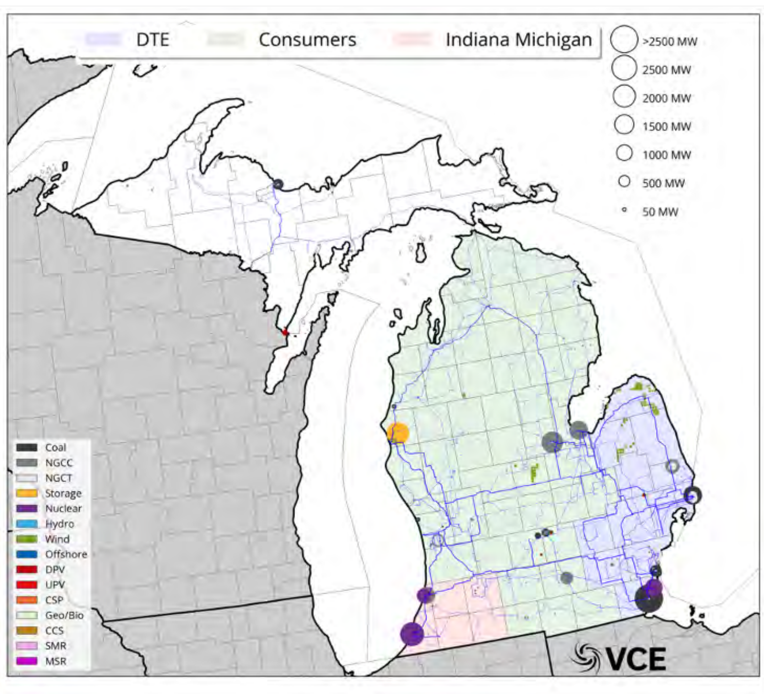

Figure 1.1: WIS:dom-P model domain and existing generators with transmission. The regions shaded show territories of the major Michigan utilities.

Existing transmission corridors between Michigan and neighboring states are modeled as imports and exports and are constrained to be consistent with limits set by MISO. The energy prices for the imports and exports are provided by a background modeling scenario ("CE-DER") from a previous study.[6] In addition, the transmission capacities between Michigan and neighboring states are assumed to remain constant over the modeling period.

Weather inputs obtained from National Oceanic and Atmospheric Administration (NOAA) High Resolution Rapid Refresh (HRRR) model[7] at 3-km horizontal resolution

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4 https://rapidrefresh.noaa.gov/hrrr/
5 https://www.eia.gov/electricity/data/eia860/
6 https://www.vibrantcleanenergy.com/wp-content/uploads/2020/12/WhyDERs_TR_Final.pdf
7 https://rapidrefresh.noaa.gov/hrrr/

and 5-minute time resolution are used in WIS:dom-P for applications with load, transmission and most noticeably with the dispatch and placement of solar and wind. The average fixed latitude tilt solar capacity factors and 100-m hub-height wind capacity factors calculated from the HRRR model output over the model domain are shown in Fig. 1.2. Michigan's wind resource is highest over the eastern part of the lower peninsula (the "thumb") and western portion of the upper peninsula along with a significantly stronger offshore resource. The solar resource is highest over the over the western part of upper peninsula and central portion of the lower peninsula.

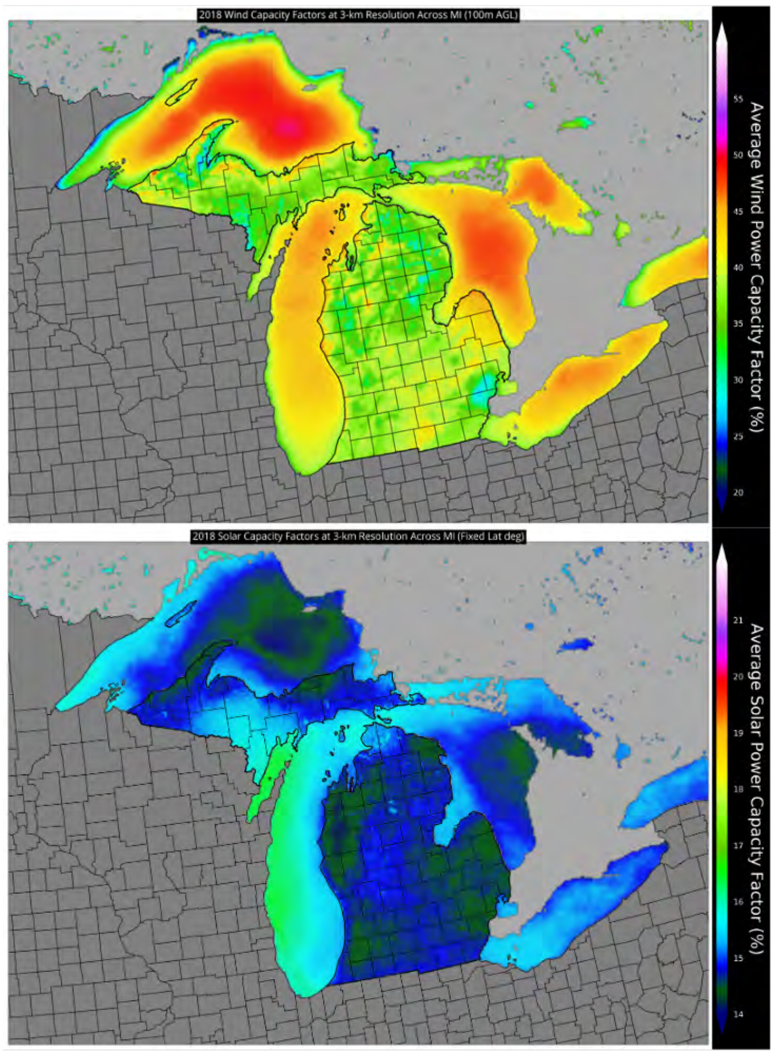

Figure 1.2: Average capacity factors for 100-m hub-height wind (top) and fixed axis latitude tilt solar (bottom) over the state of Michigan calculated from the HRRR model outputs.

2 Modeling Results

2.1 System Costs, Retail Rates & Jobs

In order to study the impact of each scenario on customer bills, the energy burden on customers is calculated for each of the scenarios modeled. The energy burden calculations include customer spending on traditional electricity, space and water heating, transport and industrial operations. The energy burden calculations are combined for residential and commercial customers, while the energy burden for industrial customers is calculated separately. The annual energy burden for an average residential and commercial customer in the "IRP" (top panel) and "Decarb+optDER" (bottom panel) scenario is shown in Fig 2.1.

In the "IRP" scenario, the economy-wide energy related activities are assumed to continue to operate on the current fuel mix and use coal[8], natural gas[9] and oil[10] cost projections from AEO High Oil and Gas Supply scenario. The energy burden in the "IRP" scenario reduces from approximately $4,950 in 2018 to $4,126 in 2030 as a result of reduced retail rates and reduced petroleum prices. After 2030, the energy burden remains almost constant as any reductions in the electricity sector spending (due to reduced retail rates) is offset by increased spending in the heating and transportation sector due to increasing natural gas and petroleum costs.

In the "Decarb+optDER" scenario, the energy burden reduces from approximate $4,950 in 2018 to $3,305 in 2030 as a result of the greater reduction in retail rates and electrification of some of the energy related activities, which cost less due to the lower-cost electricity rates and higher energy efficiency. After 2030, the rate of reduction of the energy burden slows down as any savings from electrification of heating and transport are offset by the increase in spending in the traditional electricity sector due to load growth from electrification of cooking and clothes drying as well as from the increasing electricity rates. Cumulatively by 2050, the "Decarb+optDER" scenario results in savings of $24,741 per customer compared to the "IRP" scenario. This cumulative savings translates to an annual savings of $773 per average residential and commercial customer. Therefore, the "Decarb+optDER" scenario achieves the Governor's goals of electrification and decarbonization of economy-wide energy related activities while reducing costs on energy related activities for residential and commercial customers.

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[8]https://www.eia.gov/outlooks/aeo/data/browser/#/?id=15-AEO2020&region=0-0&cases=highogs&start=2018&end=2050&f=A&linechart=~highogs-d112619a.37-15-AEO2020&map=&ctype=linechart&sourcekey=0
[9]https://www.eia.gov/outlooks/aeo/data/browser/#/?id=13-AEO2020&region=0-0&cases=highogs&start=2018&end=2050&f=A&linechart=~highogs-d112619a.35-13-AEO2020~highogs-d112619a.36-13-AEO2020&map=&ctype=linechart&sourcekey=0
[10]https://www.eia.gov/outlooks/aeo/data/browser/#/?id=12-AEO2020&region=0-0&cases=highogs&start=2018&end=2050&f=A&linechart=~~highogs-d112619a.12-12-AEO2020~highogs-d112619a.17-12-AEO2020&map=&ctype=linechart&sourcekey=0

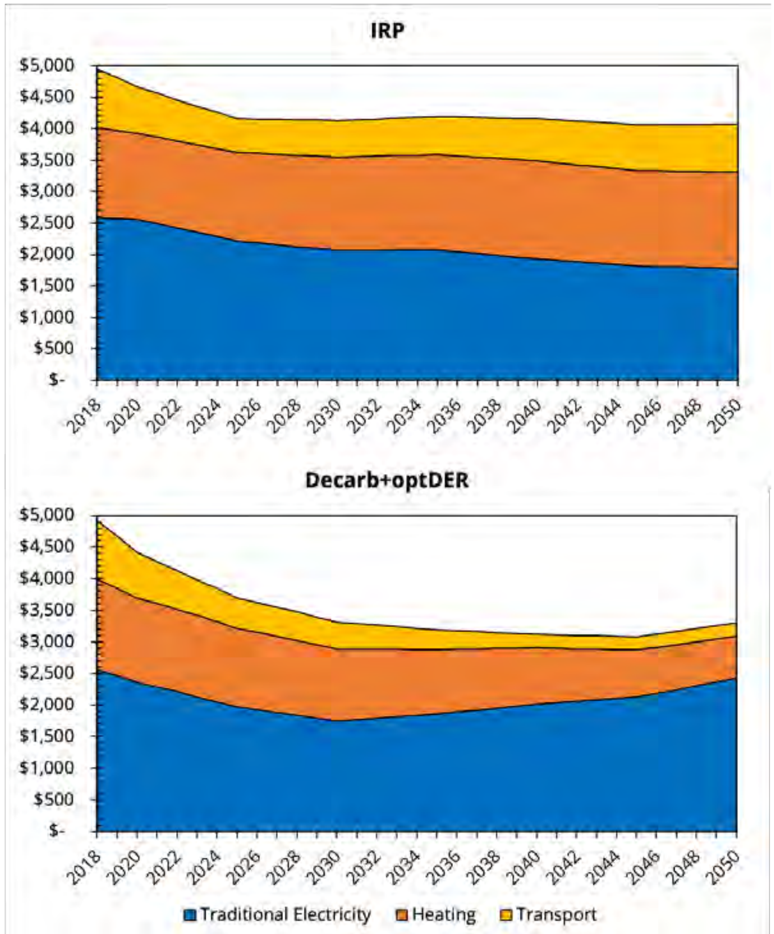

Figure 2.1: Annual spending for an average residential and commercial customer in Michigan in the "IRP" scenario (top panel) and the "Decarb+optDER" scenario (bottom panel).

The "Decarb+optDER" scenario also results in savings for industrial customers who electrify most of their operations with some high heat processes using green hydrogen. As a result of electrification, industrial customers save a cumulative of $2.23 million per customer in the "Decarb+optDER" scenario between 2018 and 2050, which is equivalent to an annual savings of $69,680 per customer. This annual savings is roughly 10% of the average annual operating cost over the modeling period. These savings in industrial energy spending can result in increased profits or be passed on to customers through reduces prices for goods.

The change in total resource costs (which are electricity sector and hydrogen[11] costs) and retail rates in Michigan for the scenarios modeled is shown in Fig. 2.2. In the "IRP" scenario, the total resource costs reduce from approximately $10.7 billion in 2018 to about $7 billion in 2050. The cost reductions come from retirement of expensive coal generation and replacing it with mostly variable renewable energy (VRE) generation along with some imports from other MISO load zones. As a result, the retail rates in

[11] Hydrogen is produced only in the "Decarb+nonOptDER" and "Decarb+optDER" scenarios. No hydrogen is produced in the "IRP" scenario.

the "IRP" scenario also decrease from approximately 11.4 ¢/kWh in 2018 to about 8 ¢/kWh in 2050.

In the two electrification and decarbonization scenarios ("Decarb+nonOptDER" and "Decarb+optDER"), the total resource costs reduce more than the "IRP" scenario until 2030 despite serving additional electricity demand due to electrification. Therefore, the retail rates in the electrification scenarios are substantially lower than the "IRP" scenario bringing significant cost savings to customers. The retail rates in the electrification scenarios drop from 11.4 ¢/kWh in 2018 to approximately 7 ¢/kWh in 2030.

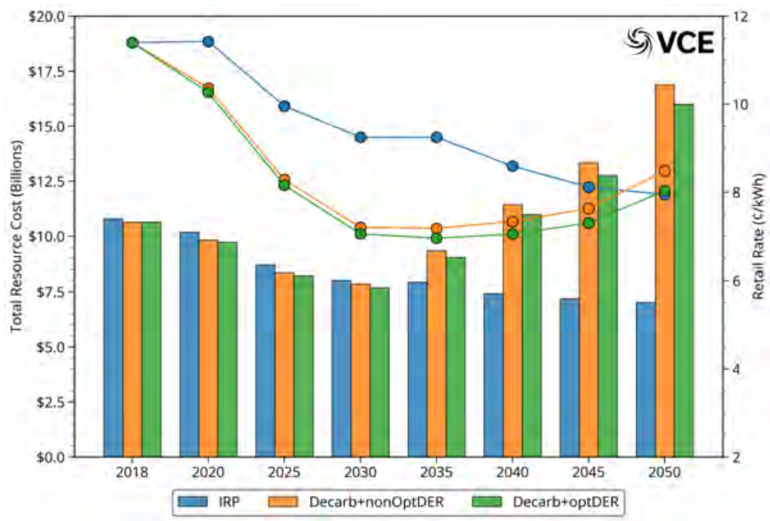

Figure 2.2: Total system cost (bars) and retail rates (solid lines) in Michigan for the scenarios modeled.

After 2030, the rate of electrification accelerates brings in significant new demand into the electricity sector, and the electrification scenarios experience greater investment in the electricity sector to build clean generation to meet the Governor's goal of electrifying and decarbonizing the economy. As a result, by 2050, the annual system cost in the "Decarb+nonOptDER" scenario is $16.8 billion, while in the "Decarb+optDER" scenario it is $15.9 billion due to savings from the distribution system co-optimization. These systems costs are however spread over a much larger load which results from electrification of energy related activities in the rest of the economy. The retail rates also start to increase slowly after 2030 as a result of the additional investments in the electricity sector and decarbonizing the economy. By 2050, the retail rates in the "Decarb+nonOptDER" scenario are slightly higher than the "IRP" scenario at 8.4 ¢/kWh, while the retail rates in the "Decarb+optDER" scenario are almost the same as the "IRP" scenario at 8 ¢/kWh. Therefore, in the "Decarb+optDER" scenario, Michigan can electrify and decarbonize its economy without causing increases in rates for customers compared to the "IRP" scenario. It is to be noted that the maximum import and exports from Michigan are held constant at 2018 levels. Therefore, it may be possible to reduce costs and thus retail rates further if the transmission capacity were allowed to grow beyond 2018 levels with the rest of MISO and possibly PJM.

The contributions to the cost per kWh of electricity delivered broken out by sectors in the scenarios modeled is shown in Fig. 2.3. In 2018, almost half the cost of electricity is due to fossil fuel generators, with coal being the largest contributor to cost of energy. In the "IRP" scenario, as the coal is gradually retired, the cost of energy reduces as the VRE generation provides energy at much lower cost.

In the electrification scenarios ("Decarb+nonOptDER" and "Decarb+optDER"), the cost of energy reduces faster than the "IRP" scenarios because the fossil fuel generation is retired at a faster rate and the cost of energy is distributed over a larger demand. The cost of energy in the electrification scenarios stays below the costs in the "IRP" scenario until 2045. After 2045, as Michigan decarbonizes the electricity sector completely, the cost of energy in the electrification scenarios increases slightly compared to the "IRP" scenario. The cost of energy increase in the electrification scenarios could be tied to limiting the amount of imports and exports out of Michigan to 2018 levels and allowing the expansion of transmission to other load zones in MISO could help Michigan achieve decarbonization at a lower cost. Compared with the "Decarb+nonOptDER" scenario, the "Decarb+optDER" scenario has lower cost of energy throughout the modeling period. The co-optimization of the distribution system ensures that the distribution system costs in the "Decarb+optDER" scenario remain lower as a result of deferring distribution system capital investment.

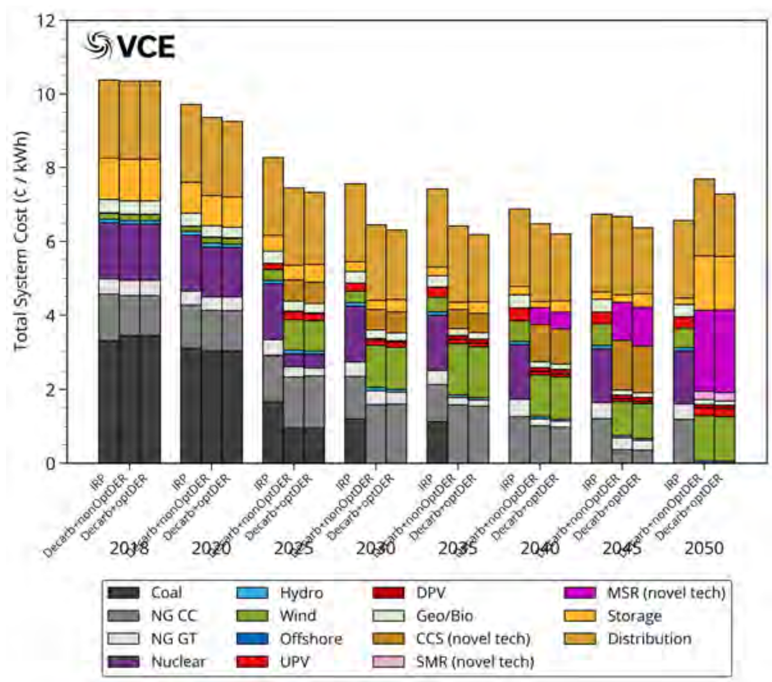

Figure 2.3: Contribution to total system cost per kWh load from each energy system sector for the scenarios modeled.

The total full-time equivalent electricity sector jobs in the scenarios modeled is shown in Fig. 2.4. The total full-time equivalent jobs in the electricity sector in the "IRP" scenario increase from about 45,000 in 2018 to 90,000 in 2050 driven largely by jobs supported by the solar industry. In the electrification scenarios, the job growth over the investment periods is higher than the "IRP" scenario due to the larger VRE deployment. By 2045, the electrification scenarios see 150,000 and 159,000 jobs in the "Decarb+nonOptDER" and "Decarb+optDER" scenarios, respectively. The largest job growth is observed in the distributed solar sector. Between 2045 and 2050, the electrification scenarios deploy large amounts of solar and storage in order to meet the 100% decarbonization goal. As a result, these scenarios see a large increase in workforce in the electricity sector to support this increase in generation deployment. By 2050, the storage industry supports the largest number of jobs in the electrification scenarios, followed by the solar industry. The "Decarb+optDER" scenario see slightly less jobs created in the distribution sector due to the distribution co-optimization deferring investments in the distribution grid.

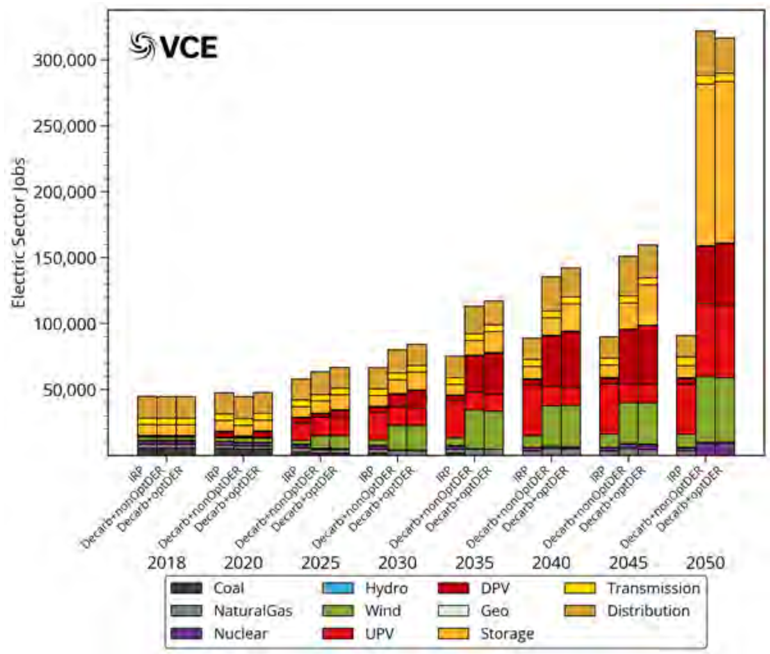

Figure 2.4: Direct full-time equivalent jobs created in the electricity sector by industry for the scenarios modeled.

2.2 Changes to Installed Capacity & Generation

The changes to installed capacity and generation mix in Michigan for the three scenarios modeled are shown in Fig. 2.5. The "IRP" scenario is the slowest to retire coal generation keeping it online until 2040. The retired coal generation in the "IRP" scenario is replaced with some new natural gas combined cycle (NGCC) generation and VRE generation with solar being the dominant addition. WIS:dom-P models both utility scale photovoltaic (UPV) and distributed photovoltaic (DPV). The distributed solar (DPV) includes both rooftop solar and community solar installations. In the electrification scenarios, the capacity turnover takes on very similar paths. Coal is completely retired by 2030 along with some older natural gas generation. Wind makes up a significant portion of new VRE generation added due to the better wind resource available in Michigan along with wind generation's better correlation with electrification load, especially in winter. The electrification scenarios deploy carbon capture and sequestration (CCS), molten salt reactors (MSR) and small modular reactors (SMR) to provide dense clean dispatchable generation. All CCS in the electrification scenarios is retired by 2050 as they are not 100% emission free.

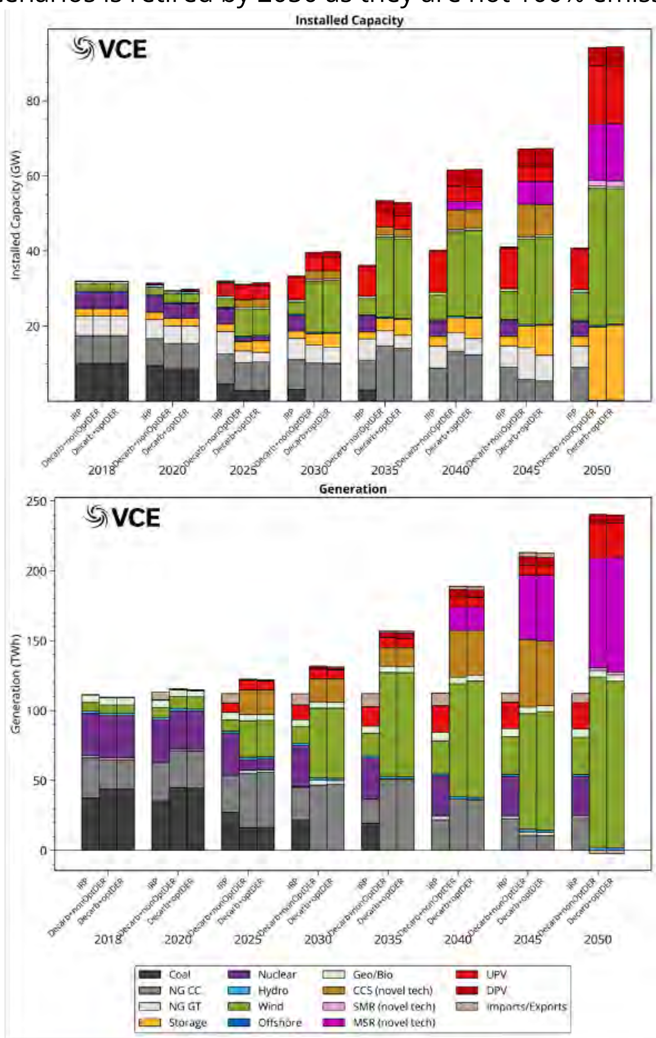

Figure 2.5: WIS:dom-P installed capacities (top) and generation (bottom) for the scenarios.

The VRE generation deployed in the "IRP" scenario is higher than that proposed in the IRPs of the major utilities in Michigan. The larger deployment in mainly to satisfy the 90% decarbonization by 2040 goal of Consumers Energy utility. In order to meet its 90% decarbonization goal, Consumers Energy utility needs to deploy about 1,400 MW of additional wind generation, 1,300 MW of additional utility-scale solar and 236 MW of additional storage over that proposed in its IRP. Furthermore, Consumers Energy depends on imports of clean generation from DTE which deploys an additional 3,000 MW of wind and 487 MW of utility-scale solar to export clean energy to Consumers Energy. Therefore, the IRP proposed by Consumers Energy through 2034 falls well short of reaching its own 90% decarbonization goal by 2040.

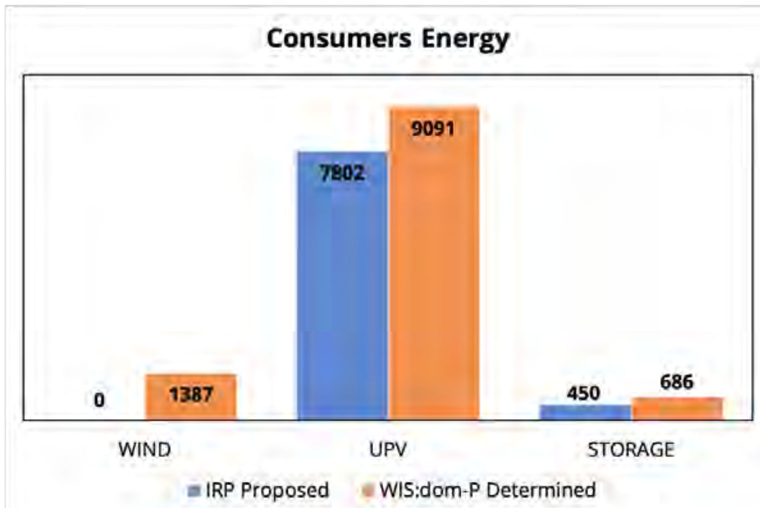

Figure 2.6: Additional VRE deployed by WIS:dom-P to ensure Consumers Energy meets it 90% decarbonization by 2040 goal.

The storage power and energy capacities installed over the investment periods in the scenarios modeled is shown in Fig. 2.7. In the "IRP" scenario, very little new storage is added until 2040 at which point about 700 MW of storage is added to the grid. In comparison, the electrification scenarios add significantly more storage over the investment periods along with a large deployment of storage between 2045 and 2050 to meet the 100% decarbonization goal. By 2045, the "Decarb+nonOptDER" scenario deploys 5,800 MW of storage to the grid to effectively utilize the installed VRE generation. The average storage duration in 2045 in the "Decarb+nonOptDER" scenario is 7.5 hours to help cover lulls in the VRE generation. The "Decarb+optDER" scenario, on the other hand, has a total of approximately 8,000 MW of storage deployed by 2045, out of which 2,000 MW is on the utility grid and the rest is on the distribution grid with an average duration of 7.5 hours.

Between 2045 and 2050, the electrification scenarios deploy large amounts of storage to the grid with the total storage installed reaching about 19,500 MW in both the electrification scenarios. In the "Decarb+optDER" scenario, 8,300 MW of the total storage is on the distribution grid. The average duration of the storage installed is approximately 24 hours. The long storage duration is specifically aimed at meeting load during the long lulls in wind generation that occur over the course of the year.

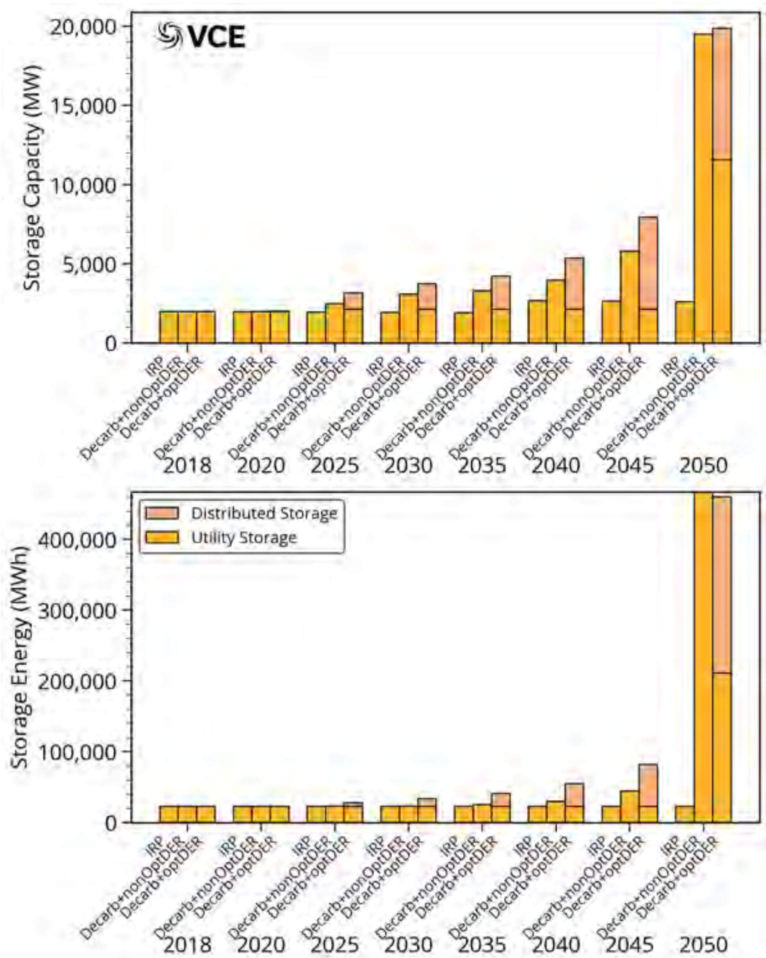

Figure 2.7: Utility storage and distributed storage installed in each investment period for the "Optimized DER" scenario.

Although the wind resource is significantly better in Michigan compared with the solar resource, the electrification scenarios add substantially more solar generation on the grid compared with the "IRP" scenario. The "IRP" scenario installs about 11,000 MW of solar by 2040. About 1,800 MW of this is additional solar added by WIS:dom-P over the values prescribed by the IRPs in order to ensure Consumers Energy meets its 90% decarbonization goal.

The electrification scenarios install more wind generation over solar until 2045 due to the better wind resource in Michigan. After 2045, the electrification scenarios install about 12,000 MW of solar to help meet the 100% decarbonization goal. The "Decarb+optDER" scenario installs slightly more distributed solar compared with the "Decarb+nonOptDER" scenario as the distribution co-optimization uses the distributed solar along with the distributed storage to defer distribution system upgrades and save costs.

2.3 CO_2 Emissions & Pollutants

The percentage reductions in economy-wide carbon dioxide (CO_2) emissions from 2005 levels for energy related activities is shown in Fig. 2.8. The "IRP" scenario reduces the economy-wide emissions by 25% from 2005 levels by 2025 and, thus, falls short of the Governor's goal of 28% reduction by 2025. By 2050, the annual economy-wide emissions reduce by 38% from 2005 level in the "IRP" scenario as a result of retirement of coal generation and replacing it with VRE generation. The additional VRE installations by WIS:dom-P over the IRP proposed values help the "IRP" scenario reach the 38% reduction by 2050. The electrification scenarios, by contrast, reduce annual economy-wide emissions by 37% by 2025, exceeding the Governor's goal. This reduction in annual emissions is possible through a combination of electrification and decarbonization of the electricity sector. By 2050, the electrification scenarios reduce annual economy-wide emissions by almost 97% from 2005 levels as the economy-wide energy related activities are electrified and the electricity sector is 100% decarbonized.

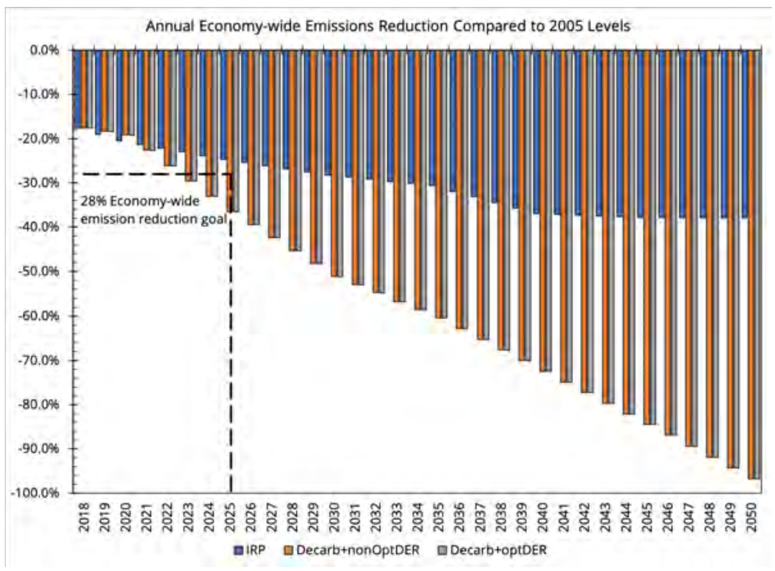

Figure 2.8: Percentage reduction in economy-wide energy related carbon emissions from 2005 levels. The black dashed line indicates the Governor's emission reduction goal of 28% by 2025.

Figure 2.9 shows the cumulative economy-wide CO_2 emissions from the three scenarios modeled. The "IRP" scenario, which does not electrify economy-wide energy related activities, has the highest cumulative CO_2 emissions of 4,374 million metric tons (mmT) by 2050. The "Decarb+nonOptDER" and the "Decarb+optDER" scenarios, which have similar emission reduction profiles, cumulatively emit 2,650 mmT of carbon dioxide by 2050. Therefore, electrification and decarbonization of the electricity sector can cumulatively reduce Michigan CO_2 emissions by 1,724 mmT by 2050, which is more than 10 times the economy-wide emissions in 2018. A majority of these emission savings (1,650 mmT) come from electrification of economy-wide energy related activities. Therefore, electrificatinon is a key element for effective decarbonization.

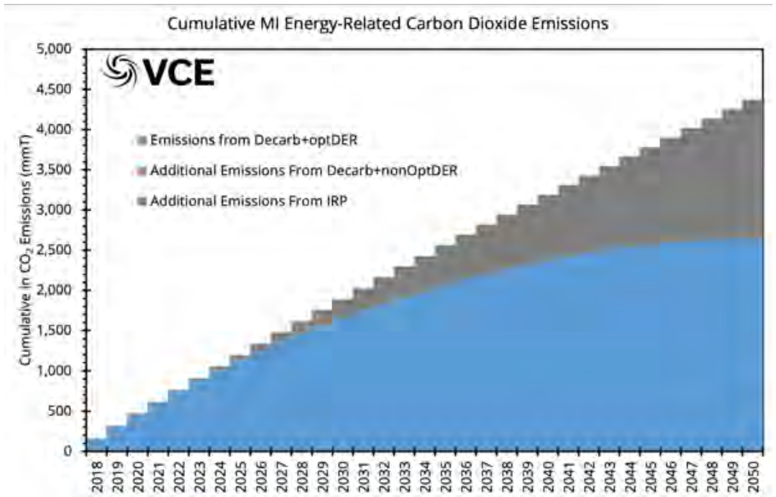

Figure 2.9: Cumulative economy-wide carbon dioxide emissions for the three scenarios modeled.

In addition to reducing CO_2 emissions, the modeled scenarios also reduce emissions of criteria air pollutants emitted by fossil fuel generation. The air pollutants tracked by WIS:dom-P emitted by the electricity sector are shown in Fig. 2.10. In the "IRP" scenario, the SO_2, PM_{10}, and $PM_{2.5}$ emissions reduce steadily from 2018 to 2035 as coal generation is retired and then sharply reduce to zero by 2040 as all coal generation gets retired. In the electrification scenarios, all coal generation is retired by 2030 and hence the SO_2, PM_{10}, and $PM_{2.5}$ emissions see rapid declines to zero by 2030. In the "IRP" scenario, some NO_x, CH_4 and VOC emissions remain due to presence of natural gas generation on the grid, while in the decarbonization scenarios these emissions are reduced to zero by 2050 as a result of the decarbonization goal. Hence the electrification scenarios not only reduce greenhouse gas emissions, but also eliminate emissions of criteria air pollutants, which will result in better health outcomes for local populations.

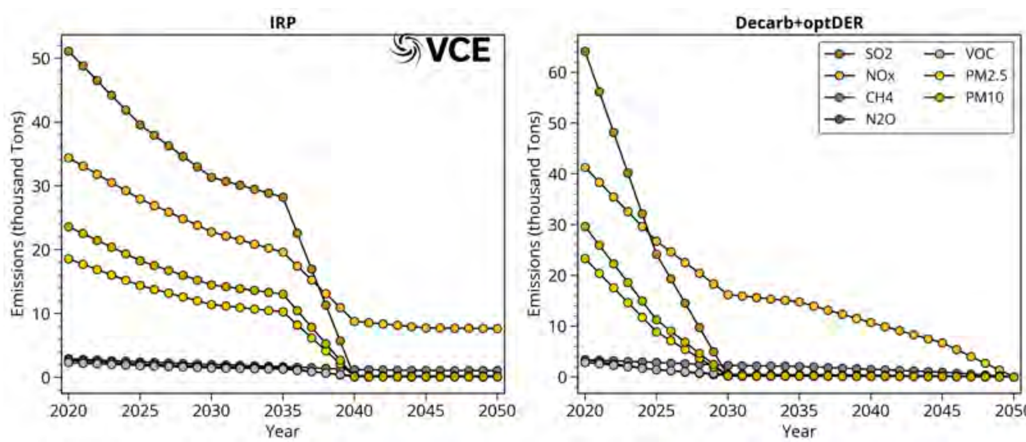

Figure 2.10: Emissions of criteria air pollutants from the electricity sector in the "IRP" scenario (left) and the "Decarb+optDER" scenario (right).

2.4 Siting of Generators (3-km)

WIS:dom-P uses weather datasets spanning multiple years at 3-km spatial resolution and 5-minute temporal intervals over the contiguous United States. WIS:dom-P performs an optimal siting of generators on the 3-km HRRR model grid. The WIS:dom-P installed capacity layout at 3-km resolution along with the transmission paths above 115 kV in 2050 for the “IRP” scenario is shown in Figure 2.11 (left panel), while the installed capacities for the “Decarb+optDER” scenario is shown in Figure 2.11 (right panel). The greater VRE deployment in the “Decarb+optDER” scenario is apparent along with deployment of dense clean dispatchable generation in the location of retired fossil fuel generation.

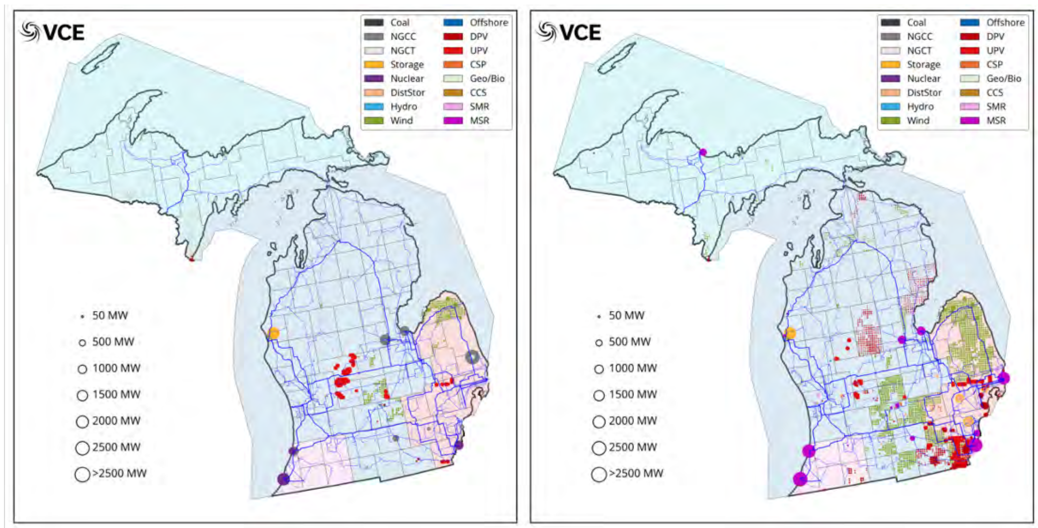

Figure 2.11: Installed generation layout in 2050 in the “IRP” scenario (left) and “Decarb+optDER” scenario (right) at 3-km resolution along with transmission paths above 115 kV.

As seen from Fig. 2.11 (left panel), the “IRP” scenario installs almost all the wind in DTE territory, and most of the solar deployed in Consumers territory. The VRE generation is more widely distributed in the “Decarb+optDER” scenario. The DTE region still installs most of the wind generation, with substantial wind installed in the Consumers regions as well. Most of the utility-scale solar is installed in the DTE region, while the Consumers region is dominated by distributed solar. The locations of retired fossil fuel generators are used to build MSRs and SMRs.

When making the siting decisions, the model takes into account several criteria to determine the optimal siting for generators. In addition to accounting for expected generation and distance from the load (for transmission considerations), the model ensures that generation is not sited in unsuitable locations. The model also ensures that the technical potential of each grid 3-km grid cell is not exceeded. The technical potential for the various VRE technologies in each grid cell is determined according to factors such as population, land cover, terrain slope, and others. In addition, each technology is limited by a maximum packing density to ensure that generators do not hamper performance of other generators in the grid cell, such as through wakes for wind turbines and excessive shading for solar panels. More information about these criteria and the WIS:dom-P model can be found in the technical documentation.[12]

[12] https://vibrantcleanenergy.com/wp-content/uploads/2020/08/WISdomP-Model_Description(August2020).pdf

MPSC Case No: U-21193
Requester: MIAC
Question No.: MIACDE-4.1a
Respondent: J. Leslie
Page: 1 of 1

Question: For Category 1 (residential distributed generation systems < 20kW) of the current distributed generation program, please determine the following values. Please include all calculations to determine these values.

a. Total kW available for Category 1 under the program (given soft cap of 0.5% of average in-state peak load).

Answer: The table below summarizes data related to the Category 1, Category 2 and Category 3 distributed generation programs. Installed capacity assumes that the resource is installed, commissioned and operational. The Company does not have insight into whether the resource is working and maintained after the initial commissioning of the customer resource.

Request	Category 1	Category 2	Category 3
a. Total available kW	54,599	27,300	27,300
b. Installed kW as of 1/31/2023	51,477	9,370	0
c. Remaining amount kW available as of 1/31/2023 (line a – line b)	3,122	17,930	27,300
d. Remaining % available as of 1/31/2023 (line c / line a)	6%	66%	100%
e. Pending KW as of 1/31/2023	5,091	1,794	0
f. Installed plus pending kW as of 1/31/2023 (line b + line e)	56,568	11,164	0
g. Remaining amount kW available if all pending application installations are approved as of 1/31/2023 (line a – line f)	-	16,136	27,300
h. Remaining % available if all pending application installations are approved as of 1/31/2023 (line g / line a)	0%	59%	100%

Attachment: *None*

Co-respondent: N. Foley

Capacity Factor (%)

MPSC Case No: U-21193
Question No.: MNSCDE-2.11d
Respondent: J. Morren

	2017	2018	2019	2020	2021
Belle River Power Plant U1	70.7%	64.8%	27.1%	45.2%	59.8%
Belle River Power Plant U2	54.1%	71.8%	71.3%	30.6%	68.3%
Greenwood Power Plant	5.8%	9.1%	12.5%	12.3%	9.1%
Monroe Power Plant U1	58.7%	53.0%	65.5%	48.6%	52.9%
Monroe Power Plant U2	42.8%	61.7%	59.0%	38.9%	60.1%
Monroe Power Plant U3	63.8%	64.5%	44.0%	53.6%	66.6%
Monroe Power Plant U4	65.5%	64.2%	58.5%	54.0%	37.8%
Belle River DG	0.0%	0.0%	-0.2%	0.0%	-0.1%
Renaissance CTG 1	4.6%	15.6%	9.0%	20.7%	12.3%
Renaissance CTG 2	3.6%	10.8%	10.3%	15.6%	2.4%
Renaissance CTG 3	4.3%	14.2%	11.3%	15.0%	15.1%
Renaissance CTG 4	4.0%	13.4%	10.7%	16.2%	14.4%
Dean CTG 1 (12-2)	3.6%	6.8%	8.3%	22.9%	10.4%
Dean CTG 2 (12-1)	3.4%	6.7%	8.3%	22.8%	9.7%
Dean CTG 3 (11-1)	3.7%	9.1%	7.8%	21.0%	9.2%
Dean CTG 4 (11-2)	3.6%	9.0%	7.6%	20.9%	8.2%
Dearborn Energy Center 1	-	-	-	89.1%	83.8%
Dearborn Energy Center 2	-	-	-	90.2%	84.6%
Dearborn Energy Center 3	-	-	-	42.7%	13.9%
Colfax DG	-0.1%	0.0%	0.6%	0.1%	0.3%
Fermi CTG	0.7%	1.4%	0.0%	-0.1%	0.0%
Monroe DG	-0.2%	-0.1%	-0.1%	-0.2%	0.0%
Oliver DG	0.0%	0.0%	0.0%	0.0%	0.0%
Placid DG	-0.1%	-0.1%	-0.1%	0.0%	0.5%
Putnam DG	0.2%	0.0%	0.1%	0.0%	0.9%
River Rouge DG	-0.3%	-0.2%	-0.2%	-0.2%	0.3%
Slocum DG	-0.2%	-0.2%	-0.2%	0.1%	0.0%
St. Clair DG 12	0.1%	0.1%	0.1%	0.0%	0.4%
Wilmot DG	0.0%	0.0%	-0.1%	0.1%	0.8%
BR 12-1 CTG	9.9%	10.5%	18.0%	19.2%	6.9%
BR 12-2 CTG	11.0%	11.0%	6.4%	17.9%	6.3%
BR 13-1 CTG	9.9%	16.4%	16.5%	8.0%	6.3%
Delray 11-1 CTG	2.6%	1.7%	1.1%	3.4%	1.6%
Delray 12-1 CTG	1.3%	0.6%	0.5%	1.6%	1.5%
Greenwood 11-1 CTG	6.0%	7.3%	3.5%	4.2%	6.9%
Greenwood 11-2 CTG	3.6%	7.4%	3.2%	4.2%	7.0%
Greenwood 12-1 CTG	6.2%	7.8%	3.9%	4.8%	6.8%
Hancock 11 CTG	0.5%	0.3%	0.1%	0.0%	1.0%
Northeast 11 CTG	0.3%	0.7%	0.1%	0.1%	0.7%
Northeast 12 CTG	0.0%	0.0%	0.1%	0.5%	1.3%
Superior CTG	0.0%	0.0%	0.0%	0.1%	0.4%
Hancock 12 CTG	0.4%	1.3%	0.6%	0.6%	1.5%
Northeast 13 CTG	0.1%	0.4%	0.1%	0.2%	0.0%
St. Clair 11 CTG	0.7%	1.2%	0.4%	0.4%	0.7%

STATE OF MICHIGAN
MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief.	)))))	Docket No. U-21193 Administrative Law Judge Sharon Feldman

DIRECT TESTIMONY OF
CHELSEA HOTALING

March 9, 2023

I. <u>BACKGROUND AND SUMMARY</u>

Q. Please state your name and business address.

A. My name is Chelsea Hotaling. My business address is 30 Court St., Canton, NY 13617.

Q. By whom are you employed and in what capacity?

A. I am employed by Energy Futures Group ("EFG") as a Consultant. Energy Futures Group is a clean-energy consulting firm headquartered in Vermont with offices in Massachusetts and New York that provides specialized expertise on energy efficiency program design and policy, power system planning, and related topics.

Q. On whose behalf are you submitting this direct testimony?

A. I appear here in my capacity as an expert witness on behalf of the Ecology Center, the Environmental Law & Policy Center, the Union of Concerned Scientists, and Vote Solar. I refer to these parties collectively in this case as the Clean Energy Organizations, or "CEO."

Q. Please summarize your qualifications, experience, and education.

A. I have worked for seven years in electric utility regulation and related fields. I have reviewed over a dozen integrated resource plans ("IRPs") and related filings by utilities located in Arizona, Colorado, Kansas, Kentucky, Iowa, Indiana, Michigan, Missouri, Montana, Minnesota, New Mexico, Nova Scotia, Puerto Rico, and South Carolina. I have performed my own capacity expansion and production cost modeling in numerous cases using EnCompass. I have reviewed planning modeling based on multiple models including EnCompass, Aurora, PLEXOS, PowerSimm, and System Optimizer. I have had formal training on the EnCompass, Aurora, and PowerSimm models.

I hold a Bachelor's Degree in Accounting and Economics from Elmira College, a Master's Degree in Business Administration, Master's Degree in Data Analytics, and a Master's Degree in Environmental Policy and Governance from Clarkson University. My work experience is summarized in my resume, provided as Exhibit CEO-6.

Q. Have you testified before the Michigan Public Service Commission previously?

A. Yes. I provided testimony in the following cases:

- *In the Matter of the Application of Indiana Michigan Power Company for Approval of its Integrated Resource Plan*, Case No. U-21189.
- *In the Matter of the Application of Consumers Energy Company for Approval of Its Integrated Resource Plan*, Case No. U-21090

Q. Have you testified or provided comments in similar state regulatory proceedings?

A. Yes. I have submitted testimony before the Colorado Public Utilities Commission and the Iowa Utilities Board regarding capacity expansion and production cost modeling using EnCompass. And I have submitted testimony on planning related topics in dockets before the Kentucky Public Service Commission.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibits:

- Exhibit CEO-6: Resume of Chelsea Hotaling
- Exhibit CEO-7: DTE response to CEODE 2.33a

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to describe the modifications I made to the EnCompass modeling performed by DTE Electric Company ("DTE" or "the Company") for its Integrated Resource Plan. I will also discuss the results of the EnCompass modeling with the CEO modifications.

Q. Please summarize your conclusions and recommendations.

A. I recommend that DTE pursue a more accelerated adoption of renewable and battery storage resources along with additional opportunities for EWR savings in order to prepare itself for the retirement of two or more of the Monroe units. In addition, DTE should explore the earlier retirement of Monroe Units 1 and 2 without the assumed replacement of a CCGT with CCS.

II. ENCOMPASS MODELING

Q. Was your EnCompass modeling based on DTE's database?

A. Yes, the modeling I performed on behalf of the CEO was based on the EnCompass database that DTE provided with its IRP. My clients were one of the parties to receive an EnCompass license from DTE for purposes of this proceeding. The CEO modeling is based on DTE's REFRESH scenario, which contains the Inflation Reduction Act ("IRA") tax credits and updated natural gas and wholesale electricity price forecasts.[1]

Q. What changes were made to the EnCompass database for the CEO modeling runs?

A. Table 1 below provides a high-level summary of the changes that were made for the CEO modeling runs.

[1] EnCompass database file named "REFRESH_PCA_OPT" provided in workpaper "NDA WP SDM 138-REF_HE_and_REFRESH Datasets".

Table 1. Summary of the CEO Modeling Changes

Modeling Input	DTE	CEO
MISO Seasonal Construct	Not Modeled	Modeled
Distributed Solar Adoption	Included DTE projections in load forecast	Additional adoption level beyond DTE's projections
Energy Justice ("Energy Equity Package")	No programs modeled explicitly	Battery Medical Resiliency Program Low Income Solar Program
Combustion Turbine ("CT") Retirement	Not included in the PCA[2]	Retirement in 2028 with battery storage replacement
Monroe 1 and 2 Retirement	Retire 2035	Retire 2030
Energy Waste Reduction ("EWR")	PCA[3]	Alternative C from MNSC[4]
Resource Constraints	1. Limits on battery storage, solar, and wind 2. Assumed Monroe 1 and 2 must be replaced with CCGT with CCS[5]	1. Removed DTE constraints on storage, solar, and wind resources. The annual wind constraint set to 1,000 MW starting in 2028 2. Removed DTE's assumption that Monroe 1 and 2 must be replaced with a CCGT with CCS
Multiday Storage as a Selectable Resource	Not Modeled	Modeled

Q. What is the MISO seasonal resource adequacy construct?

A. Previously, MISO has required that load serving entities ("LSEs") secure enough capacity to meet their MISO-coincident peak plus an annual planning reserve margin ("PRM"). On August 31, 2022, FERC approved MISO's petition for changes to its resource adequacy construct and accreditation methodology. Those changes now require LSEs to satisfy a planning reserve margin requirement ("PRMR") in each season (Summer is June through

[2] DTE performed a sensitivity where the peakers identified for retirement from the peaker analysis were replaced with DR and solar.
[3] An average of 1.5% over the planning period.
[4] 2% level of EWR and then blended with the PCA after 2027.
[5] Natural gas Combined Cycle Turbine with Carbon Capture and Sequestration ("CCGT with CCS").

August; Fall is September through November; Winter is December through February; and Spring is March through May). In addition to the seasonal PRMs and PRMRs, MISO also implemented changes to the accreditation of thermal and renewable resources such that their accreditation would vary from season to season. ***Table 2*** below shows the MISO planning reserve margin for each season for Planning Year 2023-24.

Table 2. MISO Seasonal Planning Reserve Margin

Season	**MISO PRM[6]**
Winter	25.5%
Spring	24.5%
Summer	7.40%
Fall	14.9%

I then adjusted the MISO PRM for each season to include DTE's transmission losses and coincidence factor as provided in Witness Manning's workpaper.[7]

Q. Did DTE model MISO's seasonal resource adequacy construct and seasonal resource accreditation?

A. No, DTE did not. Because the construct is now approved and at least the preliminary information needed to characterize the capacity value of both existing and new supply-side resources is now available, I updated DTE's modeling to reflect these changes. Since the seasonal construct has been approved, utilities will need to incorporate it into their IRP filings, and I expect that it will be incorporated in DTE's future IRP filings.

Q. Please explain how you modeled the MISO seasonal resource adequacy construct and seasonal resource accreditation in EnCompass.

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[6] MISO Planning Year 2023-2024 Loss of Load Expectation Study Report. MISO. Retrieved from https://cdn.misoenergy.org/PY%202023%202024%20LOLE%20Study%20Report626798.pdf
[7] NDA WP SDM 160 – DTE and Zone 7 Capacity Outlook Tool – 2022 IRP Starting Point

A. DTE conveyed to the CEO that "the Company is actively working with MISO to verify preliminary SAC values for the Company's thermal resources for Planning Year 2023/2024."[8] For this modeling, I chose to use the values that DTE has calculated.[9] Because the CEO modeling reflects the application of the newly approved seasonal construct, I also used the renewable and battery storage accreditation figures given in MISO's Renewable Resource Assessment report[10,11] except for years 2023-2025 of the planning period when I used the seasonal class averages for wind and solar published for the Planning Year 2023-24.[12] I adjusted the seasonal wind values downwards to account for my understanding that DTE's Michigan wind projects have typically received less accreditation than the average wind project in MISO. Finally, I applied the published seasonal class average values to new thermal resources included in DTE's model.[13] These changes are briefly summarized in Table 3, below.

[8] Exhibit CEO-7. DTE response to CEODE 2.33a.
[9] DTE provided the MISO SAC values in a supplemental response to CEODE 2.33a.
[10] MISO 2022 Regional Resource Assessment. Retrieved from https://cdn.misoenergy.org/2022%20Regional%20Resource%20Assessment%20Report627163.pdf
[11] As of the date of this testimony, my understanding is that MISO intends to revisit its accreditation practices for both thermal and renewable generators. Its proposed approach would accredit generators based on performance during loss of load hours simulated in MISO's Loss of Load Expectation model. While MISO has published preliminary solar and wind accreditation values, it has not provided any indication of how thermal accreditation or the PRM would change with this approach, therefore it was not possible to model it.
[12] See https://cdn.misoenergy.org/Wind%20and%20Solar%20Class%20Average%20SAC627924.pdf.
[13] See https://cdn.misoenergy.org/20221215%20Schedule%2053%20Class%20Average627347.pdf.

Table 3. Sources Used to Represent Seasonal PRM and Accreditation

Resources	Source
Existing thermal	DTE calculations
Existing solar and wind[14]	MISO seasonal average for 2023-2025 MISO RRA values for 2026-2042
Other existing resources[15]	DTE values
Existing demand response	Accredited based on months in operation[16]
New thermal	MISO seasonal class average
New renewables	MISO seasonal average for 2023-2025 MISO RRA values for 2026-2042
New battery storage	MISO RRA values for 2023-2042
New battery storage for ancillary services	DTE values
EWR	DTE values[17]

Table 4 shows the firm capacity percentages modeled for the solar, wind, solar hybrid, and battery storage resources between 2026 and 2042 from the MISO RRA Report.

Table 4. Renewable and Battery Storage Firm Capacity (%) for 2026-2042[18]

	2026-2040			
	Spring	**Summer**	**Fall**	**Winter**
Solar	17	23	18	1
Wind	8	12	14	25
Storage	76	82	68	82
Solar-Plus-Storage	33	36	29	28
	2041-2042			
	Spring	**Summer**	**Fall**	**Winter**
Solar	11	18	20	11
Wind	8	11	14	17
Storage	64	100	100	97
Solar-Plus-Storage	14	38	37	35

[14] Includes wind resources modeled as contracts in EnCompass.
[15] Non-wind contracts and the Ludington pumped storage units.
[16] Accreditation was grossed up for the seasonal PRM.
[17] My own calculations of the EWR availability during DTE's peak demand across the seasons in the planning period indicate that the firm capacity of EWR could be higher than the firm capacity assumptions that DTE modeled in EnCompass. However, in an effort to be conservative on the seasonal accreditation for EWR Alternative C, the CEO modeling assumed the firm capacity values that DTE modeled.
[18] As indicated above, values are from the MISO RRA and the wind resources were adjusted to reflect a lower accreditation for DTE's wind projects.

Q. Why did you choose to update DTE's database to reflect the introduction of seasonality to MISO's resource adequacy construct and accreditation?

A. The reliability of any given portfolio of resources has received increasing attention and concern. Resource planners are seeking ways to evaluate the reliability of their portfolios to help address these concerns. DTE chose to run its PCA in probabilistic simulations conducted in SERVM as a way to test for the reliability of that portfolio. While that modeling represented a partial look at MISO's footprint, i.e., only Zone 7, it also wasn't possible for an intervenor to conduct similar modeling. Licensing SERVM is too costly and replicating its approach in EnCompass would be difficult at best. Because MISO's changes to its resource adequacy construct and accreditation were intended to address the same concerns that DTE was exploring in its SERVM modeling, it made sense to model the seasonal construct to the extent possible as a substitute for that modeling.

Q. What assumptions were made for the distributed solar included in the CEO modeling?

A. The CEO Alternative Plan includes the distributed solar adoption levels provided by CEO Witnesses Tan and Kenworthy. The adoption levels were included in the modeling with an hourly profile that was developed for the Detroit, Michigan, location using the National Renewable Energy Laboratory ("NREL") System Advisor Model ("SAM").[19] The firm capacity for the distributed solar resource was modeled with the same seasonal accreditation value for solar resources mentioned in Table 3.

Q. What modeling changes were made to incorporate the Energy Equity Package?

[19] The profile for the Detroit, Michigan location had an annual capacity factor of 14.7%.

A. Modeling inputs were developed in collaboration with the Detroit Area Advocacy Organizations ("DAAO") to reflect a low-income community solar program and a batteries for medically vulnerable populations program. The specific details of each program are discussed in detail in the testimony of CEO Witnesses Tan, Gignac, and Kenworthy, and DAAO Witness Koeppel. Table 5 below provides a summary of the main modeling inputs for each of these programs.

Table 5. Energy Equity Package Modeling Inputs

	Low Income Solar	**Battery Medical Resiliency**
Cost	2021 NREL ATB	2021 NREL ATB
Profile	DTE Solar	-
Battery Requirement	-	Minimum of 50% energy stored[20]
Firm Capacity	Seasonal	No firm capacity[21]

Q. Did the CEO modeling runs include the retirement of any of DTE's CT units?

A. Yes. The CEO modeling included the retirement of the Greenwood Combustion Turbine ("CT") 12 in 2028. The CEO modeling assumed that the seasonal firm capacity of Greenwood 12 was replaced with a new battery storage resource with an equivalent level of firm capacity for each season. Please see the testimony of Witness Kenworthy for a discussion of why the Greenwood unit was chosen for retirement.

Q. What date was modeled for the retirement of Monroe Units 1 and 2?

A. The CEO modeling included the assumption that Monroe Units 1 and 2 would retire in 2030. I assumed the fixed O&M and capital expenditure costs for a 2030 retirement date

[20] As an example, for a four-hour 5kW battery, the total maximum energy stored would be 20 kWh and under the 50% requirement, at least 10 kWh would need to be stored in the battery resource at all times. This was modeled to account for the energy that would be stored in preparation for an outage.

[21] The firm capacity of the battery storage resources was modeled at 0% to be conservative on the accreditation of the resources.

for Monroe Units 1 and 2 based on information from DTE.[22] Please see the testimony of CEO Witnesses Kenworthy and Bilsback for further discussion about modeling a 2030 retirement date for Monroe Units 1 and 2.

Q. What changes were made to the EWR plan modeled by DTE?

A. The CEO modeling made changes to the EWR plan included in DTE's PCA as recommended by MNSC Witness Chris Neme, which the CEO refer to as EWR Alternative C. The changes include adjusting the costs and savings in comparison to the PCA EWR plan. EWR Alternative C reflects lower costs between 2024 and 2027 and then returns to the PCA EWR costs for the remainder of the planning period. EWR Alternative C also reflects higher firm peak savings for 2024 through 2027 and then reflects a blend of the EWR Alternative C and PCA EWR firm peak savings for the remainder of the planning period. Please see the Direct Testimony of MNSC Witness Chris Neme for further details on the EWR Alternative C.

Q. What changes were made to DTE's assumptions for new resource builds?

A. I relaxed the build constraints that DTE included in its modeling for renewable and battery storage resources. I did maintain DTE's assumption that new wind could not be built until 2028, but I allowed the model to select up to 1,000 MW annually starting in 2028, whereas DTE only allowed the model to select up to 200 MW annually between years 2028 and 2034 and then 1,000 MW annually between 2035 and 2042. Please see the testimony of CEO Witnesses Kenworthy and Lucas for further discussion about new resource build constraints.

Q. Did you allow the model to select new resources that DTE did not model?

[22] Exhibit A-6.1 and EnCompass file "REFRESH_BASE-22_Monroe_BelleRiver_Costs".

A. Yes, I allowed the model to select a multiday battery storage resource starting in 2030. I used the mid-point capital and fixed O&M cost information from the California Public Utilities Commission ("CPUC") IRP Zero-Carbon Technology Assessment released in September 2022.[23] The multiday storage resource was representative of long-duration iron air batteries. The multiday storage resource was included to offer the model an additional zero-carbon firm technology option.

Q. Please describe the process you used to develop the CEO modeling runs presented in your testimony.

A. I started with DTE's database used to develop the PCA. I then implemented the changes outlined in Table 1 for the CEO Alternative Plan. I also looked at the CEO Alternative Plan without the Energy Equity Package and without EWR Alternative C to evaluate the cost differences with and without those changes.

Witness Manning's testimony discussed the potential for the model to select new resources for economic purposes even when there is not a capacity shortfall.[24,25] Since I relaxed the resource build constraints for renewable and battery storage resources, I wanted to be mindful of the possibility that the model might build new resources primarily for purposes of seeking revenue from market sales. To control for this dynamic in our modeling, I decided to optimize the capacity expansion plans under the constraint that no market sales were allowed.[26]

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[23] CPUC IRP Zero-Carbon Technology Assessment. Prepared b Energy and Environmental Economics, Inc. September 2022. Retrieved from https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2022-irp-cycle-events-and-materials/cpuc-irp-zero-carbon-technology-assessment.pdf

[24] Direct Testimony of Witness Manning, page 79.

[25] On pages 79-80 of Witness Manning's Direct Testimony, Witness Manning stated "However, it is not appropriate to build significant amounts of new resources for the primary purpose of selling excess energy and capacity into the market based on the IRP optimization model's algorithms."[25]

[26] The model could still interact with the market for energy purchases.

Once the capacity expansion run was optimized under the no market sales condition, I reviewed the outputs and adjusted the expansion plan for the CEO Alternative Plan to set up build paths for the 2028 and 2030 retirement of the Monroe units. For example, in many cases, the model indicated addition of 2,000 MW of solar in 2030. In order to build up to that level of solar, I then adjusted the buildout to 400 MW each year between 2026 and 2030 to arrive at the 2,000 MW by end of 2030. I also spread solar hybrids and standalone battery storage resources that were selected between 2028 and 2030 evenly across the years from 2027 to 2030. Table 6 and

Table ***7*** show an example of how the 2028 and 2030 builds for solar, solar hybrids, and battery storage were allocated between 2026 and 2030. I then took these plans with an adjusted build path and evaluated them on an 8,760 hourly basis in production cost runs that permitted both market sales and purchases of energy.

Table 6. 2030 Build from Capacity Expansion Plan (MW Additions)

Year	Solar	Solar Hybrid	Battery Hybrid	Battery
2028 Build				839
2030 Build	2,000	800	400	457

Table 7. 2030 Build Path (MW Additions)

Year	Solar	Solar Hybrid	Battery Hybrid	Battery
2026	400			
2027	400	200	100	420
2028	400	200	100	420
2029	400	200	100	229
2030	400	200	100	237

Since the CEO modeling incorporated the seasonal construct and the change to the resource build constraints, I revised DTE's PCA to ensure that the plans could be compared on an apples-to-apples basis for costs. This plan will be referred to as the "Revised DTE PCA." I took the fixed builds that DTE had in its PCA from 2026 to 2031 for solar, solar hybrids, battery storage, and wind resources, and then allowed the model to optimize and build additional resources to meet the seasonal planning reserve margin.[27] I also included DTE's assumption that the CCGT with CCS would come online after the retirement of Monroe Units 1 and 2 in 2035.

Q. Please explain the results of the CEO modeling.

A. Table 8 shows the capacity expansion plan for the CEO Alternative Plan, including the Energy Equity Package and EWR Alternative C. Table 9 shows the capacity expansion plan for the Revised DTE PCA. For the CEO Alternative Plan, the model selects a mixture of solar, wind, and battery storage resources to replace the capacity of Monroe Units 1 and 2 when they retire in 2030.

Table 8. CEO Alternative Expansion Plan (Installed MW) for 2023 - 2035

	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Total Through 2042**
New Resources:														
Solar				400	400	400	400	400				460		4542
Solar Hybrid					200	200	200	200			400	100		2400
Wind						1000	1000	1000	760		1000	20		4808
Battery					419	419	229	236						4022
Battery Hybrid					100	100	100	100			200	50		1200
Battery Ancillary Services[28]			60	60	60									120
Belle River 1 Conversion			517											
Belle River 2 Conversion				517										
CVR/VVO[29]				8	8	8	8	8						40
EWR	165	163	161	164	165	82	85	63	113	90	28	112	46	1576
DG Solar		34	65	66	54	55	133	133	72	71	17	19	51	1411
Low Income Solar		5	8	12	20	38	38	38	38	38	38	38	38	539
Battery Resiliency		0.43	0.86	2.16	3.24	4.32	19.99	19.99	19.99	19.99	19.99	19.99	19.99	257

[27] The Revised DTE PCA was also optimized under the constraint that no market sales were allowed.
[28] Assumed the same build as DTE for 2025 – 2027.
[29] Assumed the same build as DTE for 2026 – 2030.

Table 9. Revised DTE PCA Expansion Plan (Installed MW) for 2023 - 2035

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total Through 2042
New Resources:														
Solar				400	300	200	400	400	800	77		196		5238
Solar Hybrid					100	200					1100	200		2300
Wind						1000	885	1000	1000	312	689			4886
Battery					10	716								3233
Battery Hybrid					50	100					550	100		1150
Battery Ancillary Services			60	60	60									180
Belle River 1 Conversion			517											
Belle River 2 Conversion				517										
CCGT with CCS													946	946
EWR	149	128	116	106	98	78	78	57	103	87	32	109	63	1411
CVR/VVO				8	8	8	8	8						40

Table 10 shows the present value of revenue requirements ("PVRR") results for the CEO Alternative Plans and the DTE Revised PCA. The inclusion of the Energy Equity Package adds cost to the PVRR of the plans, however, this does not mean that the programs should not be pursued. The CEO modeling was a first step in trying to incorporate energy justice programs into the IRP framework and continued work should be done to refine these inputs for representation in IRP modeling. Further, the benefits of the Energy Equity Package are explained in detail by CEO Witnesses Gignac and Kenworthy and DAAO Witness Koeppel. Without the Energy Equity Package included, the CEO Alternative Plan has a comparable cost to the Revised DTE PCA. The "No EWR Alternative C" Plan includes the Energy Equity Package and should be compared against the CEO Alternative Plan with the Energy Equity Package for a cost comparison. The results indicate there are cost savings for EWR Alternative C.

Table 10. PVRR Comparison ($000)

	CEO Alternative	Revised DTE PCA
Include Energy Equity Package	$18,443,946	$18,584,086
No Energy Equity Package	$17,772,099	$17,827,791
No EWR Alternative C	$18,806,910	

Q. How did you incorporate the transmission and distribution upgrade assumptions from the ITC study into the CEO modeling?

A. For the CEO modeling runs, I adopted the transmission upgrade costs associated with the Monroe Units 1 and 2 retiring in 2030 that DTE provided.[30] The battery storage resources added in the CEO Alternative Plan in 2027-2030 have a total capacity that is of similar size to the CCGT with CCS DTE assumed in its PCA. The battery resources could serve as a proxy for how DTE might address transmission-related concerns at Monroe in the absence of any better information about the specific transmission concerns.

III. CONCLUSION

Q. What do you recommend to the Commission?

A. I recommend that DTE pursue a more rapid adoption of renewable and battery storage resources along with additional opportunities for EWR savings in order to prepare itself for the retirement of two or more of the Monroe units. In addition, DTE should explore the earlier retirement of Monroe Units 1 and 2 without the assumed replacement of a CCGT with CCS.

[30] "WP LKM 7 Transmission and Dist costs rev req derivation".

Q. Does this conclude your testimony?

A. Yes.

Chelsea Hotaling
Consultant

ENERGY FUTURES GROUP

Professional Summary

Chelsea is a Consultant at Energy Futures Group specializing in integrated resource planning and load forecasting. Prior to joining EFG, Chelsea held a research position at Clarkson University while completing her Master's in Data Analytics and Environmental Policy & Governance. Chelsea's research focused on multi-stakeholder microgrids for resiliency. She also participated in the Reforming the Energy Vision (REV) proceedings for the Potsdam (NY) microgrid REV project. Chelsea's current work is focused on all aspects of Integrated Resource Planning including capacity expansion and production cost modeling and load forecasting. Chelsea runs the EnCompass model in support of long-term planning exercises such an IRP analyses and has critiqued IRP modeling performed using Aurora, Plexos, PowerSimm, and System Optimizer. Chelsea has experience working with numerous software programs including Python, R, and Stata.

Education

M.S., Data Analytics, Clarkson University, 2020

M.S., Environmental Policy and Governance, Clarkson University, 2019

MBA, Concentration in Environmental Management, Clarkson University, 2012

B.S., Accounting and Economics, Elmira College, 2011

Experience

2021-present: Consultant, Energy Futures Group, Hinesburg, VT

2020-2021: Senior Analyst, Energy Futures Group, Hinesburg, VT

2019-2020: Analyst, Energy Futures Group, Hinesburg, VT

2018-2019: Intern, Sommer Energy, Canton, NY

2016-2019: Research Assistant, Clarkson University, Potsdam, NY

Selected Projects

- GridLab. Performing capacity expansion and production cost modeling within EnCompass to identify resource mixes to achieve 100% emissions-free electricity by 2035 for the Public Service Company of New Mexico's electric system. (2022 to present)
- Sierra Club. Performing capacity expansion and production cost modeling within EnCompass to evaluate retirement and replacement of MidAmerican's coal plants (2022 to present)

- Kentuckians for the Commonwealth, Kentucky Solar Energy Society, and Mountain Association. Reviewed and provided comments on East Kentucky Power Cooperative's 2022 Integrated Resource Plan. (2022)
- Kentuckians for the Commonwealth, Kentucky Solar Energy Society, Metropolitan Housing Coalition, and Mountain Association. Reviewed and provided comments on Louisville Gas & Electric and Kentucky Utilities' 2021 Integrated Resource Plan. (2022)
- The Department of Attorney General and Sierra Club. Reviewed and submitted testimony on the Aurora modeling Indiana Michigan Power Company performed for its 2021 Integrated Resource Plan. (2022)
- The Environmental Law and Policy Center, The Ecology Center, Union of Concerned Scientists, and Vote Solar. Performed Aurora modeling to evaluate higher levels of distributed solar for the Consumers Energy Company's 2021 Integrated Resource Plan. (2020 to 2021)
- Colorado Office of the Utility Consumer Advocate. Performed EnCompass modeling related to the Public Service Company of Colorado's 2021 Electric Resource Plan. (2021)
- Minnesota Center for Environmental Advocacy. Evaluation of Otter Tail Power's 2021 Integrated Resource Plan and EnCompass modeling in support of that evaluation. (2022 to present) Evaluated Minnesota Power's 2021 Integrated Resource Plan and performed EnCompass modeling in support of that evaluation. (2021 to 2022) Evaluated Xcel Energy's 2020 Integrated Resource Plan and performed EnCompass modeling in support of that evaluation. (2019 to 2021)
- Earthjustice. Evaluation of PREPA's request for proposals for temporary emergency generation. (May 2020) Evaluation of the Puerto Rico Electric Power Authority's 2019 Integrated Resource Plan. (2019 to 2020)
- The Council for the New Energy Economics. Participated in Evergy's integrated resource plan stakeholder workshops and performed EnCompass modeling to evaluate coal plant retirements (2020 to 2021).
- EfficiencyOne. Supported EfficiencyOne's participation in Nova Scotia Power's integrated resource planning process. (2019 to 2020)
- Southern Alliance for Clean Energy. Evaluation of Dominion Energy South Carolina's 2020 Integrated Resource Plan. (2020)
- Washington Electric Cooperative. Conducted the analysis for the 2020 Integrated Resource Plan. (2019 to 2020)
- Coalition for Clean Affordable Energy. Evaluated the Public Service Company of New Mexico's abandonment and replacement of the San Juan generating station and performed EnCompass modeling to develop an alternative replacement portfolio. (2019 to 2020)
- Citizens Action Coalition of Indiana. Comments regarding Duke Energy Indiana's integrated resource plans to meet future energy and capacity needs (May 2022). Comments regarding Northern Indiana Public Service Company's integrated resource plans to meet future energy and capacity needs. (March 2022) Comments regarding Southern Indiana Gas and Electric's integrated resource plans to meet future energy and capacity needs (November 2020). Comments regarding Indianapolis Power and Light's integrated resource plans to meet future energy and capacity needs

(April 2020). Comments regarding Indiana Michigan Power Company's integrated resource plans to meet future energy and capacity needs (December 2019).

- Institute for Energy Economics and Financial Analysis (IEEFA). Evaluation of National Grid's long-term natural gas capacity report. (March 2020) Evaluation of the Puerto Rico Energy Commission's proposed wheeling regulation. (March 2019) Co-author for the report Retail Choice Will Not Bring Down Puerto Rico's High Electricity Rates. (August 2018) Evaluation of the Puerto Rico Energy Commission's proposed microgrid rules. (February 2018)

Publications

Hotaling, C., Bird, S., & Heintzelman, M. D. (2021). Willingness to pay for microgrids to enhance community resilience. Energy Policy, 154, 112248.

Atems, B., & Hotaling, C. (2018). The effect of renewable and nonrenewable electricity generation on economic growth. Energy Policy, 112, 111-118.

Bird, S., & Hotaling, C. (2017). Multi-stakeholder microgrids for resilience and sustainability. Environmental Hazards, 16(2), 116-132.

Bird, S., Enayati, A., Hotaling, C., and Ortmeyer, T. (2017). Resilient Community Microgrids: Governance and Operational Challenges. In Energy Internet: An Open Energy Platform to Transform Legacy Power Systems into Open Innovation and Global Economic Engine, edited by Alex Q. Huang and Wencong Su. Elsevier.

Expert Testimony

Before the Kentucky Public Service Commission, Case Number 2022-00387. *In the Matter of Electronic Tariff Filing of Kentucky Power Company for Approval of a Special Contract with Ebon International, LLC,* on behalf of Mountain Association, Kentuckians for the Commonwealth, Appalachian Citizens' Law Center, Sierra Club, and Kentucky Resources Council.

Before the Kentucky Public Service Commission, Case Number 2022-00371. *In the Matter of Electronic Tariff Filing of Kentucky Utilities Company for Approval of an Economic Development Rider Special Contract with Bitiki-KY, LLC,* on behalf of Kentuckians for the Commonwealth, Kentucky Solar Energy Society, Mountain Association, and Kentucky Resources Council.

Before the Iowa Utilities Board, Docket No. RPU-2022-0001. *Application for a Determination of Ratemaking Principle*, on behalf of Environmental Intervenors.

Chelsea Hotaling
Consultant

Before the Michigan Public Service Commission, Case No. U-21189. *In the Matter of the Application of Indiana Michigan Power Company for Approval of its Integrated Resource Plan Pursuant to MCL 460.6t, Avoided Costs and for Other Relief,* on behalf of Attorney General Dana Nessel and Sierra Club.

Before the Michigan Public Service Commission, Case No. U-21090. *In the Matter of the Application of consumers Energy Company for Approval of its Integrated Resource Plan Pursuant to MCL 460.6t and for Other Relief*, on behalf of the Environmental Law and Policy Center, the Ecology Center, Union of Concerned Scientists, and Vote Solar.

Before the Public Utilities Commission of Colorado, Proceeding No. 21A-0141E. *In the Matter of the Application of Public Service Company of Colorado for Approval of its 2021 Electric Resource Plan and Clean Energy Plan*, on behalf of the Colorado Office of the Utility Consumer Advocate.

Energy Futures Group, Inc
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MPSC Case No: U-21193	
Requester: CEO	
Question No.: CEODE-2.33a	
Respondent: S. Burgdorf	
Page: 1 of 1	

Question: Please refer to Burgdorf Direct, page 9, lines 11-25, and page 10 lines 1-9.

a. If DTE has had conversations with MISO about the calculations for DTE's thermal resources under the seasonal construct, please provide all supporting workbooks, with formulas and links intact, that support those calculations.

Answer: DTE Electric objects to the request for the reasons that the request is overly broad, seeks excessive detail, seeks confidential, proprietary research, or commercial information belonging to DTE Electric, the disclosure of which would cause DTE Electric and its customers competitive or commercial harm, seeks information involving Cyber Security, CEII (either critical energy infrastructure information or critical electric infrastructure information), North American Electric Reliability Corporation (NERC) NERC-CIP (including but not limited to BES Cyber Asset information subject to protection under the Information Protection Program pursuant to NERC Reliability Standards CIP-003-6 and CIP-011-2), Supervisory Control and Data Acquisition (SCADA),confidential Midcontinent Independent System Operation (MISO) and ITC Holdings Corp and/or its affiliate companies' information in the possession of DTE Electric, U.S. export control laws and regulations, including but not limited to 10 C.F.R. Part 810 et. seq., or 10 CFR Part 2.390 and is otherwise not reasonably calculated to lead to the discovery of admissible evidence.

Subject to and without waiving this objection, the Company is actively working with MISO to verify preliminary SAC values for the Company's thermal resources for Planning Year 2023/24. The Company will supplement this response when SAC values for Planning Year 2023/24 are finalized.

Attachment: *None.*

STATE OF MICHIGAN
MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief.	)))))	Docket No. U-21193 Administrative Law Judge Sharon Feldman

DIRECT TESTIMONY OF
JAMES GIGNAC

March 9, 2023

I. BACKGROUND AND SUMMARY

Q. Please state your name and business address.

A. My name is James Gignac. I use pronouns he, him, his. My business address is 1 N. LaSalle St., Suite 1904, Chicago, Illinois, 60602.

Q. By whom are you employed and in what capacity?

A. I am employed by the Union of Concerned Scientists ("UCS") as Midwest Senior Policy Manager for the Climate & Energy Program. In this role, I serve in an expert and team leadership capacity to manage and shape the organization's clean energy policy agenda in the Midwest. Along with colleagues, I plan, coordinate, and engage in strategic energy policy advocacy efforts, and contribute to research, analysis, and communication efforts on progressive energy policy, regulatory matters, and market reforms designed to modernize the electric grid and facilitate the equitable transition away from fossil fuels and toward greater use of clean energy resources. In my previous roles with UCS, I served as Senior and Lead Midwest Energy Analyst and conducted research and analysis to advance understanding of renewable and other energy technologies, policies, and markets, and to evaluate energy resource and climate change mitigation options in the electricity sector.

UCS was founded in 1969 by scientists and students at the Massachusetts Institute of Technology. UCS employs scientists, analysts, and engineers to develop and implement innovative, practical solutions to some of the most pressing problems that society faces today—from developing sustainable ways to feed, power, and transport humanity, to reducing the threat of nuclear war. UCS's mission is to put rigorous, independent science to work by combining technical analysis and effective advocacy to create policy solutions for a healthy, safe, and sustainable future.[1]

Q. On whose behalf are you submitting this direct testimony?

A. I appear here in my capacity as an expert witness on behalf of the Ecology Center, the Environmental Law & Policy Center, the Union of Concerned Scientists, and Vote Solar. I refer to these parties collectively in this case as the Clean Energy Organizations, or "CEO."

Q. Please summarize your qualifications, experience, and education.

A. I am a policy expert, analyst, and former attorney with over 17 years of experience in the environmental and energy fields. In my current role, I support UCS's efforts to promote the understanding and adoption of clean energy alternatives in the Midwest and nationally. I joined UCS in 2018 after serving as Environmental and Energy Counsel and an Assistant Attorney General to the Office of Illinois Attorney General Lisa Madigan. In that capacity I was responsible for representing the Attorney General, state agencies, and the People and State of Illinois in environmental, energy, and utility regulatory matters including rulemakings and enforcement cases. I began my career as an environmental attorney representing private sector clients and then worked for a national environmental organization assisting efforts related to coal-fired power plants in Midwest states including Michigan. I received a B.A. in History and Political Science from Albion College located in Albion, Michigan. I earned a Juris Doctorate from Harvard Law School located in Cambridge, Massachusetts. I was licensed to practice law by the Supreme Court of the

[1] For more information, including UCS's history and mission statement, visit: https://www.ucsusa.org/about-us.

State of Illinois beginning in 2005 and took voluntary inactive status in 2021. My resume is included as Exhibit CEO-8.

Q. Have you testified before the Michigan Public Service Commission previously?

A. Yes. I provided testimony in the following cases:

- *In the Matter of the Application of Consumers Energy Company for Approval of Its Integrated Resource Plan*, Case No. U-21090
- *In the Matter of the Application of DTE Electric Company for Approval of Its Integrated Resource Plan*, Case No. U-20471
- *In the Matter of the Application of Consumers Energy Company for Approval of Its Integrated Resource Plan*, Case No. U-20165.

Q. Have you testified or provided comments in similar state regulatory proceedings?

A. Yes. I submitted pre-filed testimony and appeared as a testifying witness at hearing before the Illinois Pollution Control Board on behalf of the Environmental Law & Policy Center, Environmental Defense Fund, Natural Resources Defense Council, Respiratory Health Association, and Sierra Club in a rulemaking proceeding involving state air pollution standards for coal-fired power plants entitled *In the Matter of: Amendments to 35 Ill. Adm. Code 225.233 Multi-Pollutant Standards (MPS)*, R18-20. Earlier in that same matter, with the Illinois Attorney General's Office, I submitted pre-filed testimony and appeared for cross-examination as a testifying witness.

I have prepared several sets of energy-related comments and presentations in various Michigan Public Service Commission, Illinois Commerce Commission, and Minnesota and Illinois legislative proceedings and workshops. *See* Exhibit CEO-8. With the Illinois Attorney General's Office, I also assisted with petitions and comments to the Federal Energy Regulatory Commission regarding capacity markets and grid resiliency matters and prepared comments to the Illinois Department of Natural Resources' rulemaking regarding regulation of high-volume hydraulic fracturing for oil and gas.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibits:

- Exhibit CEO-8: Resume of James Gignac
- Exhibit CEO-9: *Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan*
- Exhibit CEO-10: *Designing a Neighborhood Microgrid: Envisioning a Microgrid for the Parker Village Neighborhood in Highland Park, Michigan*
- Exhibit CEO-11: *On the Road to 100 Percent Renewables: States Can Lead an Equitable Energy Transition*
- Exhibit CEO-12: *On the Road to 100 Percent Renewables for Michigan: Strengthening the State's Energy Transition*

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to explain the concept of energy justice and provide background and context for the CEO collaboration with the Detroit Area Advocacy Organizations ("DAAO").

Q. Please summarize your conclusions and recommendations.

A. I conclude that the Commission should direct DTE to revise its IRP to better embrace energy justice and pursue an equitable grid transition in accordance with the recommendations of CEO witnesses, including adoption of programs aligning with the DAAO-CEO proposals for community solar and batteries for medically vulnerable populations (*i.e.*, the "Energy Equity Package"). The Commission should also direct all Michigan utilities to incorporate energy justice and equitable grid transition as planning principles in IRPs and other proceedings. A "reasonable and prudent" IRP must embrace the concepts of energy justice and equitable grid transition. An IRP proposed course of action that does not meaningfully consider these concepts is neither reasonable nor prudent; for example, the Energy Equity Package described here promotes energy justice and equitable grid transition but also aids reliability and diversity of generation supply, two of the factors the Commission must balance in determining whether an IRP is "the most reasonable and prudent" under MCL 460.6t(8).

II. <u>ENERGY JUSTICE AND EQUITABLE GRID TRANSITION</u>

Q. What is your understanding of the term "energy justice"?

A. Energy justice is an outgrowth of environmental justice, the latter of which the U.S. Department of Energy defines as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies."[2] Energy justice, as defined by the Initiative for Energy Justice, "refers to the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system."[3] Further, "energy justice explicitly centers the concerns of marginalized communities and aims to make energy more accessible, affordable, clean, and democratically managed for all communities."[4]

Like environmental justice, energy justice can be understood to have four essential elements: (1) procedural justice and meaningful participation in decision-making; (2) distributive justice in ensuring equitable distribution of the benefits and burdens of the system; (3) recognition justice of understanding the history and context of the system; and

[2] https://www.energy.gov/sites/default/files/2022-07/Environmental%20Justice%20Explainer%207_25_22.pdf
[3] https://iejusa.org/section-1-defining-energy-justice/
[4] *Id*.

(4) restorative justice of facilitating healing and harmony.[5] As explained by Professors Gabriel Chan and Alexandra Klass, "[e]nergy justice considers the distribution of costs and benefits from the generation, distribution, and consumption of energy; the process of energy decisionmaking; the recognition of unequal historical energy system impacts; and the need for the energy system to move towards a restorative justice frame."[6]

Q. What is your understanding of the term "equitable grid transition?"

A. Equitable grid transition is an outcome of energy justice. It can also be understood as a subset or specific application of energy justice actions that results in an equitable system of supply, transport, and distribution of electricity. Equitable grid transition is the process of shifting from the "business as usual" context that seldom centered or meaningfully included energy justice considerations to a context where the electric grid is planned, developed, and operated to deliver energy justice.

Q. What experience do you have working with energy justice and equitable grid transition concepts?

A. In 2021, UCS and Soulardarity published a report entitled *Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan* (Exhibit CEO-9).[7] We explored how Highland Park, an enclave city within Detroit, could envision a future of clean energy and move to a locally controlled, equitable, and just energy system—a community powered 100 percent by local, resilient, and affordable clean energy sources, owned by local people and businesses. *Let Communities Choose* explores a potential pathway to achieving the bright, resilient vision this city's residents have for their community through a combination

[5] https://www.energy.gov/sites/default/files/2022-07/Environmental%20Justice%20Explainer%207_25_22.pdf
[6] Regulating for Energy Justice, 97 NYU L. Rev. 1426, 1437 (Nov. 2022), available at https://www.nyulawreview.org/wp-content/uploads/2022/11/NYULawReview-Volume-97-Issue-5-ChanKlass.pdf
[7] https://www.ucsusa.org/sites/default/files/2021-10/Let-Communities-Choose-10-12-21.pdf

of energy efficiency, rooftop solar, community solar, other forms of distributed solar, and a community water and energy resource center. The report considers the policy changes and the modifications to a traditional utility's incentives and ways of operating that are needed to achieve that vision and its emphasis on an equitable distribution of benefits.

UCS and Parker Village, a sustainable neighborhood development in Highland Park, also published a follow-up case study in 2022 that examined options for a solar-plus-storage microgrid in Parker Village (Exhibit CEO-10).[8] Parker Village's interest in a microgrid stems from a desire for community independence, self-sufficiency, and electricity reliability. It envisions a neighborhood powered by onsite solar and energy storage batteries to generate its own power versus relying on utilities' large, often polluting, fossil fuel power plants. Equally important to Parker Village is ensuring electricity reliability.

Highland Parkers and their neighbors in Detroit have long suffered from power outages and underinvestment in their local electric distribution system. A 2021 report by the Citizens Utility Board found that Michigan ranked 46th out of 50 states and the District of Columbia with respect to average performance in electric utility reliability rankings.[9] Additionally, when customers of DTE suffer an outage, it can take a long time to restore power: an average of more than five and half hours.[10] Increased energy efficiency, distributed generation, community solar, batteries, and microgrids—examined in the analyses discussed above—would all help to improve reliability for communities like Highland Park.

[8] https://www.ucsusa.org/sites/default/files/2022-03/designing-neighborhood-microgrid.pdf
[9] https://www.citizensutilityboard.org/wp-content/uploads/2021/07/Electric-Utility-Performance-A-State-By-State-Data-Review_final.pdf
[10] Page 20, Figure 14: https://www.cubofmichigan.org/utility_performance_report_2021_edition

In 2022, UCS and our project partners published *On the Road to 100 Percent Renewables: States Can Lead an Equitable Energy Transition*, a report finding that achievement of 100 percent renewable energy standards in U.S. Climate Alliance[11] states, including Michigan, is feasible and would deliver significant health and economic benefits (Exhibit CEO-11).[12] UCS and the Michigan Environmental Justice Coalition also produced a state-specific fact sheet for Michigan outlining how the state could meet its electricity needs completely and equitably with renewable energy by 2035 and dramatically reduce its use of fossil fuels in vehicles and buildings (Exhibit CEO-12).[13] Our policy recommendations in the main report and Michigan fact sheet centered on avoiding the perpetuation of historic inequities in the energy sector. Some of the key recommendations include:

- Target reductions in pollution from electricity generation to prioritize already overburdened communities.
- Promote direct investments in expanding rooftop and community solar, energy efficiency, and the electrification of transportation and heating, with a priority on investments in historically underserved people and communities.
- Address energy burdens through targeted energy rates and expanding access to energy efficiency, rooftop solar, and other clean energy strategies for low- to moderate-income households.
- Ensure that frontline communities have power in decisionmaking.

Q. How can these recommendations be put into action in the IRP planning process?

A. Below are some examples of how the recommendations could, and should, be applied to DTE's IRP and other utility IRPs:

- Conducting a robust environmental justice and emission analysis like that provided in this case by Physicians, Scientists, and Engineers for Healthy

[11] For more information about the U.S. Climate Alliance, see here: http://www.usclimatealliance.org/
[12] https://www.ucsusa.org/sites/default/files/2022-05/on-the-road-100-renewable-report.pdf
[13] https://www.ucsusa.org/sites/default/files/2022-05/on-the-road-100-renewable-mi-fact-sheet.pdf

Energy and incorporating the results of that analysis into retirement decisions of fossil fuel plants.

- Selecting all cost-effective energy efficiency and demand response resources for inclusion.

- Promoting direct investments in expanding solar and storage access for low- to moderate-income households, underserved populations, and people with special needs by including resource sets and programs like the community solar and batteries for medically vulnerable residents as suggested in this case by CEO and DAAO witnesses and discussed further below.

- Conducting specific outreach to frontline and environmental justice communities during plan development to understand customers' experiences and burdens, solicit ideas and input on needs and improvements, and meaningfully incorporate that feedback into the proposed IRP; the Commission should also conduct post-filing public hearings specifically geared toward and accessible to such communities.

Q. Should energy justice be a planning principle and if so, how?

A. Yes. The Commission has a duty and obligation to regulate in the public interest. *See City of Detroit v. Public Service Comm.*, 308 Mich. 706, 715 (1944) ("It is the duty of the Commission, under its statutory power, to fix a just and reasonable rate. This can be accomplished only by balancing the interest of public utility investors and the consuming public."). Additionally, pursuant to MCL 460.6t(8)(a), the Commission may approve an IRP only if it "represents the *most* reasonable and prudent means of meeting the electric utility's energy and capacity needs" (emphasis added).

In carrying out its duties to determine what is just, reasonable, and prudent, the Commission has the discretion to advance energy justice to improve the livelihoods of marginalized communities.[14] As stated by Dr. Gabriel Chan in testimony to the Minnesota

[14] *See, e.g.*, Testimony of Dr. Gabriel Chan on Behalf of Just Solar Coalition to the Minnesota Public Utilities Commission in *In the Matter of the Application of Northern States Power Company for Authority to Increase Rates for Electric Service in Minnesota*, Docket No. 21-630 (October 2, 2022), available at: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={7056A383-0000-C438-ADB8-C0779764F7AA}&documentTitle=202210-189513-04.

Public Utilities Commission, through their obligation to reflect the interests of the public, entities such as the Michigan Public Service Commission can and should "make decisions that build toward a future vision that aligns with the goals" of energy justice and an equitable grid transition.[15] To assist in that decisionmaking, the Commission should direct utilities to incorporate energy justice and equitable grid transition principles[16] into their planning processes for review by the Commission, intervening parties and stakeholders, and the general public. The Commission should not approve an IRP that does not include robust consideration of the core tenets of energy justice (*i.e.*, procedural, distributive, recognition, and restorative justice).

Witnesses from PSE Healthy Energy explain how this case can build toward a future of cleaner, healthier, and more equitable energy future. Witness Kelsey Bilsback's testimony provides a more robust environmental justice analysis compared to what DTE conducted, including a quantification of the public health impacts from the continued operation of DTE's fossil fuel resources. Witness Boris Lukanov analyzes the energy cost burdens for DTE customers, particularly low- and moderate-income ratepayers, and described how sustainable and long-lasting solutions such as energy efficiency and distributed energy resources can help reduce the affordability gap in DTE's service territory. Witness William Kenworthy also elaborates on energy and environmental justice with respect to the Commission and to the CEO Alternative Plan. Witness Kenworthy recommends that the Commission direct DTE to adopt the CEO Alternative Plan with the

[15] *Id*. at 9.
[16] As an example of applying equitable grid transition principles in a specific context, see *Principles of Equitable Policy Design for Energy Storage*, a 2019 project by the Union of Concerned Scientists and participating organizations that outlines the key principles of: (1) reducing emissions, (2) improving resilience, (3) promoting local economic development, (4) accelerating greater levels of renewable energy deployment, (5) protecting consumers, and (6) ensuring participation. https://www.ucsusa.org/sites/default/files/attach/2019/05/equitable-policy-storage-principles.pdf

Energy Equity Package, accelerate the retirements of Monroe Units 1 and 2, model distributed generation as a resource, accelerate deployment of clean energy resources, and develop a plan to phase out its fossil peaking units, among other recommendations.

III. DAAO-CEO RESOURCE SETS FOR LOW- TO MODERATE INCOME HOUSEHOLDS

Q. Who are the Detroit Area Advocacy Organizations ("DAAO")?

A. The Detroit Area Advocacy Organizations ("DAAO") are intervening parties in this case and include Soulardarity, a Highland Park, Michigan, organization, and We Want Green, Too, an organization based in East Detroit. For additional details on the DAAO, please see the testimony of Witness Jackson Koeppel.

Q. How have the CEO collaborated with DAAO in this case?

A. The CEO collaborated with DAAO by creating specific resource sets targeted at low- to moderate-income households for use in the EnCompass modeling conducted by Chelsea Hotaling of Energy Futures Group and the environmental justice and equity analysis developed by Physicians, Scientists, and Engineers for Health Energy.

Q. What were the resource sets you developed?

A. We created resource set inputs for (1) community solar and for (2) batteries for medically vulnerable populations.

Q. What is community solar and why was it chosen?

A. Community solar refers to solar installations that enable subscribing customers to receive credit on their electricity bills for the electricity produced. This model is particularly advantageous for residents or businesses unable to pursue rooftop solar, either because they are renters or because their roofs cannot accommodate solar. Additionally, many low- to moderate-income ("LMI") households may not be able to afford, or may not have access to financing for, the upfront costs of installing solar themselves. In this way, community solar allows all electricity customers the ability to participate in solar and benefit from cost savings.[17] Please see Witness Boratha Tan's testimony for details on how our community solar assumptions were developed.

Q. Is the availability of community solar a part of energy justice?

A. Yes, because there cannot be a just clean energy future without ensuring that all residents can share in and benefit from the deployment of solar. While the median income of the average household installing rooftop solar is dropping over time,[18] 2017 research showed that households earning less than $45,000 annually accounted for only 13 percent of solar photovoltaic installations while representing 25 percent of total population.[19] Further, community solar helps address what is known as the split-incentive problem that appears in multiple energy contexts, including solar, energy efficiency, and beneficial electrification investments. As pointed out by Dr. Tony Reames, "LMI households are more likely to rent, by which the property owner, or landlord, who would be responsible for the cost of energy-related improvements has no incentive to [invest in energy upgrades], as they will not realize the immediate benefits [due to most renter-occupied households paying energy costs directly]."[20]

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[17] *See generally* Nate Hausman, *How Community Solar Can Benefit Low- and Moderate-Income Customers,* World Resources Institute (June 16, 2022), available at: https://www.wri.org/insights/community-solar-low-income-customers; Heeter, Jenny, et al., *Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential*, NREL (2021), available at: https://www.nrel.gov/docs/fy21osti/80532.pdf.
[18] https://www.utilitydive.com/news/low-income-residential-solar-rising-income-gap-remains-California-Texas-Florida/635527/
[19] *See* Tony G. Reames, Distributional Disparities in Residential Solar Potential and Penetration in Four Cities in the United States, Energy Research & Social Science, Volume 69, November 2020, 101612, available at https://www.sciencedirect.com/science/article/abs/pii/S2214629620301870.
[20] *Id*.

We should also ensure that community solar facilities can be owned and developed by third parties, locally, and not only built by utilities to better encourage diversity, competition, and provision of local benefits. Please see the testimony of DAAO Witness Koeppel for further discussion of the importance of expanding community ownership of energy generation and why community solar is essential for equitable solar deployment.

Q. Why were batteries for medically vulnerable populations selected?

A. Energy storage batteries installed at residences can assist in times of power outages, increasing local reliability and resiliency. People receiving medical support at home may often require the use of various equipment for their care. This can include things like oxygen tanks, ventilators, and electric wheelchairs for mobility. Equipment like this requires power to charge or operate, and it is crucial that it is in working order. Other needs like prescription medications, such as insulin, require refrigeration.

For many customers that are dependent on electrically powered medical equipment, outages of even short durations can literally mean life or death.[21] For example, in 2019 Pacific Gas & Electric Company issued power shutoffs in California as an attempt to mitigate wildfire risks and promote public safety. As a result, over 700,000 households lost power in the first round of shutoffs. Tragically, Robert Mardis Sr., a man who used an electric oxygen tank to aid his breathing, died only minutes after a shutoff affected his household.[22] The recent episodes of widespread power outages in Michigan caused substantial distress for many people, particularly those that rely on electrically powered medical equipment. Energy storage batteries can help with this problem.

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[21] https://www.cleanegroup.org/wp-content/uploads/Home-Health-Care-in-the-Dark.pdf
[22] *See* Maria Chavez, *Energy Storage Can Be a Life Saver for People With Disabilities, But Policymakers Can Do More*, Utility Dive (March 6, 2023), available at: https://www.utilitydive.com/news/energy-storage-microgrids-life-saver-people-disabilities-extreme-weather-battery-backup/644126/.

Please see Witness Boratha Tan's testimony for details on how our assumptions regarding batteries for electricity-dependent Medicare recipients were developed.

Q. Is the availability of energy storage batteries for medically vulnerable populations a part of energy justice?

A. Yes, because a just energy future and an equitable grid transition must ensure essential life-supporting energy resources are available for people with disabilities. During climate disasters and extreme weather events, people with underlying health conditions and disabilities face disproportionate harm.[23] This disproportionate harm arises from lack of inclusive planning, scarce resources, and discrimination. These systemic issues are among the reasons why people with disabilities face global mortality rates that are four times higher than those without disabilities during natural disasters.[24] Additionally, the current deployment of energy storage batteries in residential applications tends to be heavily concentrated in areas with higher median income and lower environmental justice concern.[25] An equitable grid transition means that LMI households, especially those with medically vulnerable residents, must have access to the benefits that energy storage batteries provide.

A program such as the one described here makes even more sense recognizing that DTE needs to have more batteries tied to the distribution grid in general. Deploying batteries with priority for communities and residences that need them the most is both ethical and pragmatic.

[23] https://hls.harvard.edu/today/disability-in-a-time-of-climate-disaster/
[24] Penelope J.S. Stein and Michael Ashly Stein, *Climate Change and the Right to Health of People with Disabilities*, The Lancet Global Health, Volume 10, Issue 1 (January 2022), available at: https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(21)00542-8/fulltext.
[25] David P. Brown, *Socioeconomic and Demographic Disparities in Residential Battery Storage Adoption: Evidence from California*, Energy Policy, Volume 164, 112877 (May 2022), available at: https://www.sciencedirect.com/science/article/abs/pii/S0301421522001021.

IV. <u>CONCLUSION</u>

Q. How does the CEO Alternative Plan better pursue energy justice and an equitable grid transition?

A. Witness Kenworthy describes the CEO Alternative Plan. Cleaner energy means less pollution, especially for traditionally overburdened environmental justice communities. Targeted programs like community solar and batteries for medically dependent customers also displays an awareness of and commitment to energy justice and pursuit of an equitable grid transition while increasing reliability and providing for a greater range of supply options.

Q. What should the Commission do in this case?

A. The Commission should direct DTE to revise its IRP to better embrace energy justice and clearly identify the strategy and steps DTE will pursue to advance an equitable grid transition in accordance with the recommendations of CEO witnesses, including adoption of programs to pursue the DAAO-CEO Energy Equity Package of community solar for low- to moderate-income renters and batteries for medically vulnerable populations. The Commission should also direct utilities to incorporate energy justice as a planning principle in IRPs and other proceedings.

Q. Does this conclude your testimony?

A. Yes.

JAMES P. GIGNAC

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EXPERIENCE

Midwest Senior Policy Manager, Climate & Energy Program, Union of Concerned Scientists, Chicago, IL

(December 2022–present). Serve in an expert and team leadership capacity to manage and shape the organization's clean energy policy agenda in the Midwest. Along with colleagues, plan, coordinate, and engage in strategic energy policy advocacy efforts, and contribute to research, analysis, and communication efforts on progressive energy policy, regulatory results, and market reforms designed to modernize the electric grid and facilitate the equitable transition away from fossil fuels and toward greater use of clean energy resources.

Senior Midwest Energy Analyst (August 2020–December 2022); Lead Midwest Energy Analyst (March 2018–August 2020). Conducted research and analysis to advance understanding of renewable and other energy technologies, policies, and markets, and to evaluate energy resource and climate change mitigation options in the electricity sector. Wrote and edited technical reports, fact sheets, and other materials to document and communicate research results; prepared regulatory and legislative comments and testimony; developed policy and legislative proposals; met with policymakers, regulators, and stakeholders; represented the organization and its positions at public forums.

Environmental and Energy Counsel and Assistant Attorney General to the Office of Illinois Attorney General Lisa Madigan, Chicago, IL

(Nov. 2011–March 2018). Summary: Served as assistant attorney general in advanced special counsel role; handled select regulatory, legislative, and litigation matters with an emphasis on renewable energy, coal, nuclear, efficiency, and climate change issues; explored and evaluated new matters and cases; served as liaison to external stakeholders and groups; interacted with government officials and decision-makers; frequently appeared before state and regional gatherings to speak and present on energy and environmental issues.

Examples of specific roles/efforts:

- Provided expert advice to the Attorney General and senior staff on environmental and energy policy matters;
- Prepared comments, testimony, and draft language for legislative and state commissions and agencies;

- Spearheaded Illinois participation in multi-state attorneys general matters involving federal issues such as: Clean Power Plan litigation, methane regulation, DOE efficiency standards, and other Clean Air Act rules;
- Advised re: Volkswagen $3 billion environmental mitigation trust fund and zero emission vehicle program;
- Focused on implementation of new renewable energy programs in Illinois, especially low-income solar.

Midwest Director, Sierra Club's Beyond Coal Campaign, Chicago, IL

(June 2008–Oct. 2011). Coordinated legal, grassroots organizing, and communications activities to prevent new coal plant projects and to replace existing coal capacity with clean energy solutions; served as coal working group leader for regional network of foundations and advocacy organizations.

Associate, Mayer Brown LLP, Chicago, IL

(Sept. 2005–May 2008). Represented a wide variety of private sector clients in environmental litigation, regulatory, and transactional matters, including chemical, railroad, real estate, manufacturing, mining, and wind energy industries.

Judicial Law Clerk, Alaska Supreme Court, Anchorage, AK

(Sept. 2004–Sept.2005). Assisted with all aspects of resolving appellate litigation.

EDUCATION

Harvard Law School, J.D. (2004) (Dean's Award, Community Leadership)

Albion College, B.A., History and Political Science (2001) (*summa cum laude*; Phi Beta Kappa)

TESTIMONY IN REGULATORY AND LEGISLATIVE PROCEEDINGS

- Written testimony to the Minnesota Senate Energy, Utilities, Environment, and Climate Committee on 100% Clean Energy Legislation (January 20, 2023)

- Written testimony to the Minnesota House of Representatives Climate and Energy Finance and Policy Committee on 100% Clean Energy Legislation (January 13, 2023)

- Direct testimony on behalf of the Environmental Law & Policy Center, Ecology Center, Union of Concerned Scientists, and Vote Solar before the Michigan Public Service Commission in *In the Matter of the Application of Consumers Energy Company for Approval of Its Integrated Resource Plan*, Case No. U-21090 (May 9, 2022)

- Direct testimony on behalf of the Environmental Law & Policy Center, Ecology Center, Solar Energy Industries Association, Union of Concerned Scientists, and Vote Solar before the Michigan Public Service Commission in *In the Matter of the Application of DTE Electric Company for Approval of Its Integrated Resource Plan*, Case No. U-20471 (August 21, 2019)

- Pre-filed testimony on behalf of the Environmental Law & Policy Center, Environmental Defense Fund, Natural Resources Defense Council, Respiratory Health Association, and Sierra Club before the Illinois Pollution Control Board in *In the Matter of: Amendments to 35 Ill. Adm. Code 225.233 Multi-Pollutant Standards (MPS)*, R18-20 (December 10, 2018).
    - Testifying witness at hearing (January 29, 2019)

- Direct testimony on behalf of the Environmental Law & Policy Center, Ecology Center, Union of Concerned Scientists, and Vote Solar before the Michigan Public Service Commission in *In the Matter of the Application of Consumers Energy Company for Approval of Its Integrated Resource Plan*, Case No. U-20165 (October 12, 2018)
    - Additional direct testimony (settlement agreement) (April 19, 2019)

- Pre-filed testimony on behalf of the Illinois Attorney General's Office before the Illinois Pollution Control Board in *In the Matter of: Amendments to 35 Ill. Adm. Code 225.233 Multi-Pollutant Standards (MPS)*, R18-20 (December 11, 2017)
    - Responses to pre-filed questions (January 12, 2018)
    - Testifying witness at hearings (January 17-18, 2018)
    - Responses to questions (February 16, 2018)
    - Testifying witness at hearing (March 7, 2018)

- Testimony before the State of Illinois House of Representatives Renewable Energy & Sustainability Committee, Hearing on Consumer and Public Health Impacts of Utilizing Renewable Energy Sources and Increased Energy Efficiency Programs (April 29, 2015)

COMMENTS IN REGULATORY PROCEEDINGS

- Comments on the Michigan Public Service Commission Staff's Draft Report on the Michigan Integrated Resource Planning Parameters (Case No. U-21219) (September 12, 2022)
    - Reply Comments (October 3, 2022)

- Comments on Michigan's Proposed Revised Integrated Resource Plan Filing Requirements (Case No. U-18461) (September 12, 2022)
    - Reply Comments (October 3, 2022)

- Comments to the Michigan Department of Environment, Great Lakes, and Energy on the Draft MI Healthy Climate Plan (March 14, 2022)

- Joint Comments on the Michigan Public Service Commission Staff's Report Entitled "Emissions Reporting Requirements for Utility IRPs" (January 12, 2021)
- Michigan Public Service Commission MI Power Grid Process, multiple written comment submissions and participation in working groups on behalf of Union of Concerned Scientists (2020–2022)
- Comments on behalf of Union of Concerned Scientists to the Illinois Power Agency regarding Updates to Long-Term Renewable Resources Procurement Plan (July 2019)
- Illinois Commerce Commission *NextGrid* Process, multiple written comment submissions and participation in working groups on behalf of Union of Concerned Scientists (June-September 2018)
- Comments on behalf of Union of Concerned Scientists, et al. to the Illinois Commerce Commission's Distributed Generation Valuation and Compensation Workshop (July 27, 2018 and March 30, 2018)
- Comments on behalf of the Illinois Attorney General's Office to the Illinois Commerce Commision workshops regarding resource adequacy in MISO Zone 4 (January 30, 2018 and November 30, 2017)
- Verified Reply to Responses to Objections to the Illinois Commerce Commission on the *Illinois Power Agency Petition for Approval of the Long-Term Renewable Resources Procurement Plan*, Docket No. 17-0838 (January 25, 2018); Response to Objections (January 11, 2018)
- Comments on behalf of the Illinois Attorney General's Office to the Illinois Power Agency regarding the Draft Long-Term Renewable Resources Procurement Plan (November 13, 2017)
- Comments on behalf of the Illinois Attorney General, et al. to the Federal Energy Regulatory Commission in *Grid Reliability and Resiliency Pricing*, Docket No. RM18-1 (October 23, 2017)
- Comments on behalf of the Illinois Attorney General's Office to the Illinois Power Agency regarding Development of Long-Term Renewable Resources Procurement Plan (July 5, 2017)
- Comments on behalf of the Illinois Attorney General's Office to the U.S. Department of Justice on the Proposed Partial Consent Decree in *In re: Volkswagen "Clean Diesel" Marketing, Sales Practices, and Products Liability Litigation*, Case No: MDL No. 2672 CRB (JSC) (August 5, 2016)
- Response Comments on behalf of the People of the State of Illinois before the Illinois Pollution Control Board in *In the Matter of Amendments to 35 Ill. Adm. Code Part 214, Sulfur Limitations, Part 217 Nitrogen Oxides Limitations, and Part 225, Control of*

Emissions From Large Combustion Sources, R-15-21 (September 11, 2015); Initial Comments (August 28, 2015)

- Verified Initial Comments on behalf of the People of the State of Illinois before the Illinois Commerce Commission in *Amendment of 83 Ill. Adm. Code 465 [Net Metering]*, ICC Docket No. 15-0273 (June 24, 2015); Verified Reply Comments (July 27, 2015)
- Complaint to Federal Energy Regulatory Commission, *Challenging the MISO 2015-16 Planning Resource Auction Rate for Zone 4 as Unjust and Unreasonable*, Docket No. EL15-71 (May 28, 2015); Response to Motions to Dismiss and Answer (July 17, 2015); Answer (August 14, 2015)
- Post-Hearing Comments to the Illinois Pollution Control Board in *In the Matter of: Coal Combustion Waste (CCW) Surface Impoundments at Power Generating Facilities: Proposed New 35 Ill. Adm. Code 841*, R14-10 (October 20, 2014)
- Comments to the Illinois Department of Natural Resources on Proposed Administrative Rules for the Hydraulic Fracturing Regulatory Act (62 Ill. Adm. Code 245 and 240.796) (January 2, 2014)
- Comments to the Illinois Pollution Control Board in *Illinois Power Holdings, LLC v. Illinois Environmental Protection Agency*, PCB 14-10 (Variance-Air) (September 24, 2013)
- Comments to the Illinois Power Agency on the 2013 Draft Procurement Plan (September 14, 2012)
- Comments to the Illinois Pollution Control Board in *Ameren Energy Resources v. Illinois Environmental Protection Agency*, PCB 12-126 (Variance-Air) (July 23, 2012); Post-Hearing Comments (August 10, 2012)

PRESENTATIONS

- Session Speaker and Facilitator, UCS Equitable Grid Convening (New Orleans, LA) (October 28–29, 2022)
- Equity and Environmental Justice in Clean Energy Policy: Renewable Energy Markets (REM) 2022 (Minneapolis, MN) (September 15, 2022)
- Illinois' Climate and Equitable Jobs Act: U.S. Climate Action Network Annual Meeting (Virtual) (June 23, 2022)
- On the Road to 100 Percent Renewables: RE-AMP Network (Online) (June 13, 2022)
- Study: What Does Minnesota Power's Long-Range Plan Mean for Equity and Public Health?, Fresh Energy Webinar (Online) (May 19, 2022)

- On the Road to 100 Percent Renewables for Minnesota: Energy Foundation Minnesota Climate Table (Online) (May 11, 2022)
- Climate Change Myths and Realities: Forest Preserves of Cook County Lunch & Learn (Online) (March 16, 2022)
- Let Communities Choose: A Clean Energy Sovereignty Analysis for Highland Park, Michigan (MI Healthy Climate Plan Working Group) (June 29, 2021)
- Environmental Sector Speaker, MISO Board and Advisory Council Environmental Justice Session (June 16, 2021)
- Climate Change and People-Centered Approach to Michigan's Decarbonization: Grand Rapids Breakfast Club Early Risers (Grand Rapids, MI) (June 2, 2021)
- Killer Heat in the United States: Climate Choices and the Future of Dangerously Hot Days (Roselle, IL) (January 9, 2020)
- Clean Energy Town Hall (Highland Park, IL) (November 19, 2019)
- Time-Varying Rates: Illinois NextGrid Working Group (Chicago, IL) (July 30, 2018)
- Illinois Climate and Energy Activities: Federal and State, Chicago Bar Association (Chicago, IL) (February 21, 2018)
- Illinois Commerce Commission Renewable Energy Policy Session (Chicago, IL) (July 12, 2017)
- The Changing Electricity Grid: Issues and Opportunities for State Attorney General Offices, National Association of Attorneys General (Charlotte, NC) (March 17, 2016)
- Clean Power Plan Litigation, Chicago Bar Association (Chicago, IL) (March 2016)
- Closing and Redeveloping Power Plant Sites: Lessons from the Chicago Area, American Bar Association (Chicago, IL) (October 29, 2015)
- Clean Power Plan Update, Illinois State Bar Association (Chicago, IL) (October 21, 2015)
- Clean Power Plan Implementation, Air & Waste Management National Conference (Rosemont, IL) (September 2015)
- Air Regulatory Update & Clean Power Plan Implementation, Midwest Environmental Enforcement Association (Madison, WI) (July 1, 2015)
- Nuclear Power Update, Midwest Environmental Enforcement Association (Madison, WI) (July 1, 2015)
- Petroleum Coke Regulation, Illinois State Bar Association (Chicago, IL) (April 2015)
- Climate Adaptation and Environmental Law, Chicago Bar Association (Chicago, IL) (February 24, 2015)

- Illinois Fracking Regulations, Illinois Institute for Continuing Legal Education (Chicago, IL) (January 2015)
- Illinois Air Update, Lake Michigan Association of Air & Waste Management (Oak Brook, IL) (November 12, 2014)
- Moderator to Illinois State Bar Association Panel on Illinois Renewable and Energy Efficiency Portfolio Standards Panel (Chicago, IL) (March 2014)
- Carbon Pollution and the Clean Air Act: Where We've Been and Where We're Going, Chicago Bar Association (Chicago, IL) (February 25, 2014)
- High-Volume Horizontal Fracturing Regulation in Illinois, Illinois State Bar Association (Chicago, IL) (March 2013)
- Update on Clean Air Act Regulatory Activity and Current Events in the Electricity Sector, Midwest Environmental Enforcement Association (Jefferson City, MO) (June 28, 2012)
- Update on Recent Clean Air Act Rulemakings and Litigation, Chicago Bar Association (Chicago, IL) (March 21, 2012)

PUBLICATIONS AND ANALYSES

- Blog posts available at: https://blog.ucsusa.org/author/james-gignac
- Co-Author, *On the Road to 100 Percent Renewables: States Can Lead an Equitable Energy Transition*, Union of Concerned Scientists, COPAL, GreenRoots, and Michigan Environmental Justice Coalition (2022)
- Primary Author, *On the Road to 100 Percent Renewables for Michigan: Strengthening the State's Energy Transition*, Union of Concerned Scientists and Michigan Environmental Justice Coalition (2022)
- Primary Author, *On the Road to 100 Percent Renewables for Minnesota: Strengthening the State's Energy Transition*, Union of Concerned Scientists and COPAL (2022)
- Co-Author, *Designing a Neighborhood Microgrid: Envisioning a Microgrid for the Parker Village Neighborhood in Highland Park, Michigan*, Union of Concerned Scientists and Parker Village (2022)
- Primary Author, *Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan*, Union of Concerned Scientists and Soulardarity (2021)
- Co-Author, *Energy and Emissions Benefits from Minnesota Energy Efficiency Investments: Improving the Analytical Approach to How Minnesota Values Energy Efficiency*, Union of Concerned Scientists (2020)

- Author, *Minnesota Electric Cooperatives and Out-of-State Coal Plants*, Union of Concerned Scientists (2020)
- Co-Author, *Achieving a Clean Energy Transition in Illinois: Economic and Public Health Benefits of Replacing Coal Plants in Illinois with Local Clean Energy Alternatives*, The Electricity Journal (31) (2018) 52-59.
- Co-Author, *Soot to Solar: Illinois' Clean Energy Transition*, Union of Concerned Scientists (2018)

Let Communities Choose

Clean Energy Sovereignty in Highland Park, Michigan

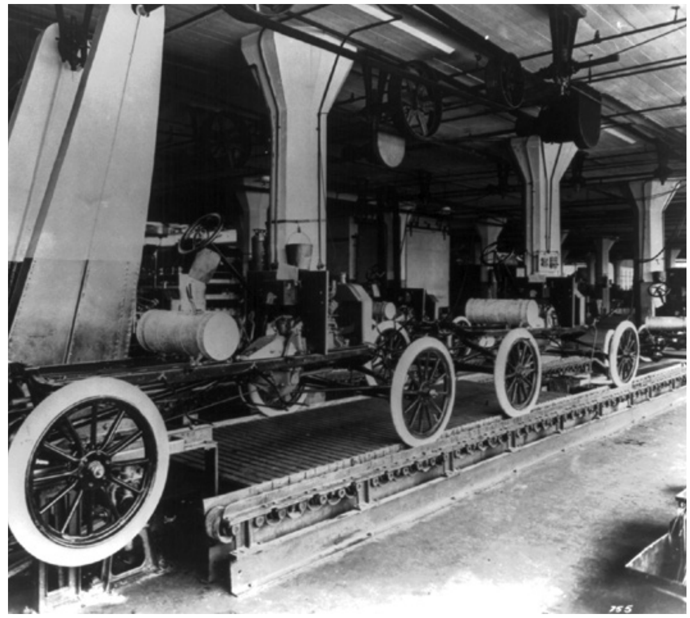
In the traditional model for electric utilities, we all use the power they supply and we pay the bills; the utilities do the rest. This model is not designed to engage the people and communities the utilities serve, nor does it provide quality service for all. Rather, it heightens the health, affordability, and climate crises that affect people already struggling with too many service outages, rising electricity rates, and downed power lines.

This is felt deeply in Highland Park, Michigan, where residents are asking fundamental questions. What if we envision a different model of supplying and consuming electricity? What if we empower communities to choose clean energy and generate electricity locally?

Increasingly, communities across the United States are doing just that. As the climate crisis accelerates, people of color and low-income working-class people, afflicted by historic systemic racism, are experiencing some of the worst effects of pollution and climate change. Fossil fuel generators that burn coal and methane gas are disproportionately sited in or near low-income and minority communities, contaminating the environment, posing health risks, and driving up carbon emissions (Grier, Mayor, and Zeuner 2019). That is a big reason why more and more neighborhoods and entire cities are demanding the development of clean energy that leads to safe, resilient, affordable, and community-driven systems. As interest in reimagining the energy system increases, communities are seeking the agency to choose locally generated electricity resources that benefit everyone and provide access to all (Schelly et al. 2020).

The Union of Concerned Scientists (UCS) and Soulardarity (a Highland Park–based nonprofit working to build a just and equitable energy system for all) set out to explore how Highland Park could envision a future of clean energy and move to a locally controlled, equitable, and just energy system—a community powered 100 percent by local, resilient, and affordable clean energy sources, owned by local people and businesses. *Let Communities Choose* explores a potential pathway to achieving the bright, resilient vision this city's residents have for their community. It considers the policy changes and the modifications to a traditional utility's incentives and ways of operating that are needed to achieve that vision and its emphasis on an equitable distribution of benefits.

Places like Highland Park are seeking energy sovereignty—the ability of communities and individuals to choose the forms, scales, and sources of the energy they use (Schelly et al. 2020). This should be a core building block as Michigan, other states, and the nation seek not only to decarbonize the provision of electricity and other services but also to address how those services reflect systemic racism.



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The world's first moving assembly line was at the Ford Motor Company's Highland Park Plant. More than a century later, Highland Park can once again be a home for innovation by owning and generating the energy used by its residents and businesses.

Achieving Self-Determination in Highland Park

In Highland Park, a 2.97 square mile city in Southeast Michigan, today's roughly 10,000 residents represent about one-fifth of its peak population of 53,000 (City of Highland Park, n.d.). The city has been ground zero for the fossil fuel model of community development. In addition to Henry Ford's creation of the world's first moving assembly line in 1913 (Detroit Historical Society, n.d.), the city and its immediate vicinity have been home to the country's first mile of concrete highway (1909) and first depressed urban expressway (1942) (MDOT 2015).

Today, innovative, dedicated local leaders in this community are fighting for just and equitable development in the face of numerous systemic crises. According to University of Michigan researchers, Highland Park is in the 92nd percentile for environmental injustice in Michigan, with among the highest levels of health vulnerability based on hazardous air pollution, poverty, and other social and environmental determinants (Zeuner, Grier, and Mayor 2019).

Income is extremely low, with 46.5 percent of the population living at or below the poverty level. Median household income is $18,474; 63 percent of residents are renters; and the median value of owner-occupied housing units is $45,700 (US Census Bureau 2019). Highland Parkers struggle with the impacts of aging and divested housing stock, food insecurity,

Cover Photo: Nick Hagen

burdensome housing costs, and a lack of Internet access (less than 50 percent of households have broadband connection).

Highland Parkers also suffer from extreme "energy poverty." The average Michigan household that has the median income of Highland Park spends 18 to 33 percent of income on energy; 6 percent or less is considered to be an affordable energy burden (Fisher Sheehan & Colton, n.d.). In part, this deficit is driven by consistent and aggressive increases in residential electric rates from DTE Energy, the local utility, while rates for industrial and other large energy users have risen much more slowly (Matheny 2019). Some Highland Parkers also experience very poor energy reliability: some households reported multiple full days of outages this past year, including during heat waves, winter storms, and pandemic conditions (House 2021).

Despite the historic forces stacked against them, Highland Parkers have organized for transformative and forward-thinking changes, and they are claiming a seat at the table in state and federal policy conversations on various important topics such as lead and copper rules, utility regulation, and community development. In 2011, when DTE Energy repossessed and removed two-thirds of the city's streetlights, residents responded by forming Soulardarity, a nonprofit organization that has since installed 17 community-owned, solar-powered streetlights and has become a strong advocate for energy democracy. At the same time, two Highland Parkers launched sustainable development projects, Avalon Village and Parker Village, that advance community-centered sustainable development visions anchored by clean energy (Avalon Village, n.d.; Parker Village, n.d.). In 2019, Soulardarity released *The Blueprint for Energy Democracy*, a plan to make Highland Park a global model for sustainability and self-determination (Soulardarity 2019).

Consumers Energy/Creative Commons (Flickr)

An artist rendering of the community solar project at Grand Valley State University in Michigan. Building larger-scale projects like these in the community can benefit Highland Park's move toward energy sovereignty.

Soulardarity's vision is for Highland Park to be powered 100 percent by local, resilient, and affordable clean energy resources that are owned by people in the community.

Toward an Energy Sovereignty Vision

Soulardarity's vision for Highland Park is a community powered 100 percent by local, resilient, and affordable clean energy resources that are owned by people and businesses in the community. UCS and Soulardarity started their analysis of how to make this possible with an assumption that Highland Park's residential and commercial sectors have a total average annual electricity demand of approximately 86,200 megawatt-hours (MWh) (Buchanan et al. 2017). What collection of resources could meet that level of demand, with a particular focus on the capacity and economics of rooftop solar? This analysis focused on the electricity sector and identified key resource categories to serve Soulardarity's vision of energy sovereignty.

- **Energy efficiency:** The foundation of the vision is energy efficiency, which reduces the amount of electricity consumed while lowering energy bills and improving the comfort, health, and longevity of homes and businesses.
- **Rooftop solar:** Hosting solar panels on the roofs of homes and other buildings can reduce both customers' electricity bills and the amount of land needed for electricity generation. Rooftop solar makes more space available for urban agriculture, recreation, and other community and economic purposes. It can also be paired with energy storage batteries to further help customers save money on their bills and to assist during power outages and periods of peak power demand (see box, p. 4).
- **Community solar facilities:** Larger yet still local solar installations enable subscribing customers to receive credit on their electricity bills for the electricity produced. This model is particularly advantageous for residents or businesses unable to pursue rooftop solar, either because they are renters or because their roofs cannot accommodate solar.

- **Other distributed solar resources:** Throughout a community, customer-owned solar can be installed in innovative ways and locations that take up little land. For example, solar carports can include charging hook-ups for electric vehicles, solar canopies can be installed over driveways, patios, or other outdoor areas, and solar trees in various shapes and sizes can be located on business grounds or in parks or other public spaces.

- **Community water and energy resource centers (CWERCs):** CWERCs are small-scale treatment facilities (1 million to 5 million gallons daily) that accept wastewater from sewer pipes and food waste from food processors and local businesses, converting it to electricity, reclaimed water, and thermal energy (CRWA 2015). CWERCs turn organics into methane through anaerobic digestion, which can be used to generate electricity and heat.

Energy Storage Batteries Can Add to Utility Bill Savings and Resilience Benefits

While the UCS-Soulardarity analysis focuses on saving and generating electricity, energy storage batteries are an important part of Soulardarity's vision for energy sovereignty. Batteries do not generate power themselves, but when paired with solar they can store electricity to be used at other times or during power outages. Batteries can also help shift solar generation to meet periods of peak demand, and they can assist customers in shifting their electricity consumption to periods of less stress on the electric grid. Front-of-meter storage installations—batteries installed as part of the electric grid or in combination with community solar sites and other renewable energy facilities—are growing dramatically in the United States (ESA 2020). Although our results from the HOMER modeling did not show behind-the-meter battery storage to be cost-effective for the single-family home scenario we tested, the economics of solar-plus-storage were better for commercial buildings we analyzed.

Nevertheless, residential battery storage is gaining traction in Michigan as battery costs continue to decline. Electricity consumers and installers are finding ways to pair batteries with solar in projects that are cost effective even under utilities' current programs (Perkins 2021). Additional incentive programs at the state or federal level—an example is Massachusetts' ConnectedSolutions program (Mass Save, n.d.)—and improved time-of-day rate offerings can further increase the attractiveness for behind-the-meter storage, enable customers to save more money on their energy bills, and bolster the resiliency of the overall system. Such programs would also help protect those who are especially vulnerable during power outages, such as seniors, low-income families, and anyone who relies on medical equipment or refrigerated medicine.

Rooftop Solar Analysis

Our analysis used the Hybrid Optimization of Multiple Energy Resources (HOMER) software model to examine Highland Park's potential for rooftop solar under current policies and programs maintained in Michigan and by DTE. The analysis included nine types of buildings.

Residential single-family homes are the most prevalent structures in Highland Park. Using census data, we estimated the number of occupied single-family homes in Highland Park. We then assumed that about 60 percent of these homes are currently solar-viable based on aggregated overhead imagery (Google Project Sunroof 2018) and input from our project team about the structural conditions of houses. The eight other structure types examined were midrise apartment, medium-size office, stand-alone retail, supermarket, warehouse, primary school, and full-service and quick-service restaurant buildings.

We then developed a reference scenario, selecting the largest solar configurations from the HOMER outputs based on rooftop size and the requirements in DTE's distributed generation program (Table 1).[1] In general, we found that single-family homes and certain other building types are limited in the amount of solar they can install because of the utility's restriction tying the size of a solar installation to a customer's annual usage and an overall limit of 150 kilowatts (kW). Also, payback periods are relatively long due in part to DTE's compensation mechanism for customer-generated solar power and the absence of other state solar incentives.

We found that installing solar in the amounts in our reference scenario (Table 1) would produce 11,343 MWh per year. This would meet about 13 percent of Highland Park's energy needs.

For additional detail on the methodology, see the technical appendix at www.ucsusa.org/resources/let-communities-choose-clean-energy.

Next we created a policy scenario to test how improved solar policies could increase the potential for rooftop solar in Highland Park. The scenario has four components:

- **Eliminating size restrictions on distributed generation:** Assuming that the owners of homes and other buildings could utilize more of their rooftop space for solar generation, we selected larger solar systems from the HOMER outputs for building categories including single-family homes, supermarkets, warehouses, and primary schools. We also assumed that energy-efficiency retrofit programs would make additional single-family homes solar-viable, so that 80 percent of homes become available to host rooftop solar, rather than 60 percent in the reference scenario.

- **Improving the compensation mechanism for solar production:** In 2016, Michigan changed its energy laws to no longer require utilities to offer full retail-rate net metering. Until that change was implemented, every kilowatt-hour (kWh) a customer's solar installation exported to the grid earned them a 1 kWh credit on their bills. Restoring full retail-rate net metering would significantly shorten payback periods for solar investments by single-family households compared with the period under DTE's current compensation mechanism. The effect of restoring full retail-rate net metering could also be achieved by creating a fair and reasonable value-of-solar calculation; Minnesota uses such an approach (MnSEIA, n.d.).

Improved compensation for rooftop solar production would significantly shorten payback periods for investments by single-family homeowners.

- **Adding a supplemental revenue stream for customer solar production:** Many states further compensate utility customers for solar generation. One form this can take is using a renewable portfolio standard (RPS) that recognizes the environmental attributes of solar and other clean energy resources. Michigan's RPS, established in 2008, is 15 percent by 2021; compliance is achieved through utilities' retiring what are known as renewable energy credits (RECs). One REC represents 1 MWh of renewable energy. As a proxy for additional solar compensation, our modeling assumes that Michigan updates and expands its RPS to include a distributed solar carve-out, as Illinois and several other state RPS programs have done; this could help create a viable solar

TABLE 1. The Reference Scenario: Rooftop Solar under Current Policies

Building Type	Assumed Number of Structures	Solar Capacity per Structure	Per-Building Annual Production	Initial Investment (with Investment Tax Credit)	Annual Bill Savings (2021$)	Payback Period
Single-Family Home	1,428	4.3 kW	5,586 kWh	$8,304	$640	15 years
Midrise Apartment	5	49.5 kW	62,862 kWh	$67,609	$9,707	7 years
Medium Office	5	86.3 kW	109,642 kWh	$117,922	$8,322	16 years
Stand-Alone Retail	10	86.9 kW	110,468 kWh	$118,811	$7,451	19 years
Full-Service Restaurant	10	17.9 kW	22,802 kWh	$24,524	$1,371	21 years
Quick-Service Restaurant	10	10.9 kW	13,798 kWh	$14,840	$890	20 years
Supermarket	2	112.7 kW	143,234 kWh	$154,051	$12,513	14 years
Warehouse	3	147.4 kW	187,377 kWh	$201,528	$11,147	22 years
Primary School	1	145.6 kW	185,041 kWh	$199,015	$14,669	16 years

The reference scenario provides a basis for comparing policy options in the UCS-Soulardarity analysis with current conditions. The modeling assumes that the federal investment tax credit (ITC) is applied to the investment cost. In addition, the kilowatt size for the single-family home is relatively small due to DTE's program limiting solar size to the customer's average annual usage.

Note: We assumed solar investments would be made in 2023, corresponding to a 22 percent federal investment tax credit. For more information, please see the technical appendix at www.ucsusa.org/resources/let-communities-choose-clean-energy.

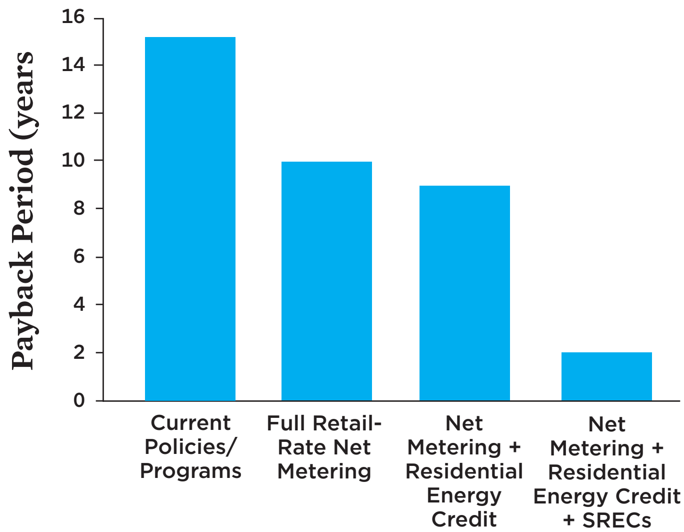
SOURCE: UCS CALCULATIONS BASED ON DATA FROM HOMER GRID.

REC (SREC) market for customers installing solar. Our policy scenario assumes that Highland Park solar owners could sell SRECs valued in the $42 to $67 range depending on the system size (equating to $0.042–$0.067 per kWh), payable upfront or shortly thereafter for 15 years of production, based on the Illinois program (Illinois Power Agency 2020).

- **Adding a Michigan Residential Energy Credit:** State tax policy can incentivize rooftop solar. For example, the Massachusetts Department of Revenue regulations (Mass. Regs. Code tit. 830, § 62.6.1) offers a credit against state personal income taxes equal to 15 percent of the net expenditure for renewable energy resources (including batteries) or $1,000, whichever is less. Our policy scenario assumes that new solar customers in the single-family-home category would receive a $1,000 state tax credit or a cash grant if the customer has no tax liability.

This suite of policies could significantly reduce the payback period for installing a 4.3 kW solar system (Figure 1). With all four policy changes, the contribution of rooftop solar in our analysis increases from supplying about 13 percent of Highland Park's electricity needs to supplying nearly 30 percent of the 86,200 MWh target. Further, both the payback

FIGURE 1. Better Energy Policies Can Make Rooftop Solar More Affordable for Highland Park Homeowners



Current state policies and DTE utility programs results in a long payback period (15 years) for a sample homeowner installing solar. Improving compensation for investments in solar significantly reduces that payback period.

SOURCE: UCS CALCULATION BASED ON DATA FROM HOMER GRID.

Spotlight Solar

Solar trees, like this one in Madison, Wisconsin, allow for distributed solar generation in open areas such as parks while preserving the land underneath for other uses.

TABLE 2. Impact of the Policy Scenario on Payback Periods and Upfront Investments

Building Type	Assumed Number of Structures	Solar Capacity per Structure	Annual Production per Structure	Initial Investment per Structure with All Monetary Incentives Included	Adjusted Payback Period
Single-Family Home	1,904	8.3 kW	10,908 kWh	$4,213	3 years
Midrise Apartment	5	49.5 kW	62,862 kWh	$56,662	3 years
Medium Office	5	86.3 kW	109,462 kWh	$98,859	4 years
Stand-Alone Retail	10	86.9 kW	110,468 kWh	$99,573	4 years
Full-Service Restaurant	10	17.9 kW	22,755 kWh	$20,050	4 years
Quick-Service Restaurant	10	10.9 kW	13,856 kWh	$12,210	4 years
Supermarket	2	225.4 kW	286,468 kWh	$271,552	8 years
Warehouse	3	245.7 kW	312,295 kWh	$296,033	10 years
Primary School	1	388.2 kW	493,443 kWh	$467,749	9 years

Installing increased solar in these amounts under our policy scenario would produce 25,105 MWh per year, about 30 percent of Highland Park's energy needs. For the single-family home category, we assumed the customer could roughly double the size of their installed system from the reference scenario without being constrained by utility program requirements. For additional detail on how we applied the different policy elements to the different building types, please refer to the technical appendix.

SOURCE: UCS CALCULATION BASED ON DATA FROM HOMER GRID.

periods and the needed upfront investments shrink substantially (Table 2).

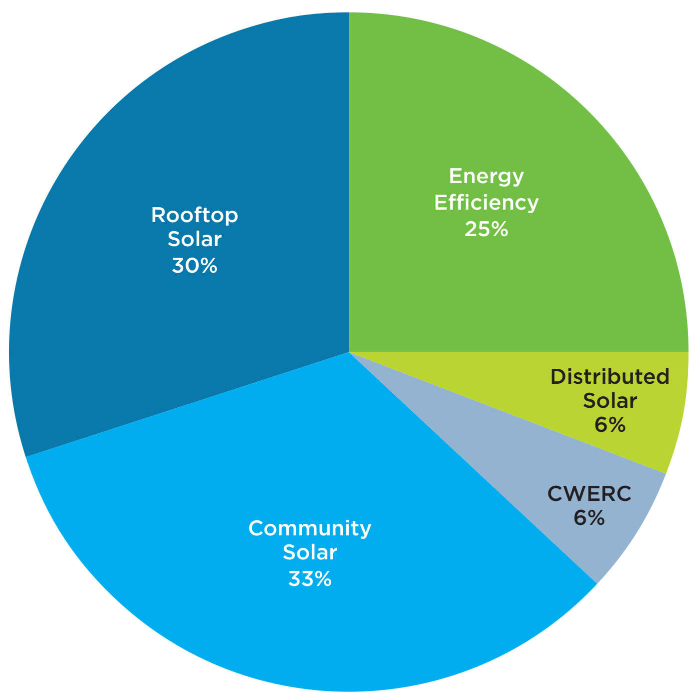
Bringing In Additional Clean Energy Components

Rooftop solar can meet a substantial portion of Highland Park's energy needs. Energy efficiency, community solar facilities, distributed solar installations, and a community water and energy resource center could help the community achieve a vision of 100 percent locally generated clean energy. Putting together all these components, Highland Park could be powered by local, resilient, and affordable clean energy resources that are owned by people and businesses in the community (Figure 2).

ENERGY EFFICIENCY

According to a study prepared for DTE's service territory, there is an achievable energy efficiency potential of about 20 percent in electricity savings in the residential and commercial sectors by 2035 (GDS Associates, Inc. 2016). This achievable potential accounts for market and adoption barriers and assumes that not all cost-effective efficiency measures will be realized. Overcoming additional barriers could yield additional savings: the study for DTE found up to 49 percent

FIGURE 2. Components of a 100 Percent Clean Energy Vision for Highland Park



energy savings for the residential sector and 36 percent for the commercial sector. Our analysis assumes that more aggressive policies and funding levels could achieve 2 percent savings per year; as a result, energy efficiency could contribute a total of 25 percent of Highland Park's energy needs by 2035.

Expanding achievable potential with respect to efficiency is important as transportation and buildings convert from fossil fuels to electrification. Moreover, efficiency can be less expensive than certain solar applications and requires no additional land use.

One advanced way to increase efficiency is a deep energy retrofit, which can include homes and other structures undergoing roof replacement and receiving improved roof insulation (Cluett and Amann 2014). Projects like these could help make more single-family homes "solar ready" by addressing subpar roof conditions or other structural concerns. Additionally, home retrofits can make many homes healthier from the perspective of indoor air quality, such as by reducing asthma triggers (Cassidy 2021).

COMMUNITY SOLAR FACILITIES

Despite the significant potential of efficiency and rooftop solar, achieving 100 percent clean energy locally in Highland Park will likely require at least some larger solar installations in the community. A key aspect of community solar is that the utility does not need to own such facilities; nonprofits, municipal governments, and other entities can own them. Additionally, customers can subscribe to a project and receive credits on their bills through "virtual" net metering based on the output from the community solar arrays. However, Michigan does not require utilities to make virtual net metering available, and DTE does not offer it.

[*Overcoming barriers and achieving additional energy efficiency saves customers money and can make more homes solar-ready.*]

In considering Highland Park's transition to clean energy, we looked at real-world solar installations to get a sense of the land area required for such facilities and the production output they provide. Our analysis illustrates the impact of transforming four Highland Park parcels of currently vacant land, with a total land area of 100 acres, into solar facilities (Table 3).[2] Together, these parcels could host 20 MW of community-owned solar and achieve about one-third of the 86,200 MWh target for Highland Park. Please refer to the technical appendix for overhead imagery of these locations.

TABLE 3. Illustrative Sites for Highland Park Community Solar Facilities

Site	Capacity	Acres	Annual Output
Former Ford Highland Park plant	10 MW	50	14,210 MWh
Former Ecoworks site	4 MW	20	5,684 MWh
Land between Johnson Controls and Coca-Cola	4 MW	20	5,684 MWh
Land north of Nandi's Knowledge Café	2 MW	10	2,842 MWh

Repurposing these four currently unoccupied parcels of land could yield about one-third of the 86,200 MWh target for Highland Park.

SOURCE: UCS CALCULATION BASED ON DATA FROM S&P MARKET INTELLIGENCE AND DAFT LOGIC.

DISTRIBUTED SOLAR INSTALLATIONS

Various types of non-rooftop, distributed solar could be installed throughout Highland Park, including creative applications such as solar carports, solar canopies, and solar trees. To produce about 6 percent of Highland Park's energy needs, we assumed the installation of 50 four-spot solar carports, 50 solar canopies, 100 solar trees, and an additional 3.25 MW of undefined distributed solar.

The 3.25 MW of undefined distributed solar is equivalent to installing one additional large community solar facility; spreading this solar capacity throughout the community would minimize additional usage of land parcels for power generation. The amount of undefined solar could be reduced through identifying additional rooftops available to host solar and by building the community solar installations with single- or dual-axis trackers to increase their output.

COMMUNITY WATER AND ENERGY RESOURCE CENTER

Despite their quirky name, CWERCs can help address a serious challenge in urban communities: wastewater treatment. In addition to producing reusable water, a CWERC captures methane that it can provide directly to nearby buildings for heating. In addition, the methane can be

2018 MLive Media Group

A solar carport sits above electric vehicle charging stations in a parking lot in Ann Arbor, Michigan. Carports and solar canopies can be installed on already developed land parcels, providing shade while also generating clean electricity.

combusted at the facility to generate electricity (CRWA, n.d.). CWERCs are chemically balanced, renewable, and carbon-neutral assuming no methane leaks from the system.

The town of Littleton, Massachusetts, with a population similar to that of Highland Park, is working on developing a CWERC to collect wastewater and divert food waste from landfills, and then treat it in an enclosed facility (Chawaga 2017). A CWERC sized to treat 3 million gallons of wastewater per day can generate 5,300 MWh of electricity per year (CRWA 2015). This would equate to about 6 percent of the 86,200 MWh target for Highland Park.

Recommendations for Michigan Policymakers and Utilities

To move toward making an energy sovereignty vision a reality, and to ensure that the transition is fair and equitable and does not repeat past mistakes and injustices, state policymakers should promote programs that target investment in traditionally underserved areas. These communities are often predominantly populated by people of color who have endured disproportionate health impacts from air pollution and other inequities associated with the energy system. We recommend that the Michigan legislature, the Michigan Public Service Commission, and the state's utilities pursue policies that empower communities to choose and achieve a clean energy vision, and to do so through a lens of equity and justice.

- **Eliminate the ability of utilities to cap distributed generation or restrict the size of customer-owned resources:** Michigan does not require utilities to compensate their customers for distributed generation once the total amount of that generation in the utility service territory exceeds 1 percent of the utility's peak load. This needs to change if Highland Park and other communities are to achieve clean energy sovereignty. Cities and towns should be able to utilize the full feasible area of rooftops and the existing built environment for a clean energy transition. DTE and current state law should remove restrictions on the size of customer-owned distributed generation.
- **Require utilities to meet higher levels of energy efficiency and address barriers to adoption:** Utilities can reach higher levels of cost-effective energy efficiency than they currently pursue. Additionally, customers should be rewarded for investing in energy efficiency through lower electricity bills, not be punished with regressive rate increases for conserving electricity usage.
- **Require utilities to offer virtual net metering to facilitate community solar:** Many states require virtual net metering, recognizing the value that customer-supported

Ifalola-James Jones

With the right policies in place, Highland Park can transition from its industrial past to a community powered by local clean energy resources.

solar provides and the role community solar plays in enabling more equitable and direct access to the benefits of clean energy. Renters and property owners who cannot install solar themselves should be able to participate in community solar and receive the financial savings it can provide.

- **Improve the compensation mechanisms for customer-owned solar:** Michigan should either restore full retail-rate net metering or conduct a thorough value-of-solar study toward fully compensating solar generation for its contributions to the electric grid. For example, although Minnesota does not require full retail-rate net metering, it offers a value-of-solar compensation rate to compensate community solar subscribers for the benefits the projects provide to the grid, including avoided transmission and distribution system upgrade costs (MnSEIA, n.d.). By recognizing the environmental and other valuable attributes of distributed solar, improved compensation increases its economic attractiveness for customers. Also, improved compensation can be paired with additional revenue streams, grants, and tax credits to recognize the multifaceted value that distributed solar provides.[3]

- **Make lower-cost financing and other investment programs more accessible to lower-income households and communities:** Approaches to more inclusive financing include requiring utilities to offer "pay as you save" or other on-bill financing programs that utilize flexible underwriting methods and protect vulnerable households from the risks of taking on direct debt for energy-related upgrades. With on-bill financing, a utility or a third-party energy services company offers programs that fund efficiency or solar installations; the customers pay back the cost over time through utility bills while still saving money overall. The financing can be at a lower interest rate than commercial lenders provide and also offered to customers with poor credit. Also, financing and other programs should include measures to ensure that projects are cost effective for customers, as well as requiring clear disclosures and resources for technical assistance and education.

> ***Improving access to lower-cost financing and other investment programs is needed to ensure lower-income households can benefit from local clean energy.***

Another option is to expand Michigan Saves, the state's nonprofit green bank, and encourage it to place more emphasis on underserved communities like Highland Park. For every dollar of public funds invested, the bank draws about $30 from private investors, and it can secure very favorable rates for its loans (Perkins 2020). Currently, however, Michigan Saves is limited by a lack of robust public funding and is still striving to be more accessible to lower-income people.

- **Create state benchmarks to ensure that clean energy development benefits communities like Highland Park:** Through a 2020 executive order by Governor Gretchen Whitmer, Michigan has set a goal of reaching economy-wide carbon neutrality by 2050 (Gignac 2020). Pathways to achieving that goal should include expansion of the state's renewable portfolio standard, with a target for reaching 100 percent clean energy. Michigan should also include carve-outs and specific goals for emerging technologies, as in Illinois's distributed generation program, and for serving underserved communities, as in the Illinois Solar for All program (Illinois Power Agency 2020).

- **Support efforts to allow conversion of the federal solar Investment Tax Credit (ITC) to a cash grant for lower-income households and businesses, governmental entities, and nonprofits:** This action alone would make a significant difference, reducing the debt incurred and shortening payback periods for investments in solar. It would also enable all households and other electricity consumers to benefit from public spending on solar development.[4] And it would reduce the phenomenon of nonprofits and households with little to no tax liability being forced to have third parties own the solar installations or involve a tax-equity investor in order to realize the ITC benefit (Brown and Sherlock 2011).

- **Expand the ability of communities to choose alternative electricity suppliers and empower community ownership of electric power systems:** A major constraint on the pace of customer solar adoption is a utility profit model that often conflicts with customers' interest in distributed generation and expanding energy efficiency. Enabling communities to pursue options for their electricity supply, and even consider owning utility service themselves, would better position places like Highland Park to transition to clean energy sovereignty. At the very least, the existence of these options would place competitive pressure on utilities to transform their business models to better meet community demands. One example of what state policymakers could do is enacting legislation to allow communities to aggregate customers to receive electricity supply from alternative providers. Another example is providing technical support and grant funds for communities exploring municipalization of utility services to achieve equitable climate and energy goals.

Recommendations for Highland Park Policymakers

Local leaders in Highland Park have a critical role in motivating state and federal action. As a historic driver of technological innovation, the city that was home to Henry Ford's first Model T moving assembly line can set the stage for more transformative policies. While most policies with respect to the electricity system are set at the federal, state, and utility levels, Highland Park can take important and necessary steps to move toward clean energy sovereignty.

- **Enact a solar ordinance:** To encourage solar development and improve protections for energy consumers, Highland Park should enact an ordinance that thoroughly addresses siting, code enforcement, and approval processes for solar installations at all scales. The city can also support and partner with local organizations that are already working to aggregate homeowners' buying power in bulk solarization efforts that reduce costs.

- **Set local clean energy benchmarks:** Highland Park should establish clean energy benchmarks, working toward a goal of 100 percent clean energy and including a timeline with interim targets. Numerous other cities and towns have developed or are developing such plans; toolkits, guidance, and other resources are available to help the city do this (RMI 2019).

Nick Hagen

At a solar training at Parker Village in May 2021, Highland Park residents learn about how rooftop solar projects connect to a home's electricity meter.

- **Offer city-sponsored on-bill financing and create municipally owned solar projects:** Through water bills, the Highland Park Water Department could offer on-bill financing for home improvements such as solar and efficiency. The on-bill model would work exactly like similar electric utility programs. Highland Park could also develop city-owned community solar projects to which residents can subscribe through the water billing system.

- **Develop solar and energy efficiency businesses:** Highland Park should seize the opportunity to foster home-grown businesses that circulate wealth locally. The city should create incentives and benefits for solar businesses in and near the city that hire Highland Park residents at high labor standards. To serve a clean energy transformation, numerous types of firms will be needed for installation, project management, construction, finance, and customer service and support.

- **Establish a local revolving loan fund:** Highland Park should establish a revolving fund for encouraging energy improvements to buildings, homes, and businesses. Such a fund could be managed in partnership with state and local financing institutions or programs such as the Clean Energy Credit Union, Michigan Saves, and the Highland Park–based Polar Bear Sustainable Energy Cooperative.

- **Set standards for developers to provide sustainable community benefits:** Highland Park should create standards for developers to construct energy-efficient buildings that maximize solar. By enacting a community benefits ordinance or similar local policies and outlining the process and standards developers must use to secure approval for projects, the city can prioritize developers that demonstrate commitments to renewable energy, affordability, efficient construction, and other community benefits such as firms that hire locally or are minority- or woman-owned.

- **Create a sustainability commission:** As recommended by the local residents' group Citizens For A Sustainable Highland Park, the city should establish a sustainability commission with representatives of the city administration, the city council, and the broader community to create alignment on the strategic goals necessary for a clean energy transformation (CFSHP 2019). Pursuing a goal of 100 percent energy sovereignty is a complex endeavor; the community should leverage the talented, networked, and energetic Highland Parkers who can assist in the pursuit of that goal.

- **Conduct research into establishing a community choice aggregation program or forming a municipal utility:** While both these strategies would likely require enabling state or federal actions, the city would be well-served to have fiscal and operation plans developed should policies turn toward greater community choice and local control of energy systems. For example, were Highland Park to directly own electricity generation and distribution, it would have significantly more autonomy to advance a clean energy transformation through local decisions on such crucial elements as rate structures, billing policies, and investment plans.

A Call for Community Energy Empowerment: Invest in Communities

Achieving energy sovereignty in Highland Park undoubtedly requires significant investment. However, a full consideration of costs must take into account the significant benefits a clean energy transformation will bring—not only in the form of lower electricity bills and improved reliability but in the health and well-being of the community. Instead of an electricity system that extracts community wealth and adversely impacts community health, those resources would be invested locally to benefit the bill-paying customers.

With respect to bill savings specifically, a 2021 report by the Institute for Local Self-Reliance (ILSR) reported that a campaign to install rooftop solar and community solar facilities to serve the equivalent of 30 million US homes over the next five years would produce $69 billion in total electricity bill savings over that time and $30 billion in ongoing annual savings (Kienbaum and Farrell 2021). The ILSR found that $2.56 billion of those five-year savings would occur in Michigan from 4,900 MW of new solar installations in the state—with $310 million in savings from 600 MW of new solar in the congressional district that includes Highland Park (MI-13). Additionally, prior ILSR research showed that solar at any scale makes economic sense (Farrell 2019). Whether it is on a residential rooftop or a vacant lot, solar can generate savings for the people using it.

The technologies considered in this analysis pay for themselves over time, yet upfront capital is needed to purchase equipment and pay installers. The keys to funding efficiency upgrades, rooftop solar, and other local sources of energy are lower-cost, inclusive financing and robust investment programs targeted to benefit communities like Highland Park. Thus, a foundational piece of Michigan's vision to decarbonize and create a more equitable electricity system should include strategic planning to boost local renewable energy development and empower communities like Highland Park to choose their local clean energy future with the support of utilities and state and regional entities. Michigan can achieve this by removing barriers to distributed solar generation, increasing investments in energy efficiency, and ensuring that communities have equitable access to financing options to invest in their neighborhoods.

> ***We must place a high priority on giving the people most affected by energy decisions a central role in shaping those decisions.***

We must place a high priority on giving the people most affected by energy decisions a central role in shaping those decisions. Our recommendations for policies and regulatory changes would enable Highland Park and other communities to choose their own paths to clean energy. Highland Park has led transformative change reaching the global scale before. It's time to do it again.

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ENDNOTES

1 The UCS-Soulardarity analysis considered only solar installations of the fixed variety. However, solar tracking systems, which are available for ground-mounted and other freestanding installations, can adjust panel orientation along a single or dual axis to maximize output. For example, installing the community solar facilities considered in this analysis with single-axis tracking would potentially increase output by as much as 25 to 35 percent (Marsh 2021).

2 Given the total land area in Highland Park of about 1,901 acres (2.97 square miles), 100 acres for community solar accounts for 5.26 percent.

3 Exemptions from state property taxes are another important component of ensuring that solar installations are cost effective. Michigan exempts solar systems from increasing owners' property taxes, but this exemption is limited to systems of 150 kW or less. Much larger systems should also qualify for property-tax exemptions. For example, Minnesota does not tax solar installations up to 1,000 kW.

4 As an example of a way to address a lack of tax equity, Section 1603 of the American Recovery and Reinvestment Act of 2009 provided cash grants in lieu of tax credits to support renewable energy projects (Brown and Sherlock 2011).

REFERENCES

Avalon Village. n.d. "The Avalon Village." Accessed July 26, 2021. http://theavalonvillage.org

Brown, Phillip, and Molly F. Sherlock. 2011. *ARRA Section 1603 Grants in Lieu of Tax Credits for Renewable Energy: Overview, Analysis, and Policy Options*. Washington, DC: Congressional Research Service. https://crsreports.congress.gov/product/pdf/R/R41635

Buchanan, Caillin, Tyler Fitch, Benny Jeong, and Anna Lenhart. 2017. *Get Free—Understanding the Potential for Community Solar Power in Highland Park*. Ann Arbor, MI: Graham Sustainability Institute. http://graham.umich.edu/media/files/dow/Dow-Masters-2017-Get-Free.pdf

Cassidy, Julie. 2021. Empowering Families Through Affordable Energy. Lansing, MI: Michigan League for Public Policy. https://mlpp.org/wp-content/uploads/2021/07/empowering-families-through-affordable-energy-final.pdf

CFSHP (Citizens For A Sustainable Highland Park). 2019. Proposed ordinance to create a Highland Park Sustainability Commission. Accessed August 9, 2021. http://tinyurl.com/sustainHP

Chawaga, Peter. 2017. "Bringing Communities Together for Wastewater Recovery." *Water Online*, June 22, 2017. https://www.wateronline.com/doc/bringing-communities-together-for-wastewater-recovery-0001

City of Highland Park. n.d. "Community Profile." Accessed July 19, 2021. https://highlandparkmi.gov/Community/Community-Profile.aspx

Cluett, Rachel, and Jennifer Amann. 2014. *Residential Deep Energy Retrofits*. Washington, DC: American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/publications/researchreports/a1401.pdf

CRWA (Charles River Watershed Association). 2015. *Annual Report FY2015: Charles River Watershed Association*. https://www.crwa.org/uploads/1/2/6/7/126781580/annual_report_fy15_web.pdf

CRWA (Charles River Watershed Association). n.d. "How a Community Water and Energy Resource Center Works." Accessed August 9, 2021. https://www.crwa.org/uploads/1/2/6/7/126781580/cwercs_faq.pdf

Detroit Historical Society. n.d. "Encyclopedia of Detroit: Ford Highland Park Plant." Accessed August 6, 2021. https://detroithistorical.org/learn/encyclopedia-of-detroit/ford-highland-park-plant

ESA (Energy Storage Association). 2020. "US Energy Storage Market Shatters Records in Q3 2020." Press release, Dec. 2, 2020. https://energystorage.org/us-energy-storage-market-shatters-records-in-q3-2020

Farrell, John. 2019. *Is Bigger Best in Renewable Energy?* Minneapolis, MN; Portland, ME; and Washington, DC: Institute for Local Self-Reliance. 2019 re-release. https://ilsr.org/wp-content/uploads/2016/09/ILSRIsBiggerBestFinalSeptember.pdf

Fisher Sheehan & Colton. n.d. "Home Energy Affordability Gap." Accessed July 19, 2021. http://homeenergyaffordability.com/index.html

GDS Associates, Inc. 2016. *DTE ENERGY Electric Energy Efficiency Potential Study*. https://www.michigan.gov/documents/mpsc/DTE_2016_Electric_ee_potential_study_w_appendices_REV_B_554359_7.pdf

Gignac, James. 2020. "Michigan Governor Whitmer's Big Step Forward on Climate Leadership." *The Equation* (blog). September 24. https://blog.ucsusa.org/james-gignac/michigan-governor-whitmers-big-step-forward-on-climate-leadership

Google Project Sunroof. 2018. "Estimated Rooftop Solar Potential of Highland Park, MI." https://sunroof.withgoogle.com/data-explorer/place/ChIJyQUcWerNJIgR913c7LWM_zs/#?overlay=flux

Grier, Laura, Delia Mayor, and Brett Zeuner. 2019. *Assessing the State of Environmental Justice in Michigan*." Master's thesis. Ann Arbor, MI: University of Michigan School for Environment and Sustainability. https://seas.umich.edu/sites/all/files/AssessingtheStateofEnvironmentalJusticeinMichigan_344.pdf

House, Kelly. 2021. "Michigan Is No Texas, But It Has Grid Reliability Issues of Its Own." *Bridge Michigan*, February 23, 2021. https://www.bridgemi.com/michigan-environment-watch/michigan-no-texas-it-has-grid-reliability-issues-its-own

Illinois Power Agency. 2020. *Long-Term Renewable Resources Procurement Plan*. https://illinoisshines.com/wp-content/uploads/2020/04/Revised-LTRRPP-updated-from-ICC-Order-20-April-2020-1.pdf

Kienbaum, Katie, and John Farrell. 2021. *The National Impact of 30 Million Solar Homes: A Vision for an Equitable Economic Recovery Built on Climate Protection and Energy Democracy*. Minneapolis, MN; Portland, ME; and Washington, DC: Institute for Local Self-Reliance. https://ilsr.org/wp-content/uploads/2021/07/30MSH-Report-Final-WebRes.pdf

Marsh, Jacob. 2021. "Solar Trackers: Everything You Need to Know." Energysage. https://news.energysage.com/solar-trackers-everything-need-know

Mass Save. n.d. "Use Your Battery Storage Device to Make the Grid More Sustainable." Accessed July 21, 2021. https://www.masssave.com/saving/residential-rebates/connectedsolutions-batteries

Matheny, Keith. 2019. "DTE Energy Rate Hikes Among Biggest in Country—As Reliability Still Lags." *Detroit Free Press*, August 5, 2019. https://www.freep.com/story/news/local/michigan/2019/08/05/dte-energy-electric-rate-hikes/1900782001

MDOT (Michigan Department of Transportation). 2015. “National Firsts.” Accessed July 28, 2021. https://www.michigan.gov/mdot/0,4616,7-151-9623_11154-129682--,00.html

MnSEIA (Minnesota Solar Energy Industries Association). n.d. “Value of Solar.” Accessed July 19, 2021. https://www.mnseia.org/value-solar

Parker Village. n.d. “About Us.” Accessed July 27, 2021. http://www.parkervillagehp.com

Perkins, Tom. 2020. “Could a Michigan Green Bank Offer a Blueprint for Biden’s Green Recovery?” *Energy News Network,* December 9, 2020. https://energynews.us/2020/12/09/could-michigan-green-bank-offer-a-blueprint-for-bidens-green-recovery

Perkins, Tom. 2021. “Michigan Solar Ruling Could Expand the Role of Residential Energy Storage.” *Energy News Network*, January 19, 2021. https://energynews.us/2021/01/19/michigan-solar-ruling-could-expand-the-role-of-residential-energy-storage

RMI. 2019. “More Than 100 American Cities Charge Toward a Renewable Future.” Press release, February 26. https://rmi.org/press-release/more-than-100-american-cities-charge-toward-a-renewable-future

Schelly, Chelsea, Douglas Bessette, Kathleen Brosemer, Valoree Gagnon, Kristin L. Arola, Andrew Fiss, Joshua M. Pearce, and Kathleen E. Halvorsen. 2020. “Energy Policy for Energy Sovereignty: Can Policy Tools Enhance Energy Sovereignty?” *Solar Energy* 205 (15): 109–12. https://doi.org/10.1016/j.solener.2020.05.056

Soulardarity. 2019. *The Blueprint for Energy Democracy*. https://www.soulardarity.com/bfed

US Census Bureau. 2019. *American Community Survey 5-Year Estimates.* Retrieved from *Census Reporter Profile page for Highland Park,* MI. http://censusreporter.org/profiles/16000US2638180-highland-park-mi

Zeuner, Brett, Laura Grier, and Delia Mayor. 2019. “Screening Tool for Environmental Justice in Michigan.” Ann Arbor, MI: University of Michigan School for Environment and Sustainability. https://www.arcgis.com/apps/webappviewer/index.html?id=dc4f0647dda34959963488d3f519fd24

Let Communities Choose

Clean Energy Sovereignty in Highland Park, Michigan

> [***We should envision a different model of supplying and consuming electricity that empowers communities to choose clean energy and generate electricity locally.***]

In Highland Park, Michigan, the energy education and advocacy organization Soulardarity has a vision of energy sovereignty: a community powered by resilient, affordable clean energy resources, owned by Highland Park residents and businesses. To that end, an analysis by the Union of Concerned Scientists and Soulardarity shows how solar power, energy efficiency, and other local resources can meet 100 percent of the community's electricity demand. Changes in public policies can make the vision not only possible but affordable for the community of Highland Park—and for others across the United States. Empowering local communities to choose clean energy can and should play a key role in overall decarbonization efforts in Highland Park, in Michigan, and across the nation.

www.ucsusa.org/resources/let-communities-choose-clean-energy

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CASE STUDY

Designing a Neighborhood Microgrid

Envisioning a Microgrid for the Parker Village Neighborhood in Highland Park, Michigan

Communities across the country are increasingly interested in greater local control over their energy needs. In the fall of 2021, the Union of Concerned Scientists (UCS) and Soulardarity teamed up to release a report, *Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan*, showing how solar power, energy efficiency, and other local resources can meet 100 percent of Highland Park's electricity demand (Gignac et al. 2021).

Parker Village, a neighborhood within Highland Park, envisions creating a smart neighborhood development[1] powered by a solar-plus-storage microgrid. As a follow-up to *Let Communities Choose*, UCS partnered with Parker Village developers to explore options for designing such a microgrid and to consider what factors are involved in that effort.

Figure 1. Parker Village Comprehensive Plan

SOURCE: Paul Bierman-Lytle, Sustainable Environment Associates Corporation (SEAS).

Neighborhood microgrids can connect with one another to form a network of clean energy resources having greater resilience and flexibility and assisting communities desiring energy sovereignty and greater local control of their energy needs. Using an energy system model and an estimate of local electricity use, we present this case study as an example for other neighborhoods and communities to consider when exploring their own microgrid options.

Parker Village: A Smart Neighborhood Development

Parker Village is a neighborhood located within Highland Park, a southeastern Michigan city of about 10,000 people. The Parker Village development envisions occupying about eight acres and accommodating more than 100 potential residents. The project includes redeveloping a former elementary school into a community center featuring commercial and office space, renovating some existing residential structures, and building several new homes and other features. The plan also includes the installation of rooftop solar throughout the neighborhood, a centralized battery storage system, several electric vehicle charging stations, an aquaponics garden, and hoop greenhouses. A solar-powered café has already been established on the site.

Microgrids: Power Systems in Miniature

In many communities, power is delivered through a local distribution system connected to the broader electric grid that spans across large regions, all linked with power lines of various sizes. While this system yields many benefits, it also means that the power can go out at people's homes and businesses from distant problems—and stay out until the electric utility can resolve the issues. This centralized system can also make it difficult for some communities to choose how their power is generated, instead holding residents subject to the choices made by utilities and regulators. Enter microgrids.

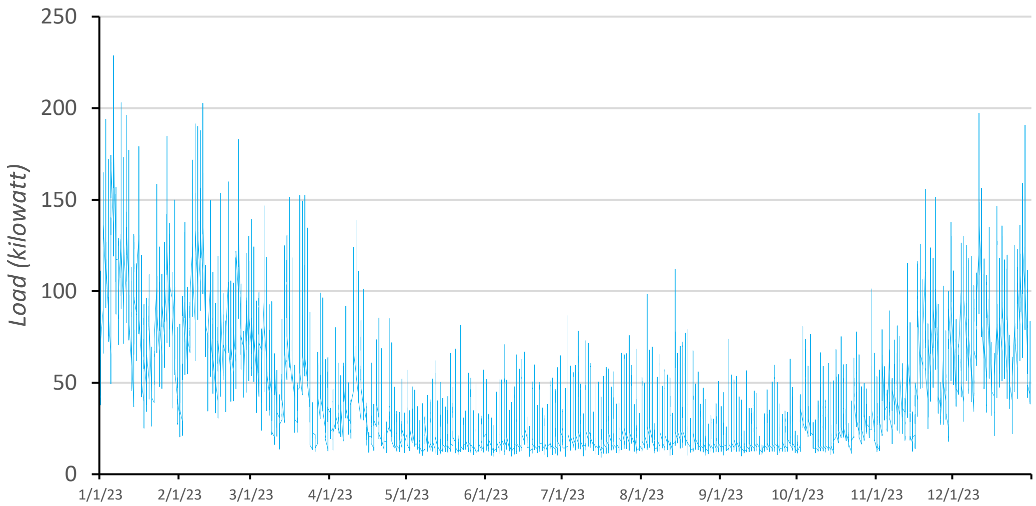
Microgrids are local energy grids either *islanded*—entirely separated—or *islandable*—capable of operating independently—from the larger grid (McNamara 2018). Microgrids can serve single facilities or power larger areas, such as campuses, neighborhoods, and small towns (Department of Energy 2014). Depending on how they are powered, microgrids have the potential to be much cleaner than the current centralized power supply. Also, they can increase resilience by continuing to supply power locally when the larger grid fails.

Exploring the Potential for a Parker Village Microgrid

We used the HOMER Grid model[2] to analyze microgrid possibilities for Parker Village. As a first step, we developed an estimate of the electricity needs the microgrid will serve based on the electric load profiles of residences and other buildings. Because the Parker Village development is not yet built, we used the comprehensive plan (Figure 1) and generic end-use load profiles from the National Renewable Energy Laboratory (NREL) for initial load profile assumptions (NREL 2021).

Specifically, we assumed that all the buildings in the neighborhood would be fully electrified and use electric heat pumps for their heating and cooling. We then selected appropriate building load profiles from the NREL database and assembled a composite annual hourly load profile for the entire neighborhood (Figure 2).

Figure 2. Composite Hourly Load Profile for Parker Village



Electric heating tends to produce winter peak demand for Parker Village. Improved efficiency designs for the neighborhood's buildings can help reduce the overall electricity demand, lower the system costs, and increase the comfort of homes and other structures. Additionally, education and incentive programs for residents can enlist their assistance with lowering peak period needs. SOURCE: UCS estimation based on data from NREL and the Parker Village comprehensive plan.

End-use load profiles are the most important input for modeling the proper amount of distributed energy resources needed to serve a microgrid. As Parker Village develops design and construction plans to make its buildings energy efficient, the initial electricity demand assumptions shown in Figure 2 can and should be adjusted.

In the next step of our microgrid analysis, we further refined the model's characteristics based on responses to several key design questions:

Microgrid Design Questions	Initial Selections for Parker Village Modeling
Will the microgrid be connected to the larger power grid? As discussed previously, microgrids can either be grid-separated (islanded) or grid-connected systems. For islanded microgrids, the system must entirely supply its own power and cannot rely on the larger grid to share electricity.	Parker Village was most interested in exploring a grid-separated microgrid to maximize community independence from the larger system.
What resources will power the microgrid? Any type of power-generating resource can serve a microgrid, considering factors such as the project preferences or goals and available land space.	Focused on clean, non-emitting resources, Parker Village envisioned a microgrid powered primarily by solar photovoltaic (PV) panels and energy storage batteries.

What backup resources can be available? Depending on the design and purpose, a grid-connected microgrid can rely on the larger power grid as its primary supply, using its own resources as backup in case of outages. The reverse occurs in which the microgrid's own resources are the primary power and the larger system is used when those resources are insufficient. However, if the microgrid is islanded, the host entity often needs to include a secondary power source as backup to help minimize outages.	Because Parker Village preferred to analyze an islanded microgrid, we allowed the model to select fossil fuel backup generation when needed; however, for comparison purposes, we also included a grid connection backup option.
What level of outages are tolerable for the microgrid's customers? While the occurrence of no outages is ideal, the willingness to tolerate some level of power interruption can help reduce the amount of resources needed to maintain the microgrid.	We modeled restricted amounts of outage tolerance.[3]

Using these initial selections, HOMER provided several feasible system configurations.[4] Table 1 shows six possible options based on the criteria described.

Table 1. Sample Feasible Configurations for Parker Village Microgrid

Solar PV (MW)	Energy Storage (Tesla Powerpack)[5]		Backup Generator			Initial Investment Cost (2021 million $)	Net Present Cost (2021 million $)
	Units	Total storage capacity	Capacity	Operating hours	Capacity factor		
Fuel type: Natural gas							
1.1	20	4.2 MWh	150 kW	216/year	2.4%	$4.57	$7.99
1.1	30	6.3 MWh	300 kW	72/year	0.8%	$6.30	$11.20
Fuel type: Diesel							
1.1	20	4.2 MWh	100 kW	312/year	3.5%	$4.35	$7.87
1.1	30	6.3 MWh	300 kW	72/year	0.8%	$5.94	$11.00
Grid connection backup							
1.1	10	2.1 MWh	3.4% of annual power supply			$2.85	$4.80
1.1	20	4.2 MWh	1.9% of annual power supply			$4.28	$7.76

Our analysis shows that a grid-separated microgrid powered primarily by solar and energy storage is possible for Parker Village. Yet, there are trade-offs. For example, in four of the configurations, Parker Village achieves its preference to be separate from the larger electric grid and to keep power outages limited. These configurations, however, require a relatively large amount of solar and battery capacity for the space available in the neighborhood. They also include fossil fuel backup generation to run during winter peak periods when solar and battery storage cannot meet the power demand of the neighborhood.

Additional trade-offs exist with the various types of backup resources. Generating units cause noise and air pollution and require maintenance to ensure they are available when needed. While natural gas is not as polluting as diesel, it requires a connection to the gas distribution system unless another local source of fuel—such as carbon-neutral biogas from a community water and energy resource center (CWERC)—is available.[6] Further, adding more battery capacity or a larger gas or diesel generator significantly lessens the backup units' operating hours per year but increases the costs (see Table 1). Finally, instead of a backup generator, a slightly less costly grid connection requires Parker Village to be dependent on the utility and larger power grid for about 2 percent of its annual power demand, while installing fewer batteries increases the grid reliance but significantly reduces costs.

As Parker Village proceeds with its development planning, it can refine its choices and continue to examine the microgrid options available. For example, building more efficient homes and other structures than we assumed in our initial load profiles would allow for the neighborhood's needs to be served with smaller amounts of solar and batteries and less, or possibly no, fossil fuel generation or grid backup. Additionally, while not modeled in this analysis, natural gas fuel cells are increasingly being used in microgrid applications and could be explored as an alternative backup power source. Fuel cells have lower direct emissions and could in the future be fully carbon free, fueled by hydrogen produced by renewable electricity. Further, there may be the possibility of locating some solar and battery resources nearby—but not within—the planned development, which could allow Parker Village its preference of being grid-separated while keeping outages to a minimum.

In conclusion, this case study illustrates that microgrids offer the possibility for neighborhoods and communities to choose what matters most to them and select their own path that best maximizes their preferred combination of clean energy, resiliency, affordability, and local control.

Microgrids as Part of Local Clean Energy Transitions

In *Let Communities Choose*, UCS and Soulardarity explored what an overall clean energy future could look like for the city of Highland Park. Microgrids in Parker Village and other Highland Park neighborhoods can serve this vision by powering their own areas with clean energy or choosing to interconnect with one another and to the larger electric grid as desired.

Utilities and state and federal policymakers should continue encouraging the development of microgrids in places such as Parker Village and throughout the country through grant programs, technical resources, and policies that promote solar and battery deployment to ensure that projects can be powered by clean resources. Together, we can make microgrids a key part of a new model of supplying and consuming electricity—one that empowers communities and neighborhoods to choose clean energy, generate electricity locally, and increase resiliency.

Youngsun Baek is an energy modeler and **James Gignac** is the senior Midwest energy analyst at the Union of Concerned Scientists. **Juan Shannon** is the founder of Parker Village.

ACKNOWLEDGMENTS

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ENDNOTES

1. Parker Village's "smart neighborhood" development plans for an integrated systems approach in areas including renewable energy, water usage, waste reduction, and food production.
2. For more information on the HOMER Grid model, see our technical appendix available at https://www.ucsusa.org/resources/let-communities-choose-clean-energy.
3. For our reliability assumption, we specified in the model that (1) the total capacity shortage in the system cannot be more than 1 percent of the total annual electric load of the community and (2) the system is allowed to have a capacity shortage of up to 20 hours per year.
4. A larger list of feasible system configurations provided by HOMER is available in Table 7 of the technical appendix.
5. For purposes of this analysis, we modeled Tesla's Powerpack product. The company also offers a Megapack product, designed for utilities and large-scale commercial customers, that has an energy capacity of 3 MWh (Marsh 2021). Two Megapacks provide roughly the same storage capacity as 30 Powerpacks, require less space, and potentially provide cost savings.
6. More information about CWERCs is available in the report *Let Communities Choose* (Gignac et al. 2021).

REFERENCES

Department of Energy (DOE). 2014. "How Microgrids Work." June 17, 2014. https://www.energy.gov/articles/how-microgrids-work.

Gignac, James, Youngsun Baek, Jackson Koeppel, Shimekia Nichols, and Edyta Sitko. 2021. *Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan.* Cambridge, MA: Union of Concerned Scientists and Soulardarity. https://ucsusa.org/resources/let-communities-choose-clean-energy.

Marsh, Jacob. 2021. "Tesla Megapack: What You Need to Know." *EnergySage*. June 15, 2021. https://news.energysage.com/tesla-megapack-what-you-need-to-know.

McNamara, Julie. 2018. "Ever Heard of Microgrids? They're Awesome—Here's Why." *The Equation* (blog). July 2, 2018. https://blog.ucsusa.org/julie-mcnamara/microgrid-examples.

NREL (National Renewable Energy Laboratory). 2021. "New Data Set Quantifies How and When Energy Is Used Across All Major U.S. Building Types and Climate Regions." Press release, October 28, 2021. https://www.nrel.gov/news/press/2021/new-data-set-quantifies-how-when-energy-used-across-all-major-us-building-types-climate-regions.html.

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On the Road to 100 Percent Renewables

States Can Lead an Equitable Energy Transition

Executive Summary

Demands for climate action surround us. Every day brings news of devastating "this is not normal" extreme weather: record-breaking heat waves, precipitation, flooding, wildfires. To build resilience and mitigate the worst impacts of the climate crisis requires immediate action to reduce heat-trapping emissions and transition to renewable energy.

On the Road to 100 Percent Renewables explores actions at one critical level: how leadership states can address climate change by reducing heat-trapping emissions in key sectors of the economy as well as by considering the impacts of our energy choices. A collaboration of the Union of Concerned Scientists and local environmental justice groups COPAL (Minnesota), GreenRoots (Massachusetts), and the Michigan Environmental Justice Coalition, with contributions from the national Initiative for Energy Justice, assessed the potential to accelerate the use of renewable energy dramatically through state-level renewable electricity standards (RESs), major drivers of clean energy in recent decades. In addition, the partners worked with Greenlink Analytics, an energy research organization, to assess how RESs most directly affect people's lives, such as changes in public health, jobs, and energy bills for households.

Focusing on 24 members of the United States Climate Alliance (USCA), the study assesses the implications of meeting 100 percent of electricity consumption in these states with renewable energy in the near term. The alliance is a bipartisan coalition of governors committed to reducing heat-trapping emissions consistent with the goals of the 2015 Paris climate agreement.[1]

On the Road to 100 Percent Renewables looks at three types of results from a transition to 100 percent RES policies: improvements in public health from decreasing the use of coal and gas[2] power plants; net job creation from switching to more labor-oriented clean energy; and reduced household energy bills from using cleaner sources of energy. The study assumes a strong push to electrify transportation and heating to address harmful emissions from the current use of fossil fuels in these sectors. Our core policy scenario does not focus on electricity generation itself, nor does it mandate retiring coal, gas, and nuclear power plants or assess new policies to drive renewable energy in non-USCA states.

Our analysis shows that:

- USCA states can meet 100 percent of their electricity consumption with renewable energy by 2035 even with strong increases in demand due to electrifying transportation and heating.
- A transition to renewables yields strong benefits in terms of health, climate, economies, and energy affordability.
- Renewable electricity standards must be paired with policies that address not only electricity consumption but also electricity generation, both to transition away from fossil fuels more quickly and to ensure an equitable transition in which all communities experience the benefits of a clean energy economy.

Currently, the states in this analysis meet their electricity needs with differing mixes of electricity sources—fossil fuels, nuclear, and renewables. Yet across the states, the study shows significant declines in fossil fuel use from transitioning to clean electricity; the use of solar and wind power—the dominant renewables—grows substantially:

- In the study's "No New Policy" scenario—"business as usual"—coal and gas generation stay largely at current levels over the next two decades. Electricity generation from wind and solar grows due to both current policies and lowest costs.
- In a "100% RES" scenario, each USCA state puts in place a 100 percent renewable electricity standard. Gas generation falls, although some continues for export to non-USCA states. Coal generation essentially disappears by 2040. Wind and solar generation combined grow to seven times current levels, and three times as much as in the No New Policy scenario.

A focus on meeting in-state electricity consumption in the 100% RES scenario yields important outcomes. Reductions in electricity from coal and gas plants in the USCA states reduce power plant pollution, including emissions of sulfur dioxide and nitrogen oxides. By 2040, this leads to 6,000 to 13,000 fewer premature deaths than in the No New Policy scenario, as well as 140,000 fewer cases of asthma exacerbation and 700,000 fewer lost workdays. The value of the additional public health benefits in the USCA states totals almost $280 billion over the two decades. In a more detailed analysis of three USCA states—Massachusetts, Michigan, and Minnesota—the 100% RES scenario leads to almost 200,000 more added jobs in building and installing new electric generation capacity than the No New Policy scenario.

The 100% RES scenario also reduces average energy burdens, the portion of household income spent on energy. Even considering household costs solely for electricity and gas, energy burdens in the 100% RES scenario are at or below those in the No New Policy scenario in each USCA state in most or all years. The average energy burden across those states declines from 3.7 percent of income in 2020 to 3.0 percent in 2040 in the 100% RES scenario, compared with 3.3 percent in 2040 in the No New Policy scenario.

Decreasing the use of fossil fuels through increasing the use of renewables and accelerating electrification reduces emissions

Cover photo: Dennis Schroeder/NREL

of carbon dioxide (CO_2), with implications for climate, public health, and economies. Annual CO_2 emissions from power plants in USCA states decrease 58 percent from 2020 to 2040 in the 100% RES scenario compared with 12 percent in the No New Policy scenario.

The study also reveals gaps to be filled beyond eliminating fossil fuel pollution from communities, such as the persistence of gas generation to sell power to neighboring states. Further, it stresses the importance of policies targeting just and equitable outcomes in the move to renewable energy.

Moving away from fossil fuels in communities most affected by harmful air pollution should be a top priority in comprehensive energy policies. Many communities continue to bear far too large a share of the negative impacts from decades of siting the infrastructure for the nation's fossil fuel power sector in or near marginalized neighborhoods. This pattern will likely persist if the issue is not acknowledged and addressed. State policies should mandate a priority on reducing emissions in communities overburdened by pollution and avoiding investments inconsistent with the need to remove heat-trapping emissions and air pollution at an accelerated rate. And communities must be centrally involved in decisionmaking around any policies and rules that affect them directly, including proposals to change electricity generation, both to retire fossil fuel plants and to build the renewable energy infrastructure.

Key recommendations in *On the Road to 100 Percent Renewables* address moving away from fossil fuels, increasing investment in renewable energy, and reducing CO_2 emissions. They aim to ensure that communities most affected by a history of environmental racism and pollution share in the benefits of the transition: cleaner air, equitable access to good-paying jobs and entrepreneurship alternatives, affordable energy, and the resilience that renewable energy, electrification, energy efficiency, and energy storage can provide. While many communities can benefit from the transition, strong justice and equity policies will avoid perpetuating inequities in the electricity system. State support to historically underserved communities for investing in solar, energy efficiency, energy storage, and electrification will encourage local investment, community wealth-building, and the resilience benefits the transition to renewable energy can provide.

A national clean electricity standard and strong pollution standards should complement state action to drive swift decarbonization and pollution reduction across the United States. Even so, states are well positioned to simultaneously address climate change and decades of inequities in the power system. While it does not substitute for much-needed national and international leadership, strong state action is crucial to achieving an equitable clean energy future.

Introduction

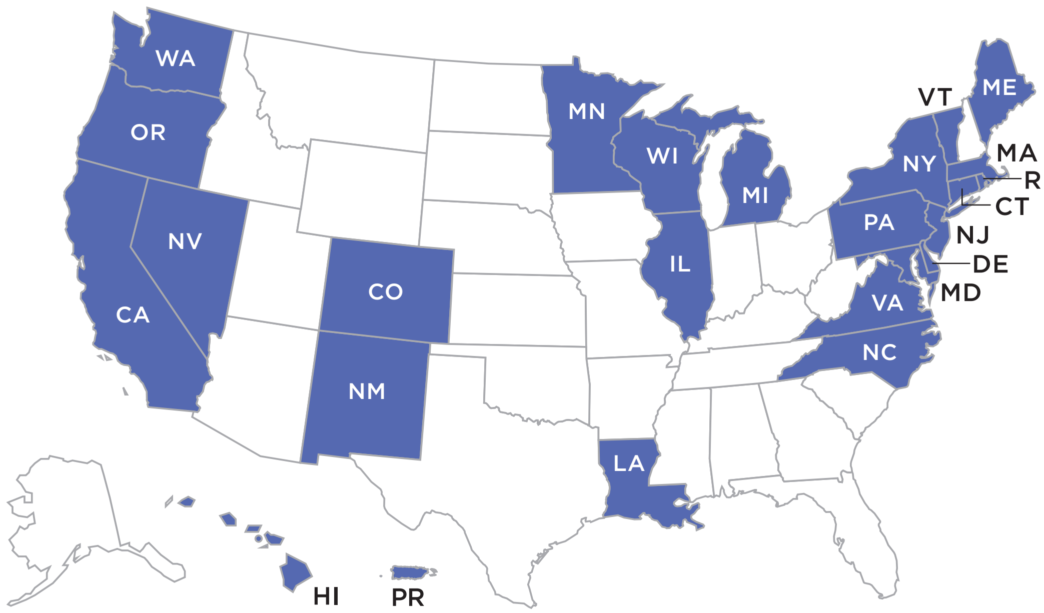
Demands for climate action surround us. Each day brings news of devastation from "this is not normal" extreme weather events: record-breaking heat waves, precipitation, flooding, wildfires. More than half of US residents (52 percent) now report they have personally experienced the effects of climate change (Leiserowitz et al. 2021). Across most of Michigan, for example, where average temperatures have increased by up to 3°F, changing weather patterns create major concerns about heat-related and respiratory illnesses, among other health effects (Michigan Department of Health and Human Services, n.d.). In 2021, following severe summer rainfall, Detroit-area families lost furnaces and water heaters when their basements flooded; many families lost power and internet for up to a week (Barrett 2021). These are among the many consequences of decades of inaction.

Nor are the impacts of climate change triggered by fossil fuel emissions limited to the environment: they also affect health, jobs, and earnings. Nationally, if we continue with business as usual, 18.4 million outdoor workers will experience seven or more unsafe workdays per year by midcentury, according to a Union of Concerned Scientists (UCS) study (Dahl and Licker 2021). Black/African American and Hispanic/Latino outdoor workers will see disproportionate impacts, with $7.5 billion to $16.1 billion of earnings at risk every year, respectively (Dahl and Licker 2021). Globally more than 8 million people died in 2018 due to air pollution from burning coal, diesel, and other fossil fuels, which are key sources of heat-trapping emissions. The pollution contributed to about one in five deaths worldwide (Vohra et al. 2021).

Yet each day also brings opportunities to think differently about the global impact of our energy choices. National and international actions are crucial to reducing heat-trapping emissions, but there is also great potential more locally to drive change. In particular, US states have an opportunity—indeed, an obligation—to help the nation as a whole address climate change by transitioning to renewable energy as quickly as possible. At the same time, states can address effects of our energy choices even beyond climate change and its impacts.

To analyze opportunities and needs in the clean energy transition from both a technical perspective *and* from the perspective of frontline communities likely to be most affected by the transition, *On the Road to 100 Percent Renewables* is a collaboration among UCS and three local environmental justice organizations—COPAL in Minnesota, GreenRoots in Massachusetts, and the Michigan Environmental Justice Coalition—with contributions from the Initiative for Energy Justice, a national organization. Also, partnering with the energy research organization Greenlink Analytics, the project explored the most direct effects

FIGURE 1. Members of the US Climate Alliance



Twenty-four states, plus the US territory of Puerto Rico, currently comprise the US Climate Alliance, a bipartisan coalition of governors committed to reducing heat-trapping emissions consistent with the goals of the Paris Agreement.

Note: Our modeling did not include areas outside the contiguous United States (Hawaii and Puerto Rico); it did include Montana, which withdrew from the USCA in 2021.

of a clean energy transition on everyday lives—changes in public health, jobs, and household energy bills.

To assess the power of state leadership, we examined what would happen if 24 states in the United States Climate Alliance (USCA) (Figure 1) follow the call from environmental justice groups and rapidly transition to 100 percent renewable energy to decarbonize the electricity grid and help limit global warming. The USCA is a bipartisan coalition of governors committed to reducing heat-trapping emissions consistent with the goals of the 2015 Paris climate agreement (USCA, n.d.). The study modeled state commitments to meeting 100 percent of their electricity consumption with renewable energy by 2035 as states act to electrify transportation and heating; that date aligns with the Biden administration's goal for achieving electricity that is free of carbon pollution. The study also modeled three additional scenarios, assessing different policy design elements with an eye toward informing our recommendations.

Our analysis had two key aims:

- Assess the technical and economic feasibility for a large portion of the United States to demonstrate a high level of clean energy leadership by moving to 100 percent renewable electricity; *and*
- Identify key recommendations toward ensuring a just and equitable transition to 100 percent renewable electricity, including the resulting distribution of health, job, wealth, and energy-affordability benefits.

Energy choices touch people's lives in many ways. Thus, the transition to clean energy should take place with strong attention to maximizing the potential public health benefits, especially for communities that have been historically most affected by environmental racism and pollution. In creating conditions for strong job creation, the transition should guarantee equitable access to job training and promote local ownership and wealth-building. And it should ensure that the savings from moving away from fossil fuels reduces energy bills for those least able to handle extra expenses.

Analyzing State Transitions to 100 Percent Renewables

How We Looked at Leadership

The analysis focused on states that have indicated strong interest in leading in a transition to clean energy—specifically, states that are part of the USCA, who have committed to developing "policy pathways and programs to decarbonize the electricity grid"

(USCA 2021). Looking at USCA states in the contiguous United States, our analysis assessed the effects if a large portion of the country fulfills that level of leadership in the absence of strong federal action. We performed a deeper analysis for Massachusetts, Michigan, and Minnesota in light of their current proposals to commit to 100 percent clean or renewable electricity.[3]

The analysis centered on two stages of modeling. The first involved the Regional Energy Deployment System (ReEDS), an electricity-sector planning model from the National Renewable Energy Laboratory (NREL, n.d.c). ReEDS considers various electricity-sector policies and projects their effects, using forecasts of costs for gas, coal, and other fuels, along with cost and performance projections for generation and other technologies. It models complex interactions among various policies, technology costs, and performance measures, at the same time ensuring the reliability of the electric system within the resolution and scope of the model.[4] ReEDS outputs include data on the construction, retirement, and use of power generation, electricity transmission, and energy storage; pollution emissions; and wholesale power prices and electricity system investments and costs.

The second stage of modeling assessed a clean energy transition in terms of direct impacts on everyday lives: changes in jobs, public health, and household energy bills. This stage used outputs from the ReEDS modeling as inputs for the Greenlink Energy Map, developed by the project partner Greenlink Analytics.

The analysis focused on two primary scenarios:

- The *No New Policy* scenario—business as usual—models existing electricity-sector policies as of July 2021. These policies include the 29 state-level renewable electricity or clean electricity standards (RESs/CESs) as well as federal tax credits that reduce the costs of solar, wind, and other renewable energy technologies with subsidies up front or per unit of electricity. This scenario includes certain announcements that electric utilities have made about retiring power plants or proposing to build new electrical generation capacity.
- The *100% RES scenario*, our core policy case, assumes that all USCA states commit to meeting 100 percent of their electricity needs with renewable energy by 2035. Most USCA states that have committed to this allow participation by a broader suite of technologies than just renewable energy, but our study focuses on renewables, which are expected to be the dominant sources of the new electrical generating capacity that results as states shift to 100 percent zero-carbon electricity. Also, renewable energy has broader support from environmental justice organizations than does the buildout of other low- or zero-carbon technologies.

TABLE 1. Key Assumptions for Each Scenario

Scenario	Key Assumptions
No New Policy	Electricity-sector policies in place as of July 2021, including the state renewable electricity or clean electricity standards and federal tax credits
100% RES	Commitment by each USCA state to meeting 100% of its electricity needs with renewable energy by 2035 56% increase in electricity demand in USCA states by 2040, reflecting strong electrification of other sectors of the economy
Electrification Without Decarbonization	Electricity-sector policies in place as of July 2021 56% increase in electricity demand in USCA states by 2040
Restricted Fossil Fuel	Focus on three states: Massachusetts, Michigan, and Minnesota Constraint on developing new gas-fueled power plants after 2025 Accelerated retirement of coal plants by 2030
Clean Electricity Standard	Inclusion of renewable energy, nuclear energy, and carbon capture and storage for meeting state 100-percent-by-2035 requirements

In the 100% RES scenario, existing nuclear plants, though not counting toward the 100 percent requirement, continue generating electricity until the end of their design lives—past 2035, in many cases—including electricity for export to non-USCA states. The scenario does not address fossil fuel plants; these may continue operating to serve non-USCA states given the interconnectedness of regional power grids and flows of electricity across state lines. This scenario incorporates significant increases in electricity demand, reflecting strong electrification of other sectors of the economy, such as transportation and home heating (NREL, n.d.a).[5] It does not include additional policies aimed at making homes and businesses more energy efficient.[6]

To consider some other electricity futures of interest, the modeling looked at three additional scenarios (Table 1):

- *Electrification Without Decarbonization:* This scenario involves the same high levels of electrification as the 100% RES scenario but without the scaled-up requirements to clean the electricity grid.
- *Restricted Fossil Fuel:* This scenario, focused on three USCA states, constrains the development of new gas-fueled power plants and accelerates the retirement of coal plants.

- *Clean Electricity Standards:* This scenario allows nuclear energy and "carbon capture and storage" (capturing and storing carbon dioxide before it is released into the atmosphere) to qualify as states seek to meet the 100-percent-by-2035 requirements. Many USCA states have taken similar approaches.

See the technical appendix at *www.ucsusa.org/resources/road-100-percent-renewables* for additional information about the study methodology.

The Findings: How the Electricity Sector Changes

The modeling projects a mix of power plants and electricity supply that ensures reliable power at the lowest cost in each scenario's demands and constraints. In both main scenarios—No New Policy and 100% RES—the country's fleet of power plants and their use evolve in the USCA states in ways that have important consequences for the residents of those and neighboring states. How much electricity we use, what its sources are, and where power plants are located all directly affect the health of individuals and communities. The amount of generating capacity fueled by the different power sources changes as some plants get built and others retire, and those changes affect the availability of jobs. How much utilities, other power-sector developers, and utility customers themselves invest in different technologies and in the electric system can affect energy bills for households and other customers.

Electricity Supply and Demand

No New Policy scenario: Electricity demand in the USCA states grows 15 percent over the next two decades. Renewable energy grows based on current policies and the favorable economics of solar and wind power, going from 25 percent of electricity supply in 2020 to 45 percent by 2040, while meeting the growth in electricity demand. However, renewables displace only some existing fossil fuel generation. Electricity from coal drops 16 percent by 2040; generation from gas remains constant. Overall, the share of electricity from fossil fuels falls from 51 percent in 2020 to 42 percent by 2040.

100% RES scenario: The move to renewable energy accelerates in USCA states to meet the 100-percent-by-2035 requirement for electricity consumption, including meeting increased demand from accelerated electrification. Electricity demand in the USCA states increases 56 percent by 2040. The bulk of increased generation comes from solar and wind: from 2020 to 2040, solar generation in these states grows nearly ninefold and wind generation more than sevenfold.

More renewable energy accelerates reductions in fossil fuel generation faster in the 100% RES scenario than in the No New Policy scenario. In the absence of additional policies directed at generation technologies, the modeled 100 percent policies target in-state consumption, not generation. Although the USCA states meet all their own electricity needs with renewables, plants fueled by coal, gas, and nuclear can continue operating because the principal US power grids are interconnected across many states, with power shared across state lines. That said, from 2020 to 2040, coal generation falls by 88 percent in the 100% RES scenario, and from 12 percent of electricity supply to 1 percent. Gas generation falls 34 percent, and drops from 40 percent of overall generation in 2020 to 17 percent in 2040.

In both scenarios, nuclear generation falls 37 percent from 2020 to 2040 in the USCA states with the retirement of some nuclear power plants.

The results include dramatically different electricity mixes (Box 1, p. 7). In the No New Policy scenario, the generation mix in USCA states moves from 51 percent fossil, 23 percent nuclear, and 25 percent renewable in 2020 to 42 percent fossil, 13 percent nuclear, and 45 percent renewable in 2040. In the 100% RES scenario, electricity generation in 2040 is 73 percent renewable, 18 percent fossil, and 9 percent nuclear (see Figure 2, p. 8).

Power Plant Capacity

No New Policy scenario: Solar power capacity more than triples in the USCA states, from 61 gigawatts (GW) in 2020 to 195 GW by 2040; wind power capacity almost doubles from 2020 levels, increasing to 81 GW by 2040 (Figure 3, p. 8). Between 2021 and 2040, close to 60 percent of net new capacity is based on renewable energy. Fossil fuels continue to play a significant role, however. No new coal plants are built, and nearly 37 GW of coal retire by 2040, largely because the economics of coal are increasingly unfavorable relative to other generation options. Yet the retirements leave half of the existing coal fleet in place, and the capacity of gas power plants (net of new plants and retirements) increases close to 20 percent, from 185 GW in 2020 to 218 GW by 2040.

100% RES scenario: Solar power capacity in USCA states increases to eight times the 2020 amount by 2040, growing to 504 GW, and wind power to five times, achieving 218 GW. The combined solar and wind capacity increases an average of 30 GW per year—enough to meet the annual electricity needs of more than 8 million typical US households. That capacity increase is three and a half times the projection in the No New Policy scenario for those states, but it is less than the wind and solar capacity added nationwide in 2021 (ACP 2022; Davis et al. 2022). The 100% RES scenario adds substantial amounts of new batteries for energy storage, important for matching the variable electricity supply from solar and wind to round-the-clock electricity demand. Storage increases from 3 GW in 2020 to 178 GW in 2040; the increase is to 40 GW in the No New Policy scenario.

BOX 1.

Different States, Different Paths to 100 Percent

Just as each state starts with its own electricity profile, each undergoes different changes to meet 100 percent of its electricity consumption with renewables. Our modeling illustrates this by looking at three states.

Massachusetts

The Bay State retired its last coal plant in 2017 and its last nuclear plant in 2019, leaving a power plant mixture dominated by gas and meeting much of its electricity consumption with imports from neighboring states and Canada. Offshore wind, required by a series of state laws beginning in 2016, is a big part of ramping up renewable energy capacity and generation in both the No New Policy and 100% RES scenarios. In the latter, gas largely disappears from the generation mix, and much more solar capacity appears—more than five times as much in 2040 as in 2020, and nearly four times as much as in the No New Policy scenario. Wind and solar together power 98 percent of generation in 2040.

Michigan

The Great Lakes State currently generates more than half of its in-state electricity from coal and gas plants and about a quarter from nuclear. The state's major utilities have built wind facilities to comply with Michigan's RES, and they plan to add significant amounts of solar to replace several coal-fired power plants slated to retire over the next decade. In addition, Governor Gretchen Whitmer's draft 2022 climate action plan aims to end coal generation no later than 2035 (Michigan Department of Environment, Great Lakes, and Energy 2022). In the 100% RES scenario, the state displaces all coal generation and meets increased demand from electrification with new solar and wind power. By 2040, solar and wind supply close to 60 percent of in-state electricity generation. Further action retiring all in-state coal generation by 2030 and constraining new gas development, as explored in our Restricted Fossil Fuel scenario, reduces fossil fuels to 4 percent of electricity generation by 2040.

Minnesota

The Land of 10,000 Lakes uses coal and gas for about half of its in-state electricity generation and nuclear for about 20 percent. However, Minnesota, an early adopter of wind power, has made significant investments in it. In the 100% RES scenario, Minnesota builds on that foundation, nearly tripling wind capacity by 2040 to supply 55 percent of the state's electricity generation. Solar also ramps up, from a low baseline to 26 percent of electricity supply. As with Michigan, the Restricted Fossil Fuel scenario points to the need to address fossil fuel generation in the transition to renewable energy, with fossil fuel nearing zero by 2040.

Also in the 100% RES scenario, coal capacity drops by 46 GW as coal plants shut down, to 63 percent below 2020 levels by 2040 in USCA states. Despite the often-promoted role of gas in integrating renewables like wind and solar and balancing electricity supply and demand, its capacity in USCA states grows by only 10 percent from 2020 to 2040, and its portion of overall capacity drops from 34 percent in 2020 to 16 percent in 2040; the growth in battery storage helps ensure reliability as electricity demand increases.

In both scenarios, no new nuclear capacity is built: nuclear is too costly relative to other technologies. Existing nuclear capacity drops the same across each scenario, to 37 percent below 2020 levels by 2040, based solely on projected end-of-life retirements.

Electricity System Investments

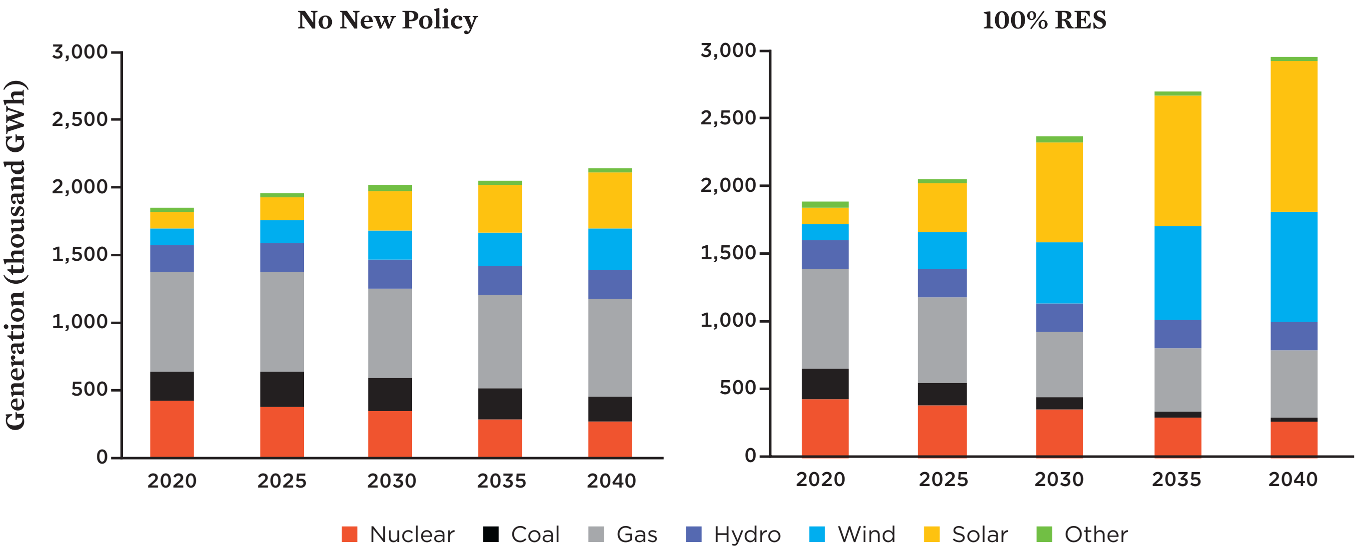
The push for 100 percent renewable electricity in USCA states leads to substantial new investment in wind projects, solar arrays, battery storage, and associated electricity transmission. Investments in power generation are 75 percent higher in the 100% RES scenario than in the No New Policy scenario over 20 years—$995 billion vs. $568 billion.[7] Transmission investments are almost twice as high.

Because solar and wind entail zero fuel costs, lower operating costs over that 20-year period partly offset the added up-front investment for the 100% RES scenario. Fuel costs due to the remaining fossil fuel power plants are 21 percent lower than in the No New Policy scenario; operation and maintenance costs are essentially the same.

What Renewable Energy Can Bring

The accelerated move toward renewable energy in the 100% RES scenario yields a range of benefits in our modeling, particularly for people living in the USCA states. Those benefits include better air quality, improved public health, fewer heat-trapping emissions, lower energy costs, and more power-sector jobs.

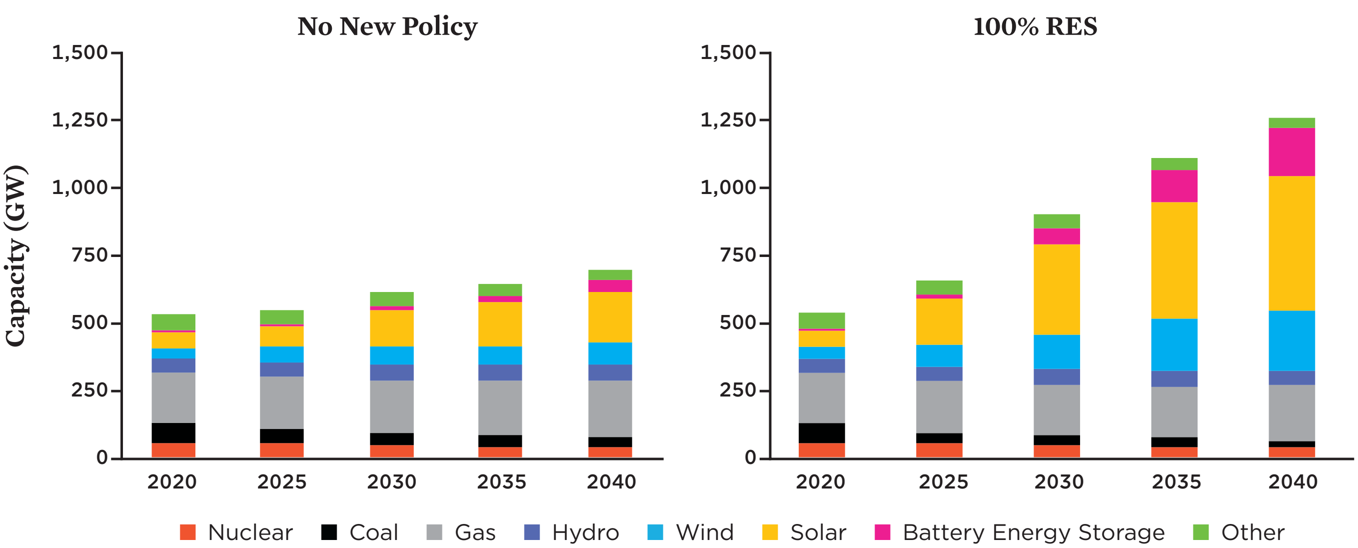
FIGURE 2. Electricity Generation in USCA States in Two Scenarios, 2020–2040



The 100% RES scenario leads to much greater use of renewable energy, chiefly wind and solar; a decrease in the use of gas; and the virtual elimination of coal generation.

Notes: GWh=gigawatt-hours. "Solar" includes utility scale, distributed solar, and concentrating solar-thermal power. "Wind" includes land-based and offshore wind. "Gas" includes combined-cycle and combustion turbine. "Other" includes oil-gas-steam, biopower, landfill gas, geothermal, and Canadian imports.

FIGURE 3. Electricity Capacity in USCA States in Two Scenarios, 2020–2040



Solar and wind capacity grow much more quickly in the 100% RES scenario, along with battery capacity. Gas capacity increases more slowly, and coal capacity also drops more quickly.

Notes: "Solar" includes utility scale, distributed solar, and concentrating solar-thermal power. "Wind" includes land-based and offshore wind. "Gas" includes combined-cycle and combustion turbine. "Other" includes biopower, landfill gas, geothermal, oil-gas-steam, and Canadian imports.

Less Fossil Fuel Generation Means Power Plants Have Less Impact on People's Health

The shift from fossil fuels to clean electricity helps reduce pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, and toxic emissions like mercury. Air pollution from burning fossil fuels has dangerous health impacts, including causing or exacerbating lung and heart ailments, asthma, diabetes, and developmental problems in children, and it leads to premature deaths (State Energy & Environmental Impact Center, n.d.). In 2018, for example, more than 350,000 people died prematurely in the United States due to effects from burning fossil fuels (Vohra et al. 2021).

While air pollution is already lower in the USCA states as a whole than in non-USCA states (USCA 2021), the modeling shows the potential for much steeper reductions. In the 100% RES scenario, SO_2 emissions from power plants in USCA states fall 88 percent from 2020 levels by 2040 compared with 27 percent in the No New Policy scenario (Figure 4). By 2040, NO_x emissions are 75 percent lower in the 100% RES scenario compared with 18 percent lower in the No New Policy scenario (Table 2, p. 10).

Such changes translate to notable public health improvements even excluding the effects of pollution reduction from replacing fossil fuels with electricity to power vehicles and heat buildings. In the USCA states as a whole, the 100% RES scenario leads to approximately 6,000 to 13,000 fewer premature deaths, more than 140,000 fewer cases of asthma exacerbation, and 700,000 fewer workdays lost to illness from 2022 to 2040 than in the No New Policy scenario.

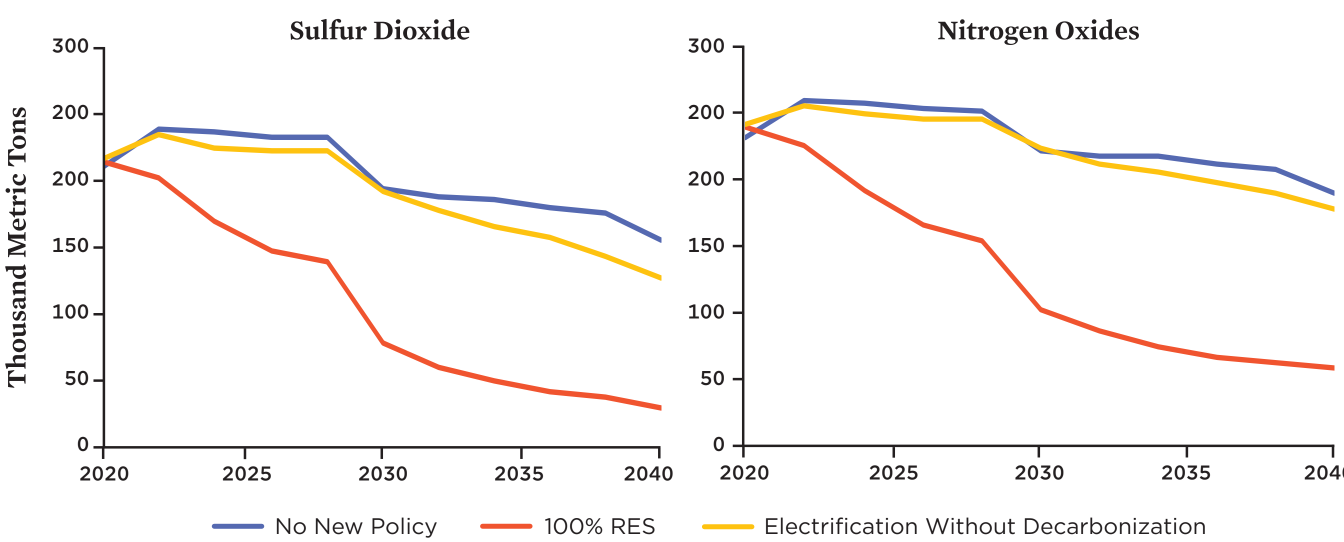
In Michigan, a state with many coal and gas power plants in densely populated urban centers, harmful air pollution from the power sector is expected to decline due to planned retirements of coal plants. That said, a faster transition to renewables yields further health benefits. In the 100% RES scenario, the state could see between 400 to 900 fewer premature deaths, 9,000 fewer cases of asthma exacerbation, and 43,000 fewer lost workdays over those two decades (Figure 5, p. 10).

In the 100% RES scenario, states experience monetary health benefits in addition to physical public-health benefits as a result of reducing air pollution from power plants. The USCA states together secure almost $280 billion in additional health benefits from 2022 to 2040. For example, in Michigan, the savings are $14.9 billion; in Massachusetts, $1.7 billion; and in Minnesota, $1.2 billion.

Deploying Renewable Energy Faster Means More Jobs

Changes in the electricity supply affect employment. Accelerating the deployment of renewable energy creates new opportunities in solar-array and wind-facility installation, increasing the need

FIGURE 4. SO_2 and NO_x Emissions in USCA States in Three Scenarios, 2020–2040



SO_2 and NO_x emissions from power plants have dangerous health impacts. The biggest and fastest reductions of these pollutants occur in the 100% RES scenario. Emissions from power plants in the Electrification Without Decarbonization scenario are almost as high in the No New Policy scenario. Electrification of vehicles and heating brings additional reductions not captured here.

TABLE 2. Key Results in Modeling the Energy Transition in Four Scenarios, 2020–2040

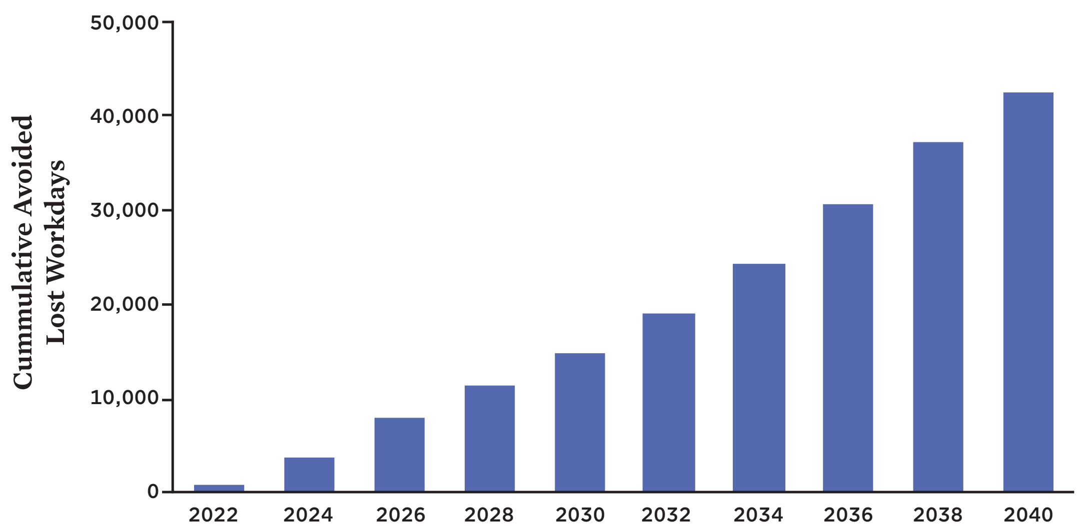
Scenario	Change Relative to 2020 Levels					
	Renewables Generation	Coal Generation	Gas Generation	CO_2 Emissions	SO_2 Emissions	NO_x Emissions
No New Policy	+205%	−16%	0%	−12%	−27%	−18%
100% RES	+461%	−88%	−34%	−58%	−88%	−76%
Electrification Without Decarbonization	+289%	−37%	+34%	+1%	−43%	−26%
Clean Electricity Standard	+369%	−67%	+25%	−45%	−82%	−67%

Note: For USCA states in 2020, renewable energy accounted for 25 percent of electricity supply, coal accounted for 12 percent, and gas accounted for 39 percent. Emissions reductions are from the power sector only.

for electricians, pipefitters, and welders, for example. It also creates opportunities in component manufacturing, sales, financing, and maintenance for those and other renewable energy technologies.[8]

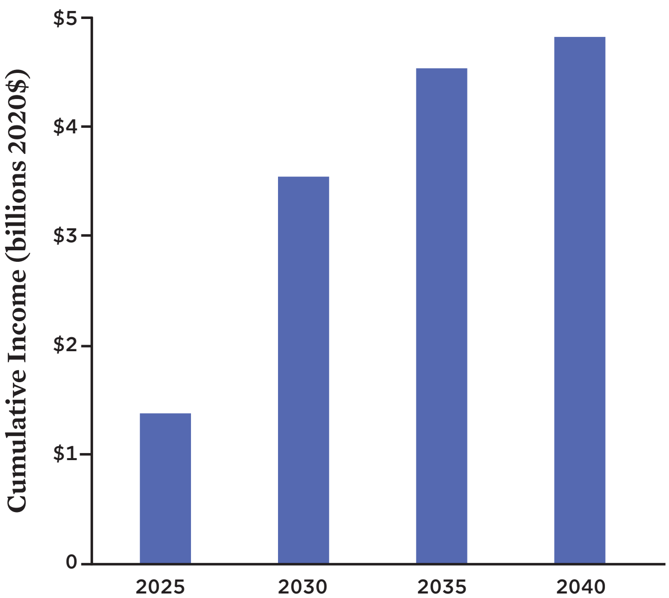
In the three states examined in more depth, almost 200,000 more people are employed in installing new generating capacity—overwhelmingly for renewable energy—in the 100% RES scenario than in the No New Policy scenario. For example, Minnesota gains more than 160,000 additional job-years—meaning more than 40,000 jobs[9]—by 2040, totaling $4.9 billion in additional labor income over those 20 years (Figure 6). Decreasing the use of fossil fuel power plants leads to job losses for those dependent on the fossil fuel industry. Yet the expected additional job growth in the 100% RES scenario is considerably greater than the total employment in coal, gas, and oil-fueled power plants in the states examined. In Minnesota, for example, fossil fuel power plants employed some 2,100 people in 2021 (DOE 2021). Only a portion of job losses would come in a given year, or even by 2040.

FIGURE 5. Reductions in Lost Workdays in Michigan, 2022–2040



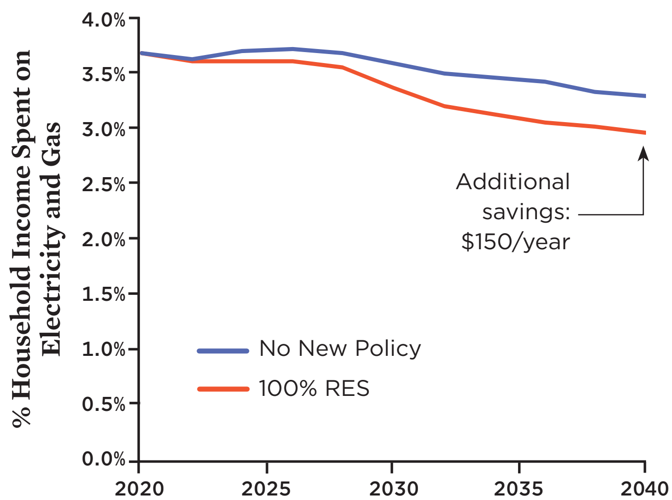
Reduced use of coal and gas plants in the 100% RES scenario leads to notable public health improvements, such as fewer workdays lost due to illness, in Michigan and elsewhere. Less fossil fuel use to power vehicles and heat buildings leads to additional health benefits, not captured here.

FIGURE 6. Additional Labor Income in Minnesota, 2022–2040



Greater job creation in installing solar panels, wind turbines, and other new electricity generating capacity in the 100% RES scenario leads to additional labor income adding up to billions of dollars by 2040.

FIGURE 7. Household Energy Burdens in USCA States in Two Scenarios, 2020–2040



Average household spending on electricity and gas as a percentage of income declines under either scenario, but declines more quickly in the 100% RES scenario. Additional savings, not included in these calculations, come from reduced spending on other fossil fuels based on electrification, including avoided gasoline costs for transportation and avoided oil or propane use for home heating.

More Renewable Energy and Electrification Can Help Make Energy More Affordable

Moving to renewable energy and electrifying cars and heating systems can lower overall energy expenses, in turn lowering average energy burdens—the portion of typical household income spent on energy. Energy burden is a particular challenge for many lower-income households. Their national average energy burden for electricity and gas alone is 8.1 percent, compared with an average of 2.3 percent for non-low-income households (Drehobl, Ross, and Ayala 2020). Renewable energy can reduce household electricity costs by displacing more expensive electricity generation from fossil fuels; renewable energy policies, as in the 100% RES scenario, can accelerate that change. Electrification can shift energy use for heating from gas or heating oil to electricity, and shift energy use for transportation from gasoline to electricity. Overall, electrification can reduce energy costs because of the higher efficiency of electric heat pumps and electric vehicles.

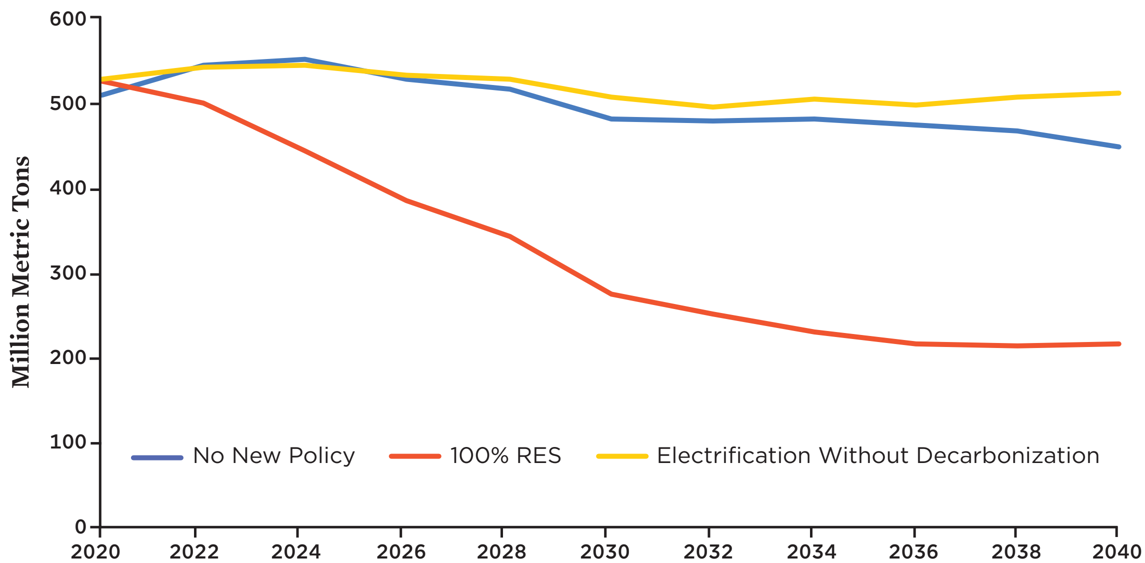
Even considering solely electricity and gas expenses, energy burdens in the 100% RES scenario are consistently at or below those in the No New Policy scenario in each USCA state in most or all years. The average energy burden across those states declines from 3.7 percent in 2020 to 3.0 percent in 2040 in the 100% RES scenario; the decline is to 3.3 percent in 2040 in the No New Policy scenario (Figure 7).

These figures understate the average savings: they include neither avoided gasoline expenditures for households that switch to electric vehicles nor avoided heating oil or propane expenditures for homes switching from those fuels.[10] Average annual household gasoline expenses in recent years have ranged from $1,600 to $2,100, for example (BLS 2021). Replacing an oil system with an air-source heat pump designed for cold climates can save a household around $1,000 per year (Efficiency Maine, n.d.; NEEP 2014).

Phasing Down Fossil Fuel Generation Reduces Global Warming

Carbon dioxide (CO_2) is the primary heat-trapping gas contributing to global warming. With the reduction in fossil fuel use in the 100% RES scenario, CO_2 emissions from power plants in the USCA states are 58 percent below 2020 levels by 2040; the reduction is only 12 percent in the No New Policy scenario (Figure 8, p. 12).[11] In 2040 alone, the total CO_2 *not* emitted by power plants in the 100% RES scenario compared with the No New Policy Scenario equals the tailpipe emissions from 100 million typical cars driving from New York to Los Angeles and back.

FIGURE 8. Power-Sector Emissions of CO_2 in USCA States in Three Scenarios, 2020–2040



Reduced use of coal and gas leads to CO_2 emissions from power plants falling almost 60 percent in the 100% RES scenario, while they stay largely flat in the No New Policy and Electrification Without Decarbonization scenarios. Electrification of transportation and heating bring additional CO_2 reductions not captured in these numbers.

While not calculated in this analysis, electrifying the transportation and heating sectors would lead to further reductions. The electrification study incorporated in this analysis (NREL 2018) envisions, by 2040, electrification of transportation, heating, and other sectors leading to reductions in the use of gasoline (53 percent), gas (22 percent), and diesel (24 percent) relative to business as usual.

Selected Results from Other Scenarios

The power sector might evolve in other ways, as in the scenarios summarized below, with different implications for people and communities.

Electrification Without Decarbonization: A strong push to electrify transportation and heating without an accompanying commitment to meeting that increased demand with clean electricity could reduce pollution from the transportation and heating sectors yet increase pollution from the power sector. In such a scenario, gas capacity grows over the coming decades in the USCA states, with gas generation supplying almost half of the increased electricity demand. Extra coal retirements expected in the 100% RES scenario do not happen under electrification without a strong push for renewable energy. The Electrification Without Decarbonization scenario leads to power plant emissions that are nearly five times higher for SO_2, more than three times higher for NO_x, and more than twice as high for CO_2 by 2040 than in the 100% RES scenario; CO_2 emissions are higher even than in the No New Policy scenario, by 14 percent. Power plant pollution has disproportionately affected low-income and marginalized communities historically, and such pollution increases are likely to perpetuate that inequity.

Restricted Fossil Fuel: Because the 100% RES scenario targets only in-state consumption, not generation, this scenario aims at reducing reliance on fossil fuel generation. Looking at Massachusetts, Michigan, and Minnesota, constraining new gas power plants after 2025 and accelerating the retirement of coal plants by 2030[12] leads to 92 percent less gas generation in 2040 in those states than in the No New Policy scenario, and 90 percent less than in the 100% RES scenario. Harmful power plant emissions of SO_2 and NO_x almost disappear by 2030 in Michigan, and in Massachusetts they are slightly lower than in the 100% RES scenario. Bulk system electricity prices (covering the cost of the complete electricity system) in 2040 are 0.2 percent higher in Massachusetts, 15.3 percent higher in Michigan, and 1.2 percent higher in Minnesota than in the 100% RES scenario. However, those price increases do not account for savings from reducing other energy costs through electrification, improving public health, or reducing heat-trapping emissions.

Clean Electricity Standard: A scenario assuming that nuclear energy and carbon capture and storage (CCS) are eligible to meet state 100-percent-by-2035 standards for clean electricity leads to less renewable energy development in USCA states. Existing nuclear generation satisfies some of the demands of 100 percent policies, though no new nuclear (or CCS facilities) appear because of their relative costs. The slower growth of renewable energy leads to slower declines in coal and gas generation. For example, gas generation in 2040 is 29 percent higher than in the 100% RES scenario. Coal and gas generation are also higher in non-USCA states due to lower growth in renewables and reduced net exports from USCA states.

The added fossil fuel generation in turn leads to higher emissions of CO_2 (32 percent), SO_2 (54 percent), and NO_x (38 percent) in USCA states in 2040 than in the 100% RES scenario. As with the Electrification Without Decarbonization scenario, low-income and marginalized communities likely disproportionately suffer from the increases in power plant pollution. However, including nuclear decreases the cost of complying with clean electricity standards, with bulk system electricity prices 7 percent lower in 2040. By reducing the expansion of renewable energy and its associated electricity transmission, use of the existing nuclear capacity also reduces transmission additions in USCA states between 2020 and 2040 by 47 percent.

Recommendations: Ensuring a Just and Equitable Energy Transition

"Energy justice requires not only that traditionally excluded voices become a central part of the energy policy conversation, but that they are first in line to receive the benefits of policies adopted to facilitate the energy transition." —Initiative for Energy Justice (Baker, DeVar, and Prakash 2019).

Advancing energy justice requires policies that address a range of challenges and opportunities. Our findings show that a transition to renewable energy and away from fossil fuels requires attention to ensuring that everyone can experience the benefits, while simultaneously avoiding the perpetuation of historic inequities in the energy sector.

Our findings suggest that USCA states pledging to cut carbon emissions can meet 100 percent renewable electricity standards for energy consumption. Such efforts are technically feasible, and they offer valuable health and net job-creation benefits, lower the cost of energy and energy burdens relative to the No New Policy scenario, and significantly reduce heat-trapping emissions from the power sector. While modeling a renewable energy transition for the nation as a whole would lead to somewhat different results, this study points to the possible outcomes from the leadership of the USCA states as they have stepped up to lead in CO_2 reductions for the United States.[13]

Nevertheless, the modeling also shows a potential for negative outcomes even in high-achieving states if they do not address the electricity system comprehensively. A suite of policies building on renewable energy standards is required to move away from fossil fuels in electricity generation as well as in consumption, reduce pollution, and promote equitable outcomes in the transition to renewable energy. Moreover, while aggressive policy action in leadership states offers important benefits and helps build momentum for clean energy, a comprehensive national approach that includes all states is essential to reaching our climate goals *and* achieving the equitable outcomes we seek.

On the Road to 100 Percent Renewables, like other research, suggests a range of issues and opportunities in moving toward equitable, 100 percent clean electricity. Here we frame key recommendations around moving away from fossil fuels and toward clean energy, while improving affordability and access to benefits for low- and moderate-income households and frontline communities most affected by pollution, and integrating good decisionmaking throughout.

Moving Away from Fossil Fuels and Related Pollution

Target Reductions in Power Plant Pollution

Some communities bear a much greater legacy burden from decades of placing infrastructure for a fossil-fueled power sector in or near marginalized neighborhoods. In New York City, of the 750,000 people living within one mile of "peaker" power plants (plants used only during periods of high electricity demand), almost 80 percent either have low incomes or are people of color (Strategen Consulting 2021). Although these plants run much less often than others, they emit higher levels of pollutants relative to the electricity they generate. States should prioritize reducing emissions in communities overburdened by pollution. For example, New York State curtails the allowable level of NO_x emissions to help meet air-quality standards (Snyder 2020).

Avoid New Investments in Fossil Fuel Power Infrastructure

Fossil fuel generation persists in the USCA states in the 100% RES scenario, and additional gas power plants appear, largely to meet electricity demand from states that do not fully commit to clean energy. Some states and regions rely heavily on gas generation, putting them at risk of shortages and extreme price fluctuations (UCS 2015). States should avoid investments inconsistent with the need to remove heat-trapping emissions from the power sector and the economy as a whole, and they should enact policies to reduce the risks of overreliance on gas.

Retire Fossil Fuel Plants Faster

The persistent use of fossil fuels in power plants points to the importance of comprehensive state action with regard to retiring fossil fuel generators even as these states ramp up renewable energy. Some states have begun addressing this issue. For example, in Illinois, the 2021 Climate and Equitable Jobs Act prescribes a retirement schedule focused on pollution reductions, with a priority on communities historically most affected by pollution (Collingsworth 2021).

Enact a National Clean Electricity Standard

States that do not commit to rapid decarbonization of their electricity systems can drive the persistence of existing fossil fuel generation and new investments in it. Congress should enact a national standard to accelerate air pollution reductions, renewable energy development, and decarbonization in all states. The EPA should implement strong standards regarding power plant pollution.

Promote Just Transitions for Fossil Fuel Workers and Communities

While many communities will benefit from net increased employment in the transition to clean energy, some will be hit harder by job losses than others. States should invest in supporting workers and communities in moving beyond fossil fuels—for example, through job training and incentives for responsible siting of clean energy investments and manufacturing. In addition, states can reduce harmful legacy effects by mandating pollution-cleanup efforts, such as reclaiming mine and power plant sites and properly disposing of coal ash. Just as important, while dislocated workers prepare for what comes next, they need income supports for a period of time, including wage replacement, health coverage, and continued employer contributions to retirement funds or pension plans (Richardson and Anderson 2021).

Promoting Equity in the Clean Energy Transition

Broaden Access to Rooftop Solar

Our modeling limited consideration of rooftop solar and other distributed-generation technologies,[14] but real life also has constraints, particularly around access for low- and middle-income communities and communities of color.[15] Some households have less access to capital, financing, and incentives for acquiring solar systems, less information about options, or fewer local solar suppliers. Renters and occupants of multifamily buildings have no roofs of their own. States should ensure support for solar, placing a priority on reaching historically underserved people and communities through such tools as community/shared solar and energy storage, as well as by broadening the tax credits that have been important for solar energy's expansion but less accessible to lower-income households (Rogers 2021). Such tools can increase resilience for individuals and communities and provide more equitable, more direct access to other benefits of clean energy, including for renters and property owners with less access to solar.

Broaden Access to Energy Efficiency

Energy efficiency is key to reducing home energy costs, but efficiency efforts skew away from low- and middle-income households, which are less able to invest in upgrades and have less access to affordable financing. Such households often have higher-priority housing and other needs, and they are more likely to rent instead of own their homes. State energy-efficiency programs should be inclusive and make available lower-cost financing and investment programs. For example, "pay as you save" initiatives enable households to pay back the cost of energy-efficiency projects through the savings they incur on their monthly utility bills (Leventis et al. 2017). In Minneapolis, the 4D Affordable Housing Incentive Program offers cost-sharing options for energy efficiency improvements and solar installations (City of Minneapolis, n.d.). State green banks, such as those in California, Connecticut, and Nevada, can provide low-income households and marginalized communities with low- or no-cost financing and other incentives for investments in clean energy, including energy efficiency (NREL, n.d.b).

Broaden Access to Electrification

Electrifying transportation and heating requires upfront investments that may be beyond the reach of low- and moderate-income households. Owning an electric vehicle also requires access to charging infrastructure, which is much less readily available to renters or residents of marginalized communities (Huether 2021). State and federal programs to encourage electrification should include affordable financing for households and promote the development of accessible charging infrastructure.

Target Transmission Additions and "Non-Wires" Alternatives at Reducing Reliance on Urban-Based Fossil Fuel Plants

Responsibly sited electric transmission and non-wires alternatives, such as distributed generation, energy storage, and energy efficiency, are needed to expand renewable electricity, accelerate the closure of fossil plants, and mitigate the harms in communities most exposed to power plant pollution. Regulators and other state leaders can push the operators of regional electricity grids to consider ways to maintain reliability while retiring fossil fuel plants. Michigan regulators recently did this with the grid operator that conducts transmission planning and runs the power

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>
> —Initiative for Energy Justice (Baker, DeVar, and Prakash 2019)

grid in much of Michigan and nearby states (Balaskovitz 2020). Additionally, as states update and electrify the grid, communities affected by transmission decisions must be involved in siting and other transmission planning.

Reduce Energy Burdens

The move to clean energy will likely reduce average household energy costs, but, without due attention, it could increase burdens for low- and moderate-income households, at least in the short term. Unequal access to tools like energy efficiency and rooftop solar could prevent low- and moderate-income households from reducing their energy burdens. States should ensure that costs incurred by electric utilities for clean energy—and legacy costs spread over declining numbers of gas users (Dyson, Glazer, and Tepin 2019)—are addressed through either targeted energy rates or statewide policies, including energy-efficiency measures to reduce consumption.

Develop a Renewable Energy Workforce That Reflects the Country

Women represented only 26 percent of the solar workforce in 2018, Hispanic or Latino workers 17 percent, Asian workers 9 percent, and Black or African American workers 8 percent. Racial and gender representation is even worse at leadership levels (The Solar Foundation 2019). As the renewable energy industry, still relatively young, grows exponentially to meet the nation's decarbonization needs, its workforce should represent the communities it serves. Companies should invest in a diverse workforce, and state and federal support should encourage training programs targeting historically marginalized communities and support for businesses owned by women and people of color.

Ensure High-Quality, Well-Paying Jobs

Good jobs should be the standard of the renewable energy industry. The BlueGreen Alliance's state policy toolkit offers a suite of actions designed to ensure that projects uphold high standards for workers, including encouraging "project labor agreements" (PLAs) (BlueGreen Alliance 2020).[16] For example, the Southeastern Massachusetts Building Trades Council and the developers of what is likely to be the first large-scale US offshore wind project signed a PLA in 2021 (Vineyard Wind 2021). Requiring prevailing wages can also help provide a floor so that all contractors for government-supported projects pay at or above market wages (Callahan et al. 2021).

Advance Energy Resilience

The deployment of solar, energy storage, and other distributed generation technologies helps mitigate the impacts of climate change, reduces the need for transmission buildout, and plays a vital role in increasing resilience, keeping the lights on and powering critical infrastructure even during grid blackouts due to extreme weather. In 2018, Hurricane Maria, which left Puerto Rico facing the largest power outage in US history, is but one of too many disasters that highlight the importance of distributed-generation resources and microgrids to power health systems, emergency shelters, and water pumping systems (García 2018). States should think creatively and advance decentralized approaches in the electricity system that can translate into savings for ratepayers, increased reliability, and improved community-level resilience in the face of extreme weather. For example, Glendale, California, dropped a $500 million gas peaker project in favor of a clean energy portfolio that will similarly support the electricity grid but save ratepayers $125 million (Spector 2019).

Address Life Cycle Issues

Renewable energy reduces or eliminates pollution from generation, but it still requires attention to ensure sustainable and responsible life cycles for the technologies involved—from manufacturing to siting to decommissioning at the end of service lives. State policies should encourage project developers to ensure responsible supply chains, incentivize the use of local manufacturers of renewable equipment, improve siting processes to better manage environmental and community considerations, and ensure recycling and reuse opportunities are available and required.

Ensuring Broad Participation in Decisionmaking: Let Communities Choose

Many low-income communities and communities of color, having disproportionately experienced the pollution and associated health and economic effects of an electricity system centered on fossil fuels, are demanding an electricity system that is safe, resilient, affordable, and community-controlled (Gignac et al. 2021). State and federal decisionmakers should take the lead from local community organizations, especially in places historically affected by pollution and the closures of fossil fuel plants, to mitigate harm and ensure that everyone derives the health and economic benefits of the transition to clean energy. For example, dozens of community organizations engaged in the development of Illinois's Climate and Equitable Jobs Act, creating comprehensive climate, clean jobs, and just-transition legislation (Collingsworth 2021). Cumulative impact assessments should go hand in hand with the involvement of communities in decisionmaking around just transitions, distributed generation, transmission, and other choices that will affect them directly.

The Road Ahead

The climate crisis demands strong action at all levels of society, and states are well positioned to help lead the nation in cleaning up the electricity sector and, through electrification, other key sectors as well. State policies for a clean energy transition also present opportunities to address issues and inequities within the existing power sector.

It is entirely feasible for states to commit to meeting 100 percent of the electricity consumption needs of their households, businesses, and institutions with renewable energy in the near term. This means accelerating state actions to improve public health, create more jobs in the energy sector, make energy more affordable, and reduce energy burdens—while cutting heat-trapping emissions. It also means dramatically ramping up the pace of installing solar panels, wind turbines, batteries, and transmission facilities. Simultaneously pushing to electrify cars, trucks, and home and business heating does increase the need for power-sector technologies, but it also drives substantial increases in benefits.

This analysis shows that the states that have declared their intention to lead the United States on a just energy transition can effectively address the power-sector piece of that transition, including significant electrification, in ways that bring a range of benefits to their residents. Even if they use only renewable energy to meet their requirements for 100 percent clean energy, these states can both meet electricity demands *and* lower energy costs.

The analysis also shows the importance of a *comprehensive* commitment to the clean energy transition. A focus on meeting only electricity consumption with clean energy leaves open the near-term possibility of new pipelines and fossil fuel plants, even if chiefly to supply states not committed to 100 percent renewable energy. Combining such commitments with a strong focus on deterring new fossil fuel investments will better position states, and the country as a whole, to meet the strong, economy-wide need to reduce heat-trapping emissions. Clean energy policies must focus on reducing the use of existing power plants fired by fossil fuels, retiring them faster, *and* constraining new investments in fossil fuel infrastructure.

Even so, states cannot count on equitably sharing the benefits and costs of the transition by default; policymakers must explicitly and proactively drive equity. The health benefits from reducing the use of power plants should accrue primarily to those who bear disproportionate burdens from plant siting and use. Black, Brown, Indigenous, immigrant, and low-income communities should have full access to the new jobs, economic development, and entrepreneurship initiatives that accelerated commitments to clean energy will yield. While renewable energy will likely lower costs overall, low- and moderate-income households should be particularly supported in accessing clean energy technologies and reducing their energy burdens. Similarly, communities now tied to fossil fuels need support in moving beyond that dependence. And through it all, frontline communities directly affected by changes in policy and practice should have power in decisionmaking processes.

In the absence of sufficient action and leadership from many on the national level, states are key to transitioning the United States to an equitable clean energy future, as well as to creating a roadmap for solutions that can be scaled nationwide. True leadership will recognize the importance of building clean energy, retiring dirty energy, and making sure that equitable outcomes are central to the transition.

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Endnotes

1. http://www.usclimatealliance.org.
2. "Gas" in this document refers to what is traditionally called natural gas.
3. See, for example, "100% Clean Act" bills in Massachusetts (An Act Transitioning Massachusetts To Clean Electricity, Heating, and Transportation), Michigan's efforts to achieve carbon neutrality by 2050 in Executive Order 2020-182 and Executive Directive 2020–10, and the Minnesota House of Representatives' omnibus bill HF 1031, proposed in 2021.
4. ReEDS encompasses the 48 contiguous states and Washington, DC, analyzes electric sector changes in two-year increments, and assesses results for 17 specific points in time during each two-year period. See the technical appendix at www.ucsusa.org/resources/road-100-percent-renewables for more information.
5. The incorporation of rising electricity demand is based on the "High" electrification scenario from a multiyear, multi-stakeholder assessment of electrification options (NREL, n.d.a).
6. While electrification generally reduces overall energy use for given uses because electric technologies are inherently more efficient, the modeling did not incorporate specific policies aimed at increasing energy efficiency beyond those already in place.
7. Findings from our analysis are expressed in 2020 dollars.
8. The analysis did not examine the job changes resulting from increased electrification.
9. A job-year is defined as a full-time position held by one person for one year. A person holds a job for an average of four years (BLS 2020).
10. In a recent winter, 5.5 million US homes, mostly in the Northeast, used oil heating (EIA 2022).
11. While CO_2 is the primary heat-trapping gas, it is not the only one. Other emissions beyond the scope of this study include methane, which traps heat more than 80 times more effectively over a 20-year period, and which leaks from gas infrastructure, such as wells, transport pipelines, neighborhood pipeline networks, and even kitchen appliances (Lebel et al. 2022).
12. We modeled accelerating some likely coal plant retirements in Michigan by 2030. We also modeled prohibiting new combined-cycle gas plants, but allowing new gas-combustion turbines, which are used solely during periods of high electricity demand.
13. For more about implementing a US move to high levels of renewable energy, see Baek et al. 2021 and NREL, n.d.c.
14. Distributed generation (also called on-site generation or decentralized generation) refers to generation of electricity for use on site, rather than transmitting energy over the electric grid from a large, centralized facility (such as a coal-fired power plant) (EESI, n.d.).
15. According to a Lawrence Berkeley National Laboratory study, out of roughly 1.4 million residential rooftop solar adopters across the country, only 15 percent were households with annual incomes below $50,000 (Barbose et al. 2020). Tufts University and the University of California–Berkeley research shows that solar adoption has been limited among Indigenous people and people of color. Black-majority census tracts installed 69 percent less rooftop solar compared with no-majority tracts; Hispanic-majority census tracts installed 30 percent less (Sunter, Castellanos, and Kammen 2019).
16. Project labor agreements, pre-hire collective bargaining agreements with one or more labor organizations, establish the terms and conditions of employment for a specific construction project; they are described in 29 U.S.C. 158(f) (White House 2022).

References

ACP (American Clean Power Association). 2022. "U.S. Surpasses 200 Gigawatts of Total Clean Power Capacity, but the Pace of Deployment has Slowed According to ACP 4Q Report." Press release, February 15. https://cleanpower.org/news/u-s-surpasses-200-gigawatts-of-total-clean-power-capacity-but-the-pace-of-deployment-has-slowed-according-to-acp-4q-report

An Act Transitioning Massachusetts to Clean Electricity, Heating, and Transportation, H.3288/S.2136, 192nd General Court of the Commonwealth of Massachusetts (2021). https://malegislature.gov/Bills/192/HD3551; https://malegislature.gov/Bills/192/S2136

Baek, Youngsun, Rachel Cleetus, Steve Clemmer, Camilo Esquivia-Zapata, Jeremy Martin, Julie McNamara, Cecilia Moura, Sital Sathia, and Sandra Sattler. 2021. *A Transformative Climate Action Framework: Putting People of Color at the Center of Our Nation's Clean Energy Transition*. Cambridge, MA: Union of Concerned Scientists. https://www.ucsusa.org/resources/clean-energy-transformation

Baker, Shalanda, Subin DeVar, and Shiva Prakash. 2019. *The Energy Justice Workbook*. Initiative for Energy Justice. https://iejusa.org/wp-content/uploads/2019/12/The-Energy-Justice-Workbook-2019-web.pdf

Balaskovitz, Andy. 2020. "Michigan Explores Importing More Electricity as Coal Plants Close." *Energy News Network,* March 2, 2020. https://energynews.us/2020/03/02/michigan-explores-importing-more-electricity-as-coal-plants-close

Barbose, Galen, Sydney Forrester, Naïm Darghouth, and Ben Hoen. 2020. *Income Trends Among U.S. Residential Rooftop Solar Adopters.* Berkeley, CA: Lawrence Berkeley National Laboratory. https://eta-publications.lbl.gov/sites/default/files/solar-adopter_income_trends_report.pdf

Barrett, Malachi. 2021. "Federal, State Officials Survey Flood Damage to Wayne County Homes." MichiganLive, July 8, 2021. https://www.mlive.com/public-interest/2021/07/federal-state-officials-survey-flood-damage-to-wayne-county-homes.html

BLS (US Bureau of Labor Statistics). 2020. "Employee Tenure Summary." Press release, September 22. https://www.bls.gov/news.release/tenure.nr0.htm

———. 2021. "Consumer Expenditures–2020." Press release, September 9. https://www.bls.gov/news.release/cesan.nr0.htm

BlueGreen Alliance. 2020. *State-Based Policies to Build a Cleaner, Safer, More Equitable Economy—A Policy Toolkit*. https://www.bluegreenalliance.org/resources/state-based-policies-to-build-a-cleaner-safer-more-equitable-economy-a-policy-toolkit

Callahan, Colleen, Daniel Coffee, J.R. DeShazo, and Silvia R. Gonzalez. 2021. *Making Justice40 a Reality for Frontline Communities: Lessons from State Approaches to Climate and Clean Energy Investments.* Los Angeles, CA: UCLA Luskin Center for Innovation. https://innovation.luskin.ucla.edu/wp-content/uploads/2021/10/luskin-justice40-final-web-1.pdf

City of Minneapolis. n.d. "4D Affordable Housing Incentive." Accessed February 24, 2022. https://www2.minneapolismn.gov/government/programs-initiatives/housing-development-assistance/rental-property/4d

Collingsworth, Jessica. 2021. "Illinois Secures a Major Climate and Equity Victory." *The Equation* (blog). September 14. https://blog.ucsusa.org/jessica-collingsworth/illinois-secures-a-major-climate-and-equity-victory

Dahl, Kristina, and Rachel Licker. 2021. *Too Hot to Work: Assessing the Threats Climate Change Poses to Outdoor Workers*. Cambridge, MA: Union of Concerned Scientists. https://doi.org/10.47923/2021.14236

Davis, Michelle, Bryan White, Rachel Goldstein, Sylvia Leyva Martinez, Sagar Chopra, Kelsey Goss, Matthew Sahd, et al. 2022. *US Solar Market Insight: 2021 Year in Review*. Executive Summary. Released March 2022. Edinburgh, Scotland, and Washington, DC: Wood Mackenzie and Solar Energy Industries Association. https://www.seia.org/sites/default/files/2022-03/USSMI%20-%202021%20YIR%20ES.pdf

Drehobl, Ariel, Lauren Ross, and Roxana Ayala. 2020. *How High are Household Energy Burdens?* Washington, DC: American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/pdfs/u2006.pdf

DOE (US Department of Energy). 2021. *Energy Employment by State*. Washington, DC. https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20State%20Reports.pdf

Dyson, Mark, Grant Glazer, and Charles Tepin. 2019. *Prospects for Gas Pipelines in the Era of Clean Energy.* Basalt, CO: Rocky Mountain Institute. https://rmi.org/insight/clean-energy-portfolios-pipelines-and-plants

EESI (Environmental and Energy Study Institute). n.d. "Distributed Generation." Accessed February 24, 2022. https://www.eesi.org/topics/distributed-generation/description

Efficiency Maine. n.d. "Compare Home Heating Costs." Accessed February 23, 2022. https://www.efficiencymaine.com/at-home/heating-cost-comparison

EIA (US Energy Information Administration). 2022. "Heating Oil Explained: Use of Heating Oil." https://www.eia.gov/energyexplained/heating-oil/use-of-heating-oil.php

Exec. Directive No. 2020-10, Building a Carbon Neutral Michigan (2020). https://www.michigan.gov/whitmer/0,9309,7-387-90499_90704-540278--,00.html

Exec. Order No. 2020-182, Council on Climate Solutions, Michigan Department of Environment, Great Lakes, and Energy (2020). https://www.michigan.gov/whitmer/0,9309,7-387-90499_90705-540277--,00.html

García, Paula. 2018. "*Queremos Sol Puerto Rico:* A 100% Local and Extraordinary Resource." *The Equation* (blog). December 20. https://blog.ucsusa.org/paula-garcia/queremos-sol-puerto-rico-a-100-local-and-extraordinary-resource

Gignac, James, Youngsun Baek, Edyta Sitko, Jackson Koeppel, and Shimekia Nichols. 2021. *Let Communities Choose: Clean Energy Sovereignty in Highland Park, Michigan.* Cambridge, MA, and Highland Park, MI: Union of Concerned Scientists and Soulardarity. https://www.ucsusa.org/resources/let-communities-choose-clean-energy

Huether, Peter. 2021. *Siting Electric Vehicle Supply Equipment (EVSE) with Equity in Mind*. Washington, DC: American Council for an Energy-Efficient Economy. https://www.aceee.org/white-paper/2021/04/siting-electric-vehicle-supply-equipment-evse-equity-mind

Lebel, Eric D., Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. 2022. "Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes." *Environmental Science & Technology* 2022 56 (4): 2529–2539. https://doi.org/10.1021/acs.est.1c04707

Leiserowitz, Anthony, Edward Maibach, Seth Rosenthal, John Kotcher, Jennifer Carman, Liz Neyens, Jennifer Marlon, Karine Lacroix, and Matthew Goldberg. 2021. *Climate Change in the American Mind, September 2021*. Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication. https://climatecommunication.yale.edu/wp-content/uploads/2021/11/climate-change-american-mind-september-2021.pdf

Leventis, Greg, Steven R. Schiller, Chris Kramer, and Lisa C. Schwartz. 2017. *Energy Efficiency Financing for Low-and Moderate-Income Households: Current State of the Market, Issues, and Opportunities.* Prepared for the State and Local Energy Efficiency Action Network. Berkeley, CA: Lawrence Berkeley National Laboratory. https://www.energy.gov/sites/default/files/2021-07/ee-financing-lmi.pdf

Michigan Department of Environment, Great Lakes, and Energy. 2022. *Draft MI Healthy Climate Plan*. Lansing, MI. https://www.michigan.gov/documents/egle/Draft-MI-Healthy-Climate-Plan_745872_7.pdf

Michigan Department of Health and Human Services. n.d. "Climate Change." Accessed February 08, 2022. https://www.michigan.gov/mdhhs/0,5885,7-339-71548_54783_54784_78428_78429_98577---,00.html

Minnesota House of Representatives Omnibus Bill HF1031, 92nd Legislature (2021–2022).

NEEP (Northeast Energy Efficiency Partnerships). 2014. *Northeast/Mid-Atlantic Air Source Heat Pump Market Strategies Report*. Lexington, MA. https://neep.org/sites/default/files/resources/NortheastMid-Atlantic%20Air-Source%20Heat%20Pump%20Market%20Strategies%20Report_0.pdf

NREL (National Renewable Energy Laboratory). n.d.a. "Electrification Futures Study." Accessed February 24, 2022. www.nrel.gov/analysis/electrification-futures.html

———. n.d.b. “Green Banks.” Accessed February 24, 2022. https://www.nrel.gov/state-local-tribal/basics-green-banks.html

———. n.d.c. “Regional Energy Deployment System Model.” Accessed February 23, 2022. https://www.nrel.gov/analysis/reeds

———. 2018. “EFS_71500_Figure_Data.” Supplement to *Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States*. https://data.nrel.gov/system/files/90/EFS_71500_figure_data%20%281%29.xlsx

Richardson, Jeremy, and Lee Anderson. 2021. *Supporting the Nation’s Coal Workers and Communities in a Changing Energy Landscape*. Cambridge, MA, and Washington, DC: Union of Concerned Scientists and Utility Workers Union of America. https://www.ucsusa.org/resources/support-coal-workers

Rogers, John. 2021. “Lower-Income Households Shouldn’t Pay More for Solar. Congress Can Fix It.” *The Equation* (blog). November 16. https://blog.ucsusa.org/john-rogers/lower-income-households-shouldnt-pay-more-for-solar-congress-can-fix-it

Snyder, J.J. 2020. Letter to Peter D. Lopez, Regional Administrator, US Environmental Protection Agency, Region 2, May 14. https://www.dec.ny.gov/docs/air_pdf/siprevision2273.pdf

The Solar Foundation. 2019. *U.S. Solar Industry Diversity Study 2019: New Resources on Diversity and Inclusion in the Solar Workforce*. https://www.seia.org/sites/default/files/2019-05/Solar-Industry-Diversity-Study-2019.pdf

Spector, Julian. 2019. “Another California City Drops Gas Peaker in Favor of Clean Portfolio.” *Greentech Media,* July 30, 2019. https://www.greentechmedia.com/articles/read/glendale-drops-gas-peaker-in-favor-of-clean-and-distributed-portfolio

State Energy & Environmental Impact Center. n.d. “Health Effects of Burning Fossil Fuels.” New York, NY: New York University School of Law. Accessed January 13, 2022. https://www.law.nyu.edu/centers/state-impact/projects-reports/projects/climate-and-health/health-effects-of-burning-fossil-fuels

Strategen Consulting. 2021. *The Fossil Fuel End Game: A Frontline Vision to Retire New York City’s Peaker Plants by 2030*. PEAK Coalition. https://2ff79216-d177-457f-a12d-75ba71e79310.filesusr.com/ugd/f10969_e27774865535495598a21be0242560a8.pdf

Sunter, Deborah, Sergio Castellanos, and Daniel M. Kammen. 2019. “Disparities in Rooftop Photovoltaics Deployment in the United States by Race and Ethnicity.” *Nature Sustainability* 2 (2019): 71–76. https://doi.org/10.1038/s41893-018-0204-z

UCS (Union of Concerned Scientists). 2015. *Rating the States on Their Risk of Natural Gas Overreliance: Analysis Document*. Cambridge, MA. https://www.ucsusa.org/sites/default/files/attach/2015/12/natural-gas-overreliance-analysis-document.pdf

USCA (United States Climate Alliance). n.d. “Alliance Principles.” Accessed February 24, 2022. http://www.usclimatealliance.org/alliance-principles

———. 2021. *Further. Faster. Together: Meeting the Climate Challenge with Bold, State-Led Action and Collaboration*. https://static1.squarespace.com/static/5a4cfbfe18b27d4da21c9361/t/620d5c9ae08f8e1e4df792d5/1645042862828/USCA_2021+Annual+Report_20220216-LowRes.pdf

Vineyard Wind. 2021. “Building Trades Union and Vineyard Wind Sign Historic Project Labor Agreement.” Press release, July 16. https://www.vineyardwind.com/press-releases/2021/7/16/building-trades-union-and-vineyard-wind-sign-historic-project-labor-agreement

Vohra, Kahn, Alina Vodonos, Joel Schwartz, Eloise A. Marais, Melissa P. Sulprizio, and Loretta J. Mickley. 2021. “Global Mortality from Outdoor Fine Particle Pollution Generated by Fossil Fuel Combustion: Results from GEOS-Chem.” *Environmental Research* 195 (April): 110754. https://doi.org/10.1016/j.envres.2021.110754

The White House. 2022. “Executive Order on Use of Project Labor Agreements for Federal Construction Projects.” February 4, 2022. https://www.whitehouse.gov/briefing-room/presidential-actions/2022/02/04/executive-order-on-use-of-project-labor-agreements-for-federal-construction-projects

On the Road to 100 Percent Renewables

States Can Lead an Equitable Energy Transition

Renewable energy can provide leading states with 100 percent of the electricity they consume by 2035 even as electrifying transportation and heating increases demand, according to an analysis by COPAL, GreenRoots, the Michigan Environmental Justice Coalition, and the Union of Concerned Scientists. Replacing electricity generated by coal and gas plants with renewables decreases emissions of air pollutants, leading to 6,000 to 13,000 fewer premature deaths and 700,000 fewer lost workdays between 2022 and 2040. It also creates jobs, reduces household energy burdens, and significantly reduces heat-trapping emissions. Key recommendations of the analysis address rapidly moving away from fossil fuels and increasing investment in renewables, and ensuring that the benefits of the transition go to communities most affected by environmental racism and pollution as well as to workers and communities that depend on fossil fuels. While state action cannot substitute for national leadership, it, too, is crucial to a clean and equitable energy future.

www.ucsusa.org/resources/road-100-percent-renewables
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KEY FACTS

On the Road to 100 Percent Renewables for Michigan

Strengthening the State's Energy Transition

✔ **A 100 percent renewable energy future is possible by 2035.**
Chiefly by using **wind, solar, and batteries** for energy storage, Michigan can meet all its electricity needs with clean, carbon-free sources by 2035 and dramatically reduce the use of fossil fuels in vehicles and buildings.

✔ **More renewable energy = better health.**
A faster transition to renewable energy reduces harmful air pollutants faster, especially in environmental justice communities, saving Michigan nearly **$15 billion** in public health costs.

✔ **More renewable energy = more jobs, lower energy bills, and other economic benefits.**
The transition to renewable energy will create more than **$10 billion** in net labor income by 2040.

✔ **We must act now to avert the worst of climate change.**
Switching to renewable energy faster and prohibiting construction of new gas-fueled power plants leads to a **96 percent** drop in heat-trapping emissions between 2020 and 2040.

✔ **A clean energy future for all.**
To advance racial and economic justice in the transition to clean energy, Michigan policymakers must ensure **traditionally excluded groups**—including Black, Brown, Indigenous, immigrant and low-income communities—and fossil fuel–dependent workers **have power in decisionmaking** and receive direct benefits from the transition.

Michigan Environmental Justice Coalition
Union of Concerned Scientists

Michigan Needs a Renewable Electricity Future—and It is Possible

Demands for climate action surround us. In Michigan, the average yearly temperature has increased by up to 3°F across parts of the state, leading to changes in weather patterns that create major concerns about heat-related and respiratory illnesses, among other dangers (Michigan Department of Health and Human Services, n.d.). Further increases in extreme heat could put nearly 900,000 outdoor workers in the state at risk of losing an average of three workdays per person each year, jeopardizing $466 million in total earnings each year (UCS 2021).

To act on climate change, Michigan must eliminate heat-trapping emissions from how the state generates electricity. It also must convert transportation, heating, and other sectors to run on carbon-free electricity instead of fossil fuels.

In considering the path forward, Michigan must account for effects of our energy choices beyond climate change so that the benefits of a cleaner electricity grid reach everyone. Specifically, the transition to clean energy must end historic inequities that have overexposed low-income communities and communities of color to air pollution.

Recognizing the urgent need for action, in 2019, under Governor Gretchen Whitmer, Michigan joined the US Climate Alliance (USCA), a group of states committed to upholding the objectives of the 2015 Paris Climate Accords. In 2020, Governor Whitmer also established a goal for the state to achieve "economy-wide carbon neutrality" by 2050. As the state decarbonizes its economy, the electricity sector plays a key role given the adverse climate and health consequences of burning coal, gas,[1] and other fossil fuels to generate electricity and given the importance of electrifying heating and transportation.

The Union of Concerned Scientists partnered with the Michigan Environmental Justice Coalition to explore potential pathways to reach 100 percent renewable electricity in Michigan on a timely basis. Using the Regional Energy Deployment System (ReEDS) electricity model from the National Renewable Energy Laboratory, we examined how a portfolio of energy resources under a strengthened renewable electricity standard (RES) could meet all of the state's electricity needs by 2035. Our "100% RES" scenario also modeled high levels of electrification as the state works to meet its overall climate goals given the need to decarbonize transportation, heating, and other sectors. In addition, we partnered with the research nonprofit Greenlink Analytics to assess how a transition to renewable energy most directly affects everyday lives, in terms of changes in public health, jobs, and household energy bills.

FracTracker Alliance (BY-NC CC2.0)

As Michigan decarbonizes its economy, the electricity sector plays a key role given the adverse climate and health consequences of fossil fuel–fired power plants (such as the coal-fired Monroe plant, one of the state's most polluting facilities). Our modeling research shows that Michigan can meet 100 percent of its electricity needs by 2035 using renewable resources.

A Faster Move to Renewable Electricity Brings Many Benefits

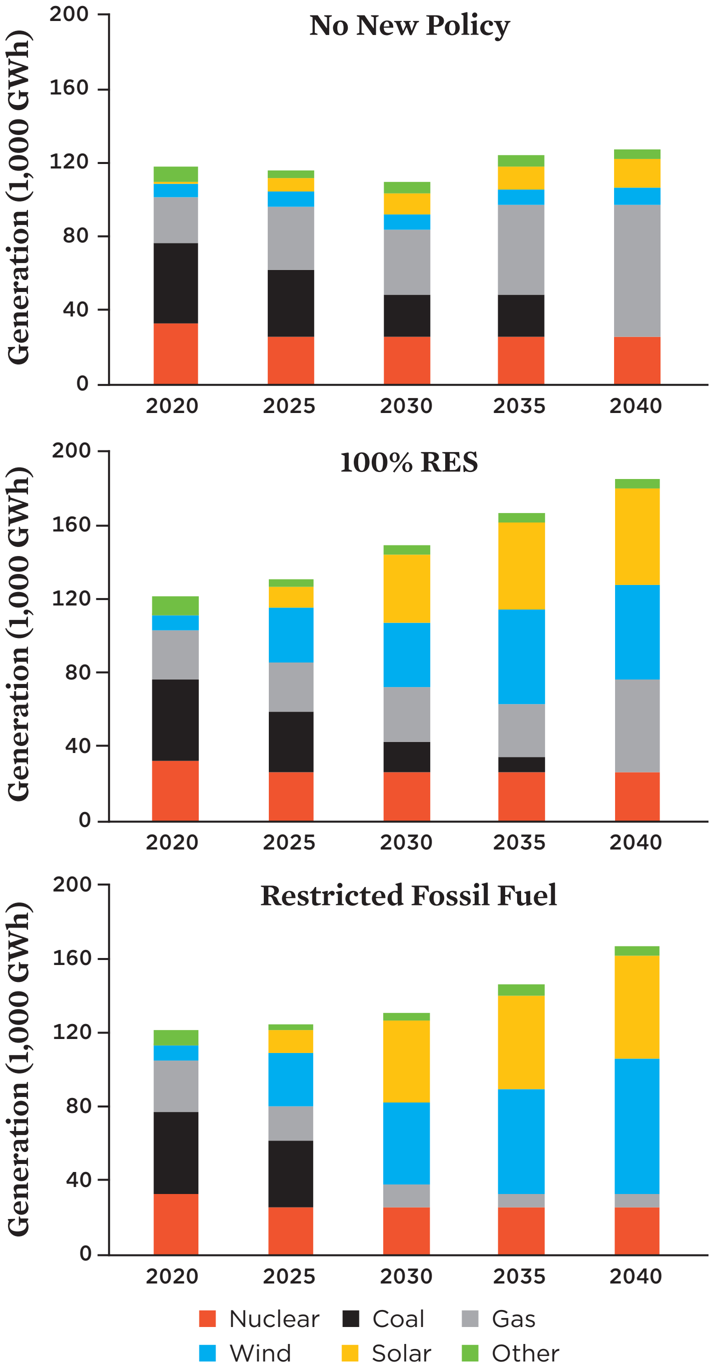
Energy Capacity and Generation

Under current policies and plans—the "No New Policy" scenario in our analysis—the state has about 3 gigawatts (GW) of wind capacity in 2040, producing about 9,600 gigawatt-hours (GWh); 8 GW of solar produces about 15,000 GWh. Wind and solar go from 7 percent of the state's electricity generation in 2020 to 20 percent in 2040. However, that increase displaces only some fossil fuel generation. While coal generation disappears, electricity from gas nearly triples. Overall, the share of electricity from fossil fuels falls slightly, from 62 percent in 2020 to 57 percent by 2040.

By building out wind, solar, and batteries for energy storage more aggressively, Michigan can meet 100 percent of its electricity consumption with renewable energy by 2035, even with high electrification. By 2040, the 100% RES scenario yields more than 14 GW of wind, more than 24 GW of solar, and almost 6 GW of batteries. The wind and solar resources produce 51,000 GWh and 52,000 GWh in that year, respectively, going from 7 percent of electricity supply in 2020 to 57 percent by 2040—thus meeting growth in electricity demand.

While renewable resources meet all of Michigan's electricity consumption needs in the 100% RES scenario, coal and gas plants continue operating. This is because the Midwest power grid, like grids in much of the United States, is interconnected across states and power is exported across state lines. To better reflect how Michigan might achieve its goals for carbon reduction,

FIGURE 1. Three Scenarios for Michigan Electricity Generation, 2020–2040



While the No New Policy scenario shows some growth in solar power, the 100% RES scenario leads to much more solar and wind. The Restricted Fossil Fuel scenario leads to even greater growth in renewable energy and avoids dangerous overreliance on gas.

Notes: "Solar" includes utility scale and distributed solar. "Gas" includes combined-cycle and combustion turbine. "Other" includes hydro, landfill gas, oil-gas-steam, and Canadian imports.

TABLE 1. Health Benefits from a Renewable Energy Transition in Michigan

Health Impact	Cumulative Avoided Numbers, 2022–2040
Premature Deaths	400–900
Asthma Exacerbations	9,000
Lost Workdays	43,000

we also modeled a "Restricted Fossil Fuel" scenario; it includes retiring all coal-fired power plants in the state by 2030 and restricting the construction of new combined-cycle, gas-fired plants.

By 2040, the Restricted Fossil Fuel scenario shows roughly 21 GW of wind, 27 GW of solar, and 9 GW of batteries. By 2040, wind produces 73,000 GWh and solar 55,000 GWh. Michigan would need to retire some remaining gas plants to fully eliminate emissions from the power sector (Figure 1).

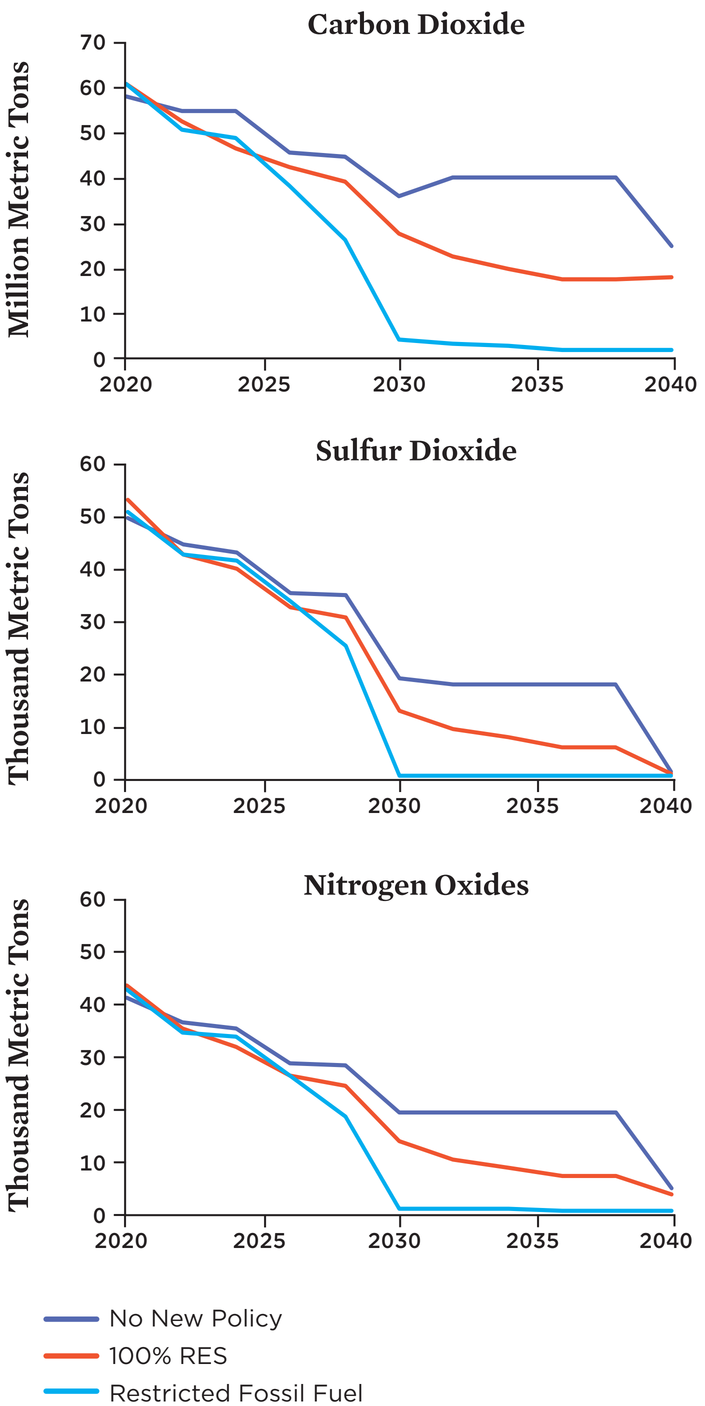
Public Health Benefits

Replacing electricity generated by burning fossil fuels with renewable electricity in the 100% RES scenario reduces the amount of air pollution that power plants and vehicles emit, such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, and mercury and other toxic pollutants. Improvements in air quality yield substantial health benefits, including reductions in lung and heart ailments, asthma, diabetes, and developmental problems in children. The avoided health impacts from the electricity sector alone would save Michigan $14.9 billion[2] in public health costs between 2022 and 2040, largely due to reductions in carbon dioxide (CO_2) and SO_2 pollution from power plants (Table 1). The largest benefits would accrue to Wayne County, parts of which have been out of compliance with federal SO_2 standards for several years.

Emissions Reductions

Along with reducing pollutants that directly affect public health, cleaning up the power sector can decrease emissions of CO_2, the primary heat-trapping gas contributing to global warming. While emissions from Michigan's power sector will likely decline under current plans to retire coal plants in the No New Policy scenario, the reductions are faster and greater in the 100% RES scenario (Figure 2). Phasing out coal more quickly and limiting the construction of new gas-fueled plants while simultaneously transitioning to 100 percent renewable energy in the Restricted Fossil Fuel scenario produces even better results, saving nearly a decade's worth of harmful pollution.

FIGURE 2. Emissions Reductions in Three Scenarios, 2020–2040



Avoiding construction of new gas plants and moving to 100 percent renewables under the Restricted Fossil Fuel Scenario keeps Michigan's electricity sector emissions trending toward near-zero with high electrification of the transportation and building sectors.

Economic Benefits

The 100% RES scenario yields significant economic benefits, with substantial net growth in three key economic categories above those in the No New Policy scenario.

- **Jobs:** Michigan gains more than *400,000 additional job-years*—meaning more than 100,000 additional jobs[3]—in the construction or installation of new power capacity, chiefly wind and solar, from 2022 to 2040. Thousands of additional jobs are created in most years, offsetting by far jobs lost in retiring fossil fuel power plants.[4]
- **Labor Income:** Cumulatively, labor income in Michigan increases *$10 billion* more by 2040. Labor income includes wages and salaries, benefits, and payroll taxes, as well as income earned by self-employed individuals and unincorporated business owners.
- **Gross Domestic Product (GDP):** The jobs increase fuels *$20.6 billion* in additional growth of the state GDP by 2040.

Affordability

Consumers must be able to afford a renewable energy transition. A key metric is "energy burden," the percentage of income a household or individual spends on electricity and gas. In a 2021 survey, 54 percent of respondents had estimated energy burdens at or above 6 percent, a common marker for when energy burden becomes unaffordable (Our Power Michigan, n.d.). About 700 people, split between the City of Detroit and the Upper Peninsula, responded to the survey.

Considering only electricity and gas expenses, the average residential energy burden across the state drops in both the 100% RES and No New Policy scenarios, from 4.9 percent to 3.8 percent, between 2020 and 2040. Yet the strong electrification push in the 100% RES scenario brings further substantial savings not captured in that calculation, from reduced gasoline use for households switching to electric vehicles, as well as savings from reduced propane use for households adopting electric heat pumps.

Recommendations: Ensuring a Just and Equitable Energy Transition

Michigan, like other states that pledge to reduce carbon emissions, has technically feasible and highly beneficial paths to achieving 100 percent renewable energy. A transition away from fossil fuels can yield cleaner air, better health, and more jobs. However, the outcomes can be unequitable if Michigan does not implement the transition with care. We must ensure that everyone reaps the benefits and that the transition does not perpetuate historic inequities in the energy sector.

Here are key recommendations as Michigan moves away from fossil fuels and toward renewable energy, improves affordability for low- and moderate-income households, and ensures good decisionmaking throughout:

- **Target reductions in power plant pollution.** State policy should prioritize reducing pollution in already overburdened communities, deter new investments in the infrastructure for fossil fuel power, and avoid dangerous overreliance on gas. Clean energy sources, such as solar, wind, and batteries for energy storage, should replace generation from fossil fuel sources, including the Monroe coal-fired power plant, one of the state's most polluting facilities.
- **Promote just transitions for fossil fuel workers and frontline communities.** As fossil fuel power plants close—including planned retirements of coal plants owned by Consumers Energy and DTE Energy—job training, income support, and incentives for responsibly siting infrastructure for clean energy and manufacturing at former fossil fuel sites are key to a successful transition for workers and fossil fuel–dependent communities.
- **Directly invest in communities to increase clean energy.** State policies should promote direct investments in expanding rooftop and community solar, energy efficiency, and the electrification of transportation and heating, with a priority on investments in historically underserved people and communities. Additionally, for all communities, the state should eliminate the ability of utilities to cap distributed generation resources such as rooftop solar. Currently, Michigan does not require utilities to compensate their customers for distributed generation once the total amount of that generation in a utility's service territory exceeds 1 percent of its peak load.


Nick Hagen

Solar trainings—like this one in Highland Park, Michigan—help communities learn about how rooftop solar can reduce reliance on fossil fuels for electricity. By building out wind, solar, and batteries for energy storage more aggressively, Michigan can meet 100 percent of its electricity consumption with renewable energy by 2035.

- **Reduce energy burdens.** The move to clean energy will likely reduce average residential energy costs in most or all years, but, without due attention, it could increase burdens for low- and moderate-income households at some points. Unequal access to energy efficiency, rooftop solar, and other clean-energy strategies could keep low- and moderate-income households from enjoying reduced energy costs. Michigan should ensure that costs incurred by electric utilities for clean energy—and legacy costs spread over declining numbers of gas users (Dyson, Glazer, and Tepin 2019)—are addressed through either targeted energy rates or statewide policies, including energy-efficiency measures to reduce consumption. One approach is to enact percentage-of-income payment plans paired with energy-efficiency programs for households with energy burdens higher than 6 percent.
- **Develop workforce programs and entrepreneurship initiatives in renewable energy to foster high-quality, good-paying jobs.** The state must strive to advance a diverse, equitable, and inclusive workforce in clean energy industries. Everyone should be able to participate in and benefit from growth in the many sectors of the clean energy industry. In Illinois, for example, the 2021 Climate and Equitable Jobs Act provides for several workforce hubs across the state to expand access to quality jobs and economic opportunities, particularly for economically disadvantaged communities; it also mandates an incubator program to provide statewide training, mentorship, and recruitment opportunities for small clean energy businesses and contractors (Collingsworth 2021).
- **Ensure that frontline communities have power in decisionmaking.** Michigan's Interagency Environmental Justice Response Team and Advisory Council on Environmental Justice, both created in 2020, are steps in the right direction. Work toward improving equity in the energy sector and meaningful frontline community involvement in decisionmaking must continue.
- **Target transmission additions and "non-wires" alternatives at reducing reliance on urban-based fossil fuel plants.** Responsibly sited electric transmission and non-wires alternatives, such as distributed generation, energy storage, and energy efficiency, are needed to expand renewable electricity, accelerate the closure of fossil plants, and mitigate the harms in communities most exposed to power plant pollution. Legislators and other state leaders should enact policies that promote equitable siting while advancing clean energy.
- **Ensure sustainable and responsible life cycles for clean energy technologies.** Michigan should encourage responsible supply chains, incentivize the use of local manufacturers

of renewable equipment, and enact policies that require recycling and reuse opportunities and make them available statewide.

- **Support strong federal policies.** State leaders should advocate for a strong national clean energy standard to accelerate decarbonization in *all* states and drive a swift transition to a clean, carbon-free electricity system.

This fact sheet is part of a multi-state analysis of the potential effects of bold clean energy action by leadership states. Learn more at www.ucsusa.org/resources/road-100-percent-renewables.

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Acknowledgments

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Organizational affiliations are listed for identification purposes only. The opinions expressed herein do not necessarily reflect those of the organizations that funded the work or the individuals who reviewed it. The Michigan Environmental Justice Coalition and the Union of Concerned Scientists bear sole responsibility for the report's contents.

Endnotes

1. "Gas" in this document refers to what is traditionally called natural gas.
2. Findings from our analysis are expressed in 2020 dollars.
3. A job-year is defined as a full-time position held by one person for one year. A person holds a job for an average of four years (BLS 2020).
4. Michigan's coal, gas, and oil-fired power plants employed 6,500 people in 2021 (DOE 2021).

References

BLS (Bureau of Labor Statistics). 2020. "Employee Tenure Summary." Press release, September 22. https://www.bls.gov/news.release/tenure.nr0.htm

Collingsworth, Jessica. 2021. "Illinois Secures a Major Climate and Equity Victory." *The Equation* (blog). September 14. https://blog.ucsusa.org/jessica-collingsworth/illinois-secures-a-major-climate-and-equity-victory

DOE (US Department of Energy). 2021. *Energy Employment by State*. https://www.energy.gov/sites/default/files/2021-07/USEER%20 2021%20Main%20Body.pdf

Dyson, Mark, Grant Glazer, and Charles Tepin. 2019. *Prospects for Gas Pipelines in the Era of Clean Energy*. Basalt, CO: Rocky Mountain Institute. https://rmi.org/insight/clean-energy-portfolios-pipelines-and-plants

Michigan Department of Health and Human Services. n.d. "Climate Change." Accessed February 11, 2022. https://www.michigan.gov/mdhhs/0,5885,7-339-71548_54783_54784_78428_78429_98577---,00.html

Our Power Michigan. n.d. "Energy Burden Study." Accessed March 21, 2022. https://ourpowermi.org/research/energy-burden-study

UCS (Union of Concerned Scientists). 2021. "Extreme Heat Could Threaten $466 Million Annually in Michigan Outdoor Worker Earnings by Midcentury." Press release, August 15. https://www.ucsusa.org/about/news/extreme-heat-could-threaten-466-million-annually-michigan-outdoor-worker-earnings

www.ucsusa.org/resources/road-100-percent-renewables
es.ucsusa.org/recursos/en-la-ruta-hacia-100-por-ciento-energia-renovable

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MICHIGAN ENVIRONMENTAL JUSTICE COALITION

The Michigan Environmental Justice Coalition (MEJC) works to achieve a clean, healthy, and safe environment for Michigan residents most affected by inadequate policies. We build power and unity within our community, so we all can thrive.

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STATE OF MICHIGAN
MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the Application of DTE ELECTRIC COMPANY for approval of its Integrated Resource Plan pursuant to MCL 460.6t	))))	Case No. U-21193

DIRECT TESTIMONY OF

BORIS LUKANOV, PHD

March 9, 2023

Table of Contents

I. Name and Qualifications

Q1. What is your name, business name, and business address?

A1. My name is Boris Lukanov (he/him). I am a Senior Scientist at Physicians, Scientists, and Engineers for Healthy Energy (PSE Healthy Energy). My business address is 1440 Broadway, Suite 750, Oakland, California, 94612.

Q2. On whose behalf are you testifying in this case?

A2. I appear here in my capacity as an expert witness on behalf of the Environmental Law & Policy Center, the Ecology Center, the Union of Concerned Scientists, and Vote Solar. Collectively, these parties are referred to collectively as the Clean Energy Organizations or "CEO."

Q3. Can you please summarize your educational background?

A3. I have a PhD in Mechanical Engineering and Materials Science from Yale University, and a BA in Physics and Astronomy from Wesleyan University.

Q4. Can you please summarize your work experience?

A4. I joined PSE Healthy Energy in 2017 to develop analyses on energy transition pathways that maximize health, equity, and environmental co-benefits. My research focuses on energy equity, air quality, energy efficiency, and integrated resource modeling and optimization. I have co-authored peer-review papers and technical reports on equity-focused climate strategies, equitable access to clean energy, energy affordability, and energy transition pathways. My work experience is set forth in more detail in my resume, which is attached as Exhibit CEO-13.

Q5. Have you ever been involved in prior regulatory proceedings?

A5. Yes. I have sponsored testimony and exhibits before the MPSC in the *CONSUMERS ENERGY COMPANY*, Integrated Resource Plan, Case No. U-21090.

Q6. Are you sponsoring any exhibits?

A6. Yes, I am sponsoring the following exhibit:

- Exhibit CEO-13: Resume of Boris Lukanov

II. <u>Purpose and Summary</u>

Q7. What is the purpose of your Testimony?

A7. The purpose of my testimony is to discuss the energy equity and environmental justice dimensions of DTE ELECTRIC COMPANY's ("DTE" or the "Company") Integrated Resource Plan ("IRP"). More specifically, my goal is to:

- Evaluate *energy cost burden* disparities across DTE's service territory and across different income and sociodemographic segments of DTE customers.
- Define and estimate the *energy affordability gap*—a key equity metric that helps quantify the full societal cost of achieving energy equity and energy affordability.
- Discuss the evolution of energy cost burdens and the energy affordability gap in the context of the DTE's Proposed Course of Action ("PCA") and quantify the potential impact of specific clean energy interventions/programs that can help lower energy cost burdens over time while simultaneously achieving climate targets and reducing overall societal costs.

- Provide a framework of how energy cost burden and energy affordability considerations should be integrated within these and other IRP proceedings to help achieve a broader set of goals related to energy equity and environmental justice.

Q8. Please summarize your conclusions.

A8. Energy cost burden and energy affordability analyses are an essential component of integrated resource planning. The Commission should require DTE to evaluate and submit energy cost burden and energy affordability gap analyses for approval as part of the IRP. In our analysis for this case we found that:

- Approximately 600,000, or nearly 30 percent, of DTE's residential customers are energy cost burdened—typically defined as spending more than 6 percent of their income on energy costs.

- DTE has a staggering total annual energy affordability gap of approximately $800 million. The portion of this gap attributable to low- and moderate- income ("LMI") households is about $650 million. We estimate that current annual bill assistance (DTE, state and federal) covers less than 20 percent of this gap.

- Energy cost burdens are distributed unevenly across DTE territory. Rural homes reliant on expensive heating sources—such as electric resistive heating and propane—and low-income urban homes in Detroit's historically redlined communities experience the greatest challenges to pay their bills, with typical energy cost burdens in excess of 15 percent of income.

- Certain resources within this IRP can enable significant energy cost burden reductions. Targeted interventions for LMI households, including energy waste reduction, electrification, community solar, and demand response, can shrink the total annual energy affordability gap by $300 million within 15 years while also helping meet emission reduction targets in the residential buildings sector.

While not all of these measures can be addressed directly in an IRP, the IRP can enable some of these resources to be targeted in other proceedings without over-building supply-side resources that can be offset by these programs.

III. Energy Cost Burdens

Q9. What are energy cost burdens and why do they matter?

A9. Energy cost burden is defined as the percentage of household income spent on residential energy bills (excluding transportation). Energy cost burdens above 6 percent of income are considered too high.[1] According to the U.S. Department of Energy, the average household energy cost burden nationally is 8.6 percent for low-income households, compared to 3 percent for non-low-income households,[2] although this figure varies widely from region-to-region and household-to-household. As a metric, energy cost burden helps us compare energy affordability and energy equity across different

[1] The 6 percent threshold is derived from combining a 1981 amendment to the 1969 Housing and Urban Development Act, which states that housing costs, including utilities, should not exceed 30 percent of gross income, with the conventional rule of thumb that energy-related expenses should not exceed 20 percent of housing costs.

[2] *U.S. Department of Energy. "Low-Income Community Energy Solutions."* https://www.energy.gov/eere/slsc/low-income-community-energy-solutions

geographic areas and different populations and is also a key indicator of energy insecurity—the inability of a household to meet their basic energy needs.[3]

High energy cost burdens can lead to cascading financial and health challenges. Affordable energy is needed for a variety of essentials, including home heating and cooling, preparing food, refrigerating medicine, running vital medical equipment, accessing information online, etc. High energy cost burdens can force individuals and families to make impossible choices between paying utility bills or paying for other essentials such as medicine, rent, or food. Roughly one in ten American households report keeping their home at an unhealthy or unsafe temperature due to inability to afford their energy bills.[4] Conversely, should households use energy beyond what they can afford, they often face difficult tradeoffs in paying for other goods and services. One in five American households forgoes or reduces necessities such as food and medicine to make sure they can pay their energy bills.[5]

Within DTE's service territory, we estimate that about 600,000 households (approximately 30% of DTE's residential customers) pay energy bills that exceed the six percent income threshold (more details below). What's more, many of these energy-cost-burdened households are disproportionately concentrated in low-income areas in Detroit with higher density of Black households, as well as among rural populations in the northern parts of DTE's service territory who use more expensive heating fuels such as

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[3] Hernández D. (2013). Energy Insecurity: A Framework for Understanding Energy, the Built Environment, and Health Among Vulnerable Populations in the Context of Climate Change. *American Journal of Public Health, 103*(4), e32–e34. https://doi.org/10.2105/AJPH.2012.301179
[4] *U.S. Energy Information Administration. "Today in Energy" September 2018. https://www.eia.gov/todayinenergy/detail.php?id=37072*
[5] *ibid*

propane and electric resistive heating. In these areas, median cost burdens often exceed 15 percent of income. Detroit has a significantly higher proportion of people of color (81 percent) and higher poverty rates (29 percent) compared to national averages (31 percent and 12 percent respectively).[6]

A detailed analysis of the distribution of energy cost burdens is critical for understanding the scope of the energy equity problem within DTE's service territory. Analyzing DTE's existing energy cost burdens in geographic and demographic detail is also essential for identifying the characteristics of communities and populations who may struggle to pay their energy bills and for determining priority areas, housing types, and income groups that need relief the most. This type of analysis can also show where clean energy investments would result in the greatest systemic reductions in energy cost burdens, thus alleviating the need for bill assistance and reducing the overall societal cost of achieving energy equity.

Q10. How do you estimate energy cost burdens?

A10. Energy cost burden is calculated using a simple equation: the annual household energy bills (consumption of electricity and other fuels multiplied by their respective prices) are divided by the household income to obtain the fraction of household income spent on residential energy needs. While fuel prices and median household incomes by census tract are generally available from various public sources, residential energy consumption data are not publicly available at geographic scales conducive to highly granular spatial or demographic analysis, such as at the census tract or the household level. To estimate

[6] *U.S. Census Bureau QuickFacts: United States.* https://www.census.gov/quickfacts/fact/table/US/PST045221

census tract and household-level electricity and fuel use, we developed a regression model based on a variety of geographic, demographic, housing-related, and climate variables to generate a simulated portfolio of energy use for all residential buildings and households within DTE territory.

The model builds on previously developed methods[7,8] and includes the most commonly used residential energy fuels in Michigan: natural gas, electricity, propane, fuel oil, and wood. Predictive variables were extracted from the 2015 Residential Energy Consumption Survey[9] and matched with household-level data (by census tract) from the U.S. Census Bureau's 2015-2019 American Community Survey. Using the generated estimates of household energy consumption, we are able to aggregate households within DTE's service area by various characteristics, including income, fuel type, home type, race, and other variables to investigate trends in affordability across different populations.

Q11. What factors contribute to high energy cost burdens?

A11. By definition, variations in energy cost burden are largely determined by differences in income and energy costs. Because household incomes are significantly more variable than energy costs, they are the primary determinant of high energy cost burdens. Low-income households typically spend a larger fraction of their income on energy bills compared to other income groups, even though low-income households tend to consume

[7] Jihoon Min, Zeke Hausfather, and Qi Feng Lin. "A High-Resolution Statistical Model of Residential Energy End Use Characteristics for the United States." Journal of Industrial Ecology. October 2010. https://doi.org/10.1111/j.1530-9290.2010.00279.x
[8] Jones, C. and Kammen, D. M. "Spatial Distribution of US Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density." Environmental Science & Technology 48.2 (2014): 895-902. https://doi.org/10.1021/es4034364
[9] *U.S. Energy Information Administration. "Residential Energy Consumption Survey 2015." https://www.eia.gov/consumption/residential/data/2015/*

less energy per household on average.[10] However, energy costs are still an important determinant of energy cost burdens and can vary substantially across different geographic regions, climate zones, utility service areas, home types, and fuel types.[11] A number of other factors can also contribute to high energy cost burdens, including home size, home age, appliance efficiency, renter or homeowner status, climate, geography, and even race. For example, energy costs can be disproportionately high for communities of color, even when controlling for household income.[12,13,14] Policies such as redlining, as well as discriminatory lending practices, employment discrimination, and a legacy of segregated and underfunded schools, among other systemic barriers, have had massive impacts on economic and social inequality between racial groups that persist to this day.[15,16,17]

Q12. What is the distribution of energy cost burdens in DTE territory, and which populations experience the highest energy cost burdens?

A12. Income inequality is the primary driver of energy cost burden disparities in DTE territory. **Figure 1** shows the distribution of energy cost burdens within five income brackets for households earning below twice (200 percent) the federal poverty level ("FPL"). We

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[10] Krieger, E., Lukanov, B., Krieger E. et al. (2020). Equity-Focused Climate Strategies for Colorado: Socioeconomic and Environmental Health Dimensions of Decarbonization. *PSE Healthy Energy.*

[11] B. Lukanov, Makhijani, A., Shetty, K., Kinkhabwala, Y., Smith, A. and Krieger, E. (2022). Pathways to Energy Affordability in Colorado. *PSE Healthy Energy.*

[12] Kontokosta, C., V. Reina, and B. Bonczak. (2019). "Energy Cost Burdens for Low-Income and Minority Households." *Journal of the American Planning Association* 86 (1): 89–105. https://doi.org/10.1080/01944363.2019.1647446

[13] Lyubich, E. (2020). "The Race Gap in Residential Energy Expenditures". *Energy Institute at HAAS*. WP-306

[14] Krieger, E., Lukanov, B. et al. (2020). Equity-Focused Climate Strategies for New Mexico: Socioeconomic and Environmental Health Dimensions of Decarbonization. *PSE Healthy Energy*.

[15] Danyelle Solomon, C. M. (2019, August 7). Systematic Inequality and Economic Opportunity. https://www.americanprogress.org/issues/race/reports/2019/08/07/472910/systematic-inequality-economic-opportunity/

[16] Lombardo, C. (2019, February 26). Why White School Districts Have So Much More Money. https://www.npr.org/2019/02/26/696794821/why-white-school-districts-have-so-much-more-money

[17] Jargowsky, P. (2015). Architecture of Segregation: Civil Unrest, the Concentration of Poverty, and Public Policy. *New York: The Century Foundation*.

categorize these households as low- to moderate-income. Households with high energy cost burdens (above 6 percent) are colored light-to-dark orange, while households with energy cost burdens below this threshold are colored light-to-dark blue.

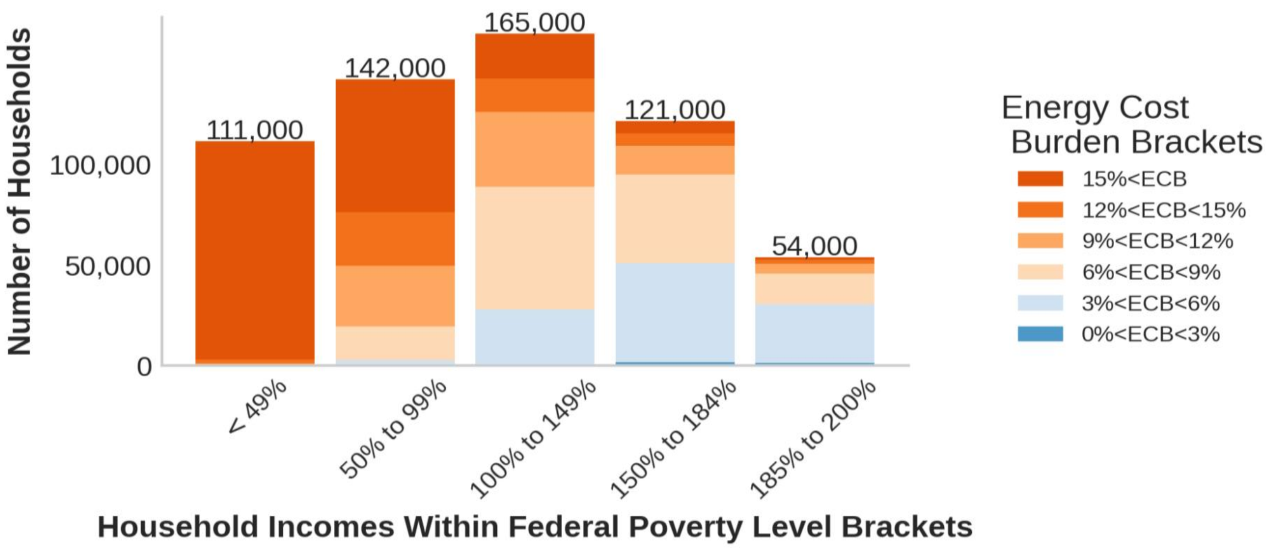


Figure 1: Number of DTE LMI customers within five income brackets shown as a percent of the federal poverty level and colored by energy cost burden (ECB). Households with incomes above 200 percent of federal poverty level are not shown.

Our estimates show that the total number of LMI households in DTE territory is roughly 600,000, (nearly 30 percent of all residential DTE customers). Over 80 percent of these households are energy cost-burdened, compared to only 8.5 percent of the households with incomes greater than twice the FPL (not shown). Practically all households with incomes below the federal poverty level (around 250,000 in total) are energy cost-burdened and the vast majority of them are *extremely* energy cost-burdened—at levels above 15 percent of income. In total, around 620,000 households within DTE territory (about 30 percent of DTE's residential customers) pay energy bills that exceed the 6 percent income threshold. These numbers are staggering. Many of the lowest-income neighborhoods have *median* energy cost burdens that are well in excess of 15 percent of income. We should note here that we analyze combined energy cost burdens, inclusive of both electricity and other residential fuel costs, which allows for a fair comparison between fully electrified households and those with mixed use of electricity and other fuels.

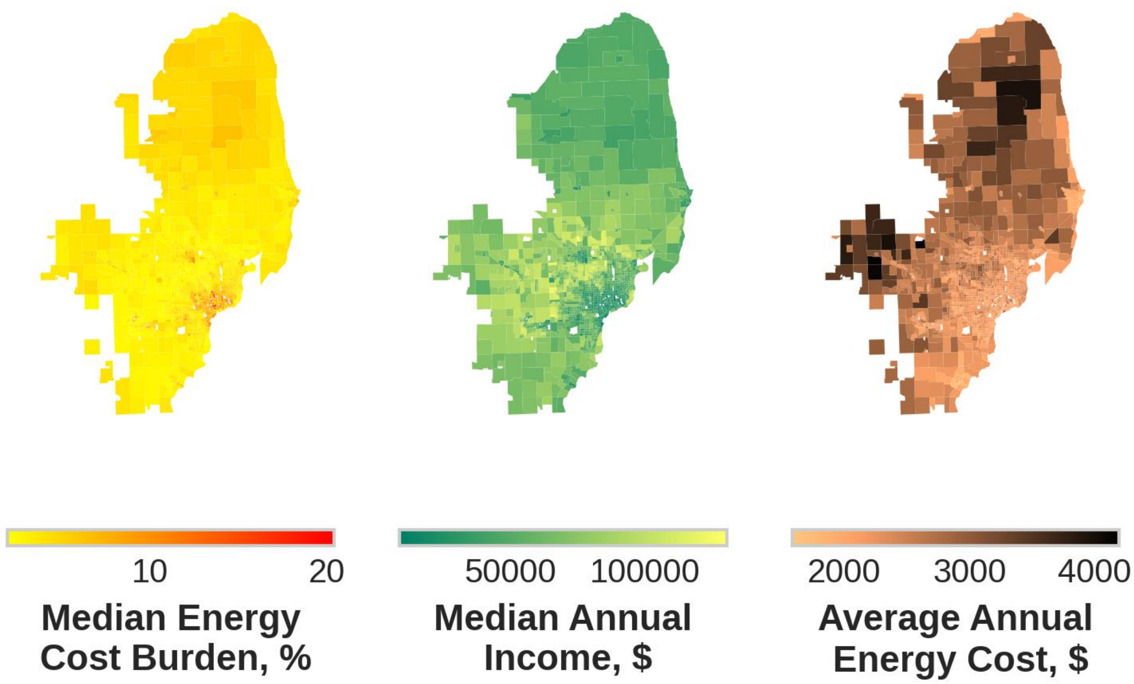


Figure 2: Average household energy costs, median household income, and median household energy cost burden by census tract (DTE service territory).

Figure 2 (left) shows the geographic distribution of median household energy cost burdens by census tract. Energy cost burdens are distributed unevenly, with the highest median energy cost burdens concentrated in the Detroit area. This is largely driven by the lower median household incomes in Detroit **Figure 2 (middle)** and is true despite the fact that the average annual energy costs per household in Detroit are substantially lower **Figure 2 (right)** due to smaller average home sizes and the predominant use of natural gas for heating as opposed to electric resistive heating or propane. Energy cost burdens also tend to be high in rural areas in the north **Figure 2 (left**), where incomes tend to be low **Figure 2 (middle)** and energy costs tend to be high **Figure 2 (right)** due to the larger average home sizes, the colder climate, and the use of more expensive heating fuels such as propane.

Q13. What other household characteristics contribute to high energy cost burdens besides household income and energy costs?

A13. Variations in energy affordability can be driven by a variety of other factors that can function together in complicated ways. Some of these factors include heating fuel type, home type, home quality and age, renter status, appliance efficiency, demographics, and others.

The fuel type used for water and space heating can strongly influence overall energy costs due to significant differences in rates charged for different fuels. **Table 1** shows the average 2021 rates for different heating fuels within DTE territory, the percentage of households using these fuels, and the respective median energy cost burden for each heating fuel type. In 2021, natural gas was the most affordable fuel per unit energy (other than wood), propane was the most expensive fossil fuel per unit energy, and electricity the most expensive heating fuel per unit energy overall. The median household energy cost burdens by heating fuel shown in **Table 1** reflect this order as well. However, care should be taken in comparing fuels based only on the cost per unit energy, as this does not provide the full picture of energy costs. In our analysis, we have assumed that all households heated by electricity, which has a higher cost per unit of energy delivered, use electric resistive heating. In reality, a small fraction of electric-heated households use much more efficient heat pump technology that can drastically reduce the total amount of energy needed to heat a home and, for some homes, can even provide the lowest energy bills. I explore this topic in more detail below.

Heating Fuel Type	Average 2021 Rate ($/MMBtu)	Median ECB	% of Households
Natural Gas	$8.9	3.1%	85%
Electricity	$52.3	8.9%	9%
Propane	$17.5	3.7%	4%
Fuel Oil	$15.4	NA	< 1%
Wood	$7	NA	< 1%

Table 1: Average 2021 rates, median household energy cost burdens, and fraction of households by fuel type (DTE territory).

The geographic distribution of heating fuel types in DTE territory is shown in **Figure 3**. Natural gas is by far the most common heating fuel type in urban areas and the areas surrounding Detroit, where piped gas is available. Propane is more commonly used in rural areas in the northern and western parts of DTE's service territory.

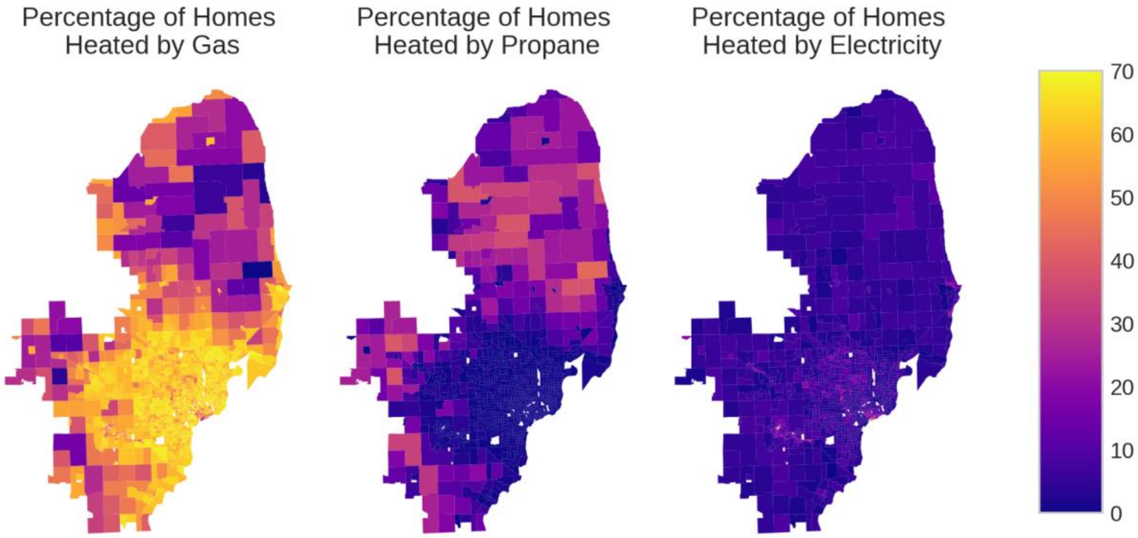


Figure 3: The geographic distribution of heating fuels in DTE service territory. The percentage of homes (by census tract) using the three most common fuels is indicated by the color scheme on the right.

Home type and renter status are two other important factors correlated with variations in energy cost burden and energy affordability. A breakdown of the average annual energy costs, median household incomes, median energy cost burdens, and percent renters by home type are shown in **Table 2.**

Households living in mobile homes, apartment buildings with 2-4 units, and apartment buildings with five or more units have the highest median energy cost burdens (5.2, 4.9 and 4.9 percent respectively). This is driven by multiple factors including income, fuel type, geographic location, and home size, among others. The large majority of households living in multifamily buildings are renters—they constitute 80 percent of households living in multifamily buildings with 2-4 units, and over 90 percent of households living in buildings with five or more units. The fraction of renters among

LMI households within DTE territory is 50 percent. In Detroit, the renter fraction jumps to 61 percent of LMI households.

Home Type	Average Annual Energy Cost, $	Median HH Income, $	Median ECB, %	Percent Renters
Single Attached	$1,685	$55,634	2.8%	33%
Single Detached	$2,471	$71,484	3.2%	13%
Multifamily 2-4 units	$1,877	$35,278	4.9%	80%
Multifamily 5+ units	$1,959	$35,845	4.9%	91%
Mobile	$2,277	$40,385	5.2%	24%

Table 2: Average energy costs, median household incomes, median energy cost burdens, and percent renters broken down by home type.

Home quality and demographics are two other important factors affecting energy cost burdens. LMI households tend to live in homes that are less efficient per square foot, thereby increasing energy costs, and are more likely to have problems such as mold, lead, and leaky roofs. Energy costs also tend to be disproportionately higher for communities of color, even when controlling for household income.[18,19,20] Systemic and structural

[18] Kontokosta, C., V. Reina, and B. Bonczak. (2019). "Energy Cost Burdens for Low-Income and Minority Households." *Journal of the American Planning Association* 86 (1): 89–105. doi.org/10.1080/01944363.2019.1647446
[19] Lyubich, E. (2020). "The Race Gap in Residential Energy Expenditures". *Energy Institute at HAAS*. WP-306
[20] Krieger, E., Lukanov, B. et al. (2020). Equity-Focused Climate Strategies for New Mexico: Socioeconomic and Environmental Health Dimensions of Decarbonization. *PSE Healthy Energy*.

inequities have contributed to this disparity between racial and ethnic groups, from federal government-sponsored segregation in housing, to redlining (e.g., refusing to insure mortgages in and around Black neighborhoods).[21] Because of such systemic exclusions, Black, Indigenous, and People of Color ("BIPOC") communities also tend to live in less efficient and less healthy homes, and may experience higher costs when investing in energy efficiency upgrades.[22,23,24]

Q14. How do energy cost burdens in Detroit compare to the rest of DTE service territory?

A14. Detroit presents unique challenges when it comes to energy affordability. LMI households in Detroit are more often renters than owners: roughly 61 percent of LMI households in Detroit rent their homes compared to 46 percent in the rest of DTE's territory. While average household energy bills for LMI households in Detroit are typically lower, median energy cost burdens in Detroit are higher than in the rest of DTE's service territory due to the much lower median household incomes. The average LMI household's annual energy consumption and energy costs in Detroit are 116 MMBtu and $2,150 respectively, compared to 125 MMBtu and $2,340 for the rest of DTE's territory. However, incomes in Detroit are starkly lower than the rest of DTE's service

https://www.psehealthyenergy.org/our-work/programs/clean-energy/western-states-deep-decarbonization/new-mexico/

[21] Gross, T. (2017, May 3). A 'Forgotten History' Of How The U.S. Government Segregated America. https://www.npr.org/2017/05/03/526655831/a-forgotten-history-of-how-the-u-s-government-segregated-america

[22] J. Lewis, D. Hernandez, and A. Geronimus. (2019). "Energy Efficiency as Energy Justice: Addressing Racial Inequalities through Investments in People and Places." *Energy Efficiency*, *13,* 419–32. https://doi.org/10.1007/s12053-019-09820-z.

[23] Reames, T. G. (2016). Targeting Energy Justice: Exploring Spatial, Racial/Ethnic and Socioeconomic Disparities in Urban Residential Heating Energy Efficiency. *Energy Policy*, *97*, 549-558.

[24] Reames, T. G., Reiner, M. A., & Stacey, M. B. (2018). An Incandescent Truth: Disparities in Energy-Efficient Lighting Availability and Prices in an Urban U.S. County. *Applied Energy*, 218, 95-103.

area—Detroit's median household income is only $32,100 compared to over $67,000 outside of Detroit. In addition, while Detroit contains roughly 14 percent of DTE's residential customers, it is home to over 27 percent of DTE's LMI households.

The census-tract level maps in **Figure 4** show that the affordability challenges in Detroit are not distributed uniformly. For example, neighborhoods with some of the highest energy cost burdens are also located in historically disadvantaged environmental justice ("EJ") communities that were traditionally affected by policies such as redlining, which disproportionately impacted BIPOC populations. BIPOC households represent over 80 percent of all LMI households in Detroit. As noted by CEO Witnesses Gignac and Kenworthy, these communities also suffer from poor quality electric service, resulting in more frequent and more prolonged outages, in addition to paying a higher share of income for their energy.

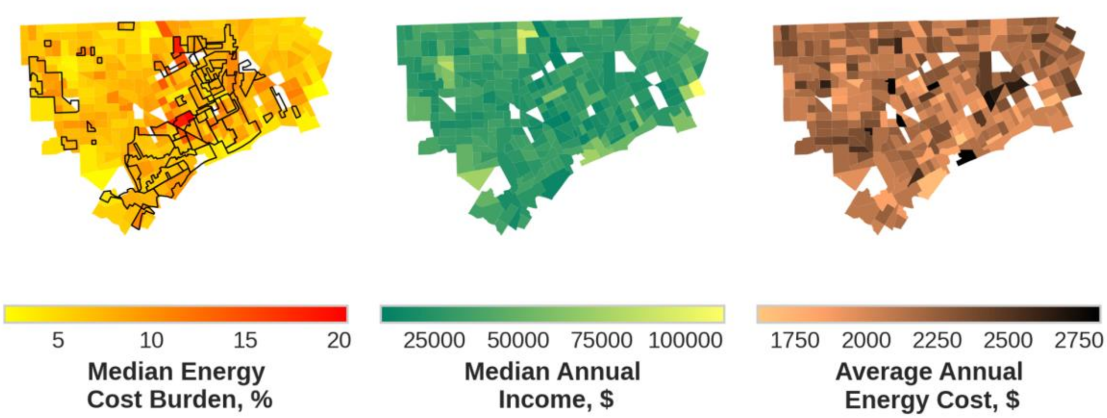


Figure 4: Average household energy costs, median household income, and median household energy cost burden in Detroit. "Redlined neighborhoods" outlined in black received the lowest score by the Home Owners' Loan Corporation.[25]

[25] *Mapping Inequality: Redlining in New Deal America.* *https://dsl.richmond.edu/panorama/redlining/#loc=11/39.293/-76.79&city=baltimore-md&area=B1*

IV. Energy Affordability Gap

Q15. What is the energy affordability gap and how does it relate to energy equity?

A15. The energy affordability gap is defined as the difference between the total energy bills paid by energy-cost-burdened households and the total amount that is considered affordable (i.e. 6 percent of income or less).[26] In essence, the energy affordability gap is a metric that measures the total annual costs of achieving full energy affordability across a certain territory or certain population groups (e.g. DTE's service territory) through strategies such as bill assistance (e.g. a Percent of Income Payment Plan). As such, the energy affordability gap metric helps to quantify the full scale of the energy equity problem and represents the total societal cost for achieving full energy affordability across the board. To pursue energy equity means to pay for this cost one way or another—whether through bill assistance, or through increased investments in LMI energy waste reduction ("EWR"), or through accounts going into arrears carried by the rest of ratepayers, etc.

Q16. How do you calculate the energy affordability gap and what is the annual energy affordability gap for DTE's service territory?

A16. Once energy cost burdens and energy consumption are known at the household level (per the methods described above), the affordability gap is calculated by simply adding up all household energy expenditures that are in excess of 6 percent of income. Unlike energy

[26] The concept was introduced by Fisher, Sheehan, and Colton, who have provided estimates of the energy affordability gaps down to the county scale across the U.S. for many years. Fisher, Sheehan, and Colton: Home Energy Affordability Gap. http://www.homeenergyaffordabilitygap.com/

cost burden, the energy affordability gap metric can capture the cumulative financial magnitude of the energy equity challenge in the context of energy affordability.

For DTE's service territory, we estimate that the total LMI-household energy affordability gap in 2021 was approximately **$650 million**. **Figure 5** shows that the energy affordability gap is largest for the lowest income bracket despite the fact that the number of households in this bracket is lower compared to other income brackets (see also **Figure 1**). This is due to the fact that, on average, a greater proportion of the lowest income households' energy bills must be paid down in order to reach the six percent threshold. This overall sum, then, represents the total annual funds needed (e.g. in the form of bill assistance) to ensure that no LMI household spends more than six percent of their income on residential energy needs. There are also roughly 130,000 households with incomes above 200 percent of the federal poverty level who also have energy cost burdens greater than 6 percent (not shown in **Figure 5**). In these cases, they are generally only slightly above six percent and thus do not contribute as significantly to the total annual energy affordability gap. Our estimate of the total annual energy affordability gap inclusive of these households is approximately **$800 million**.

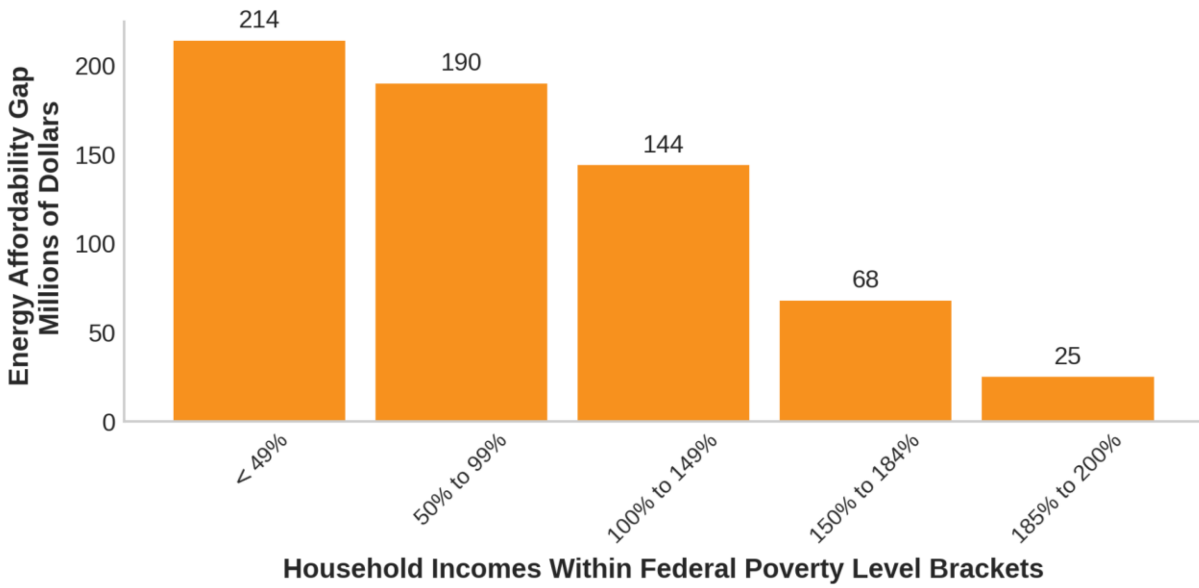
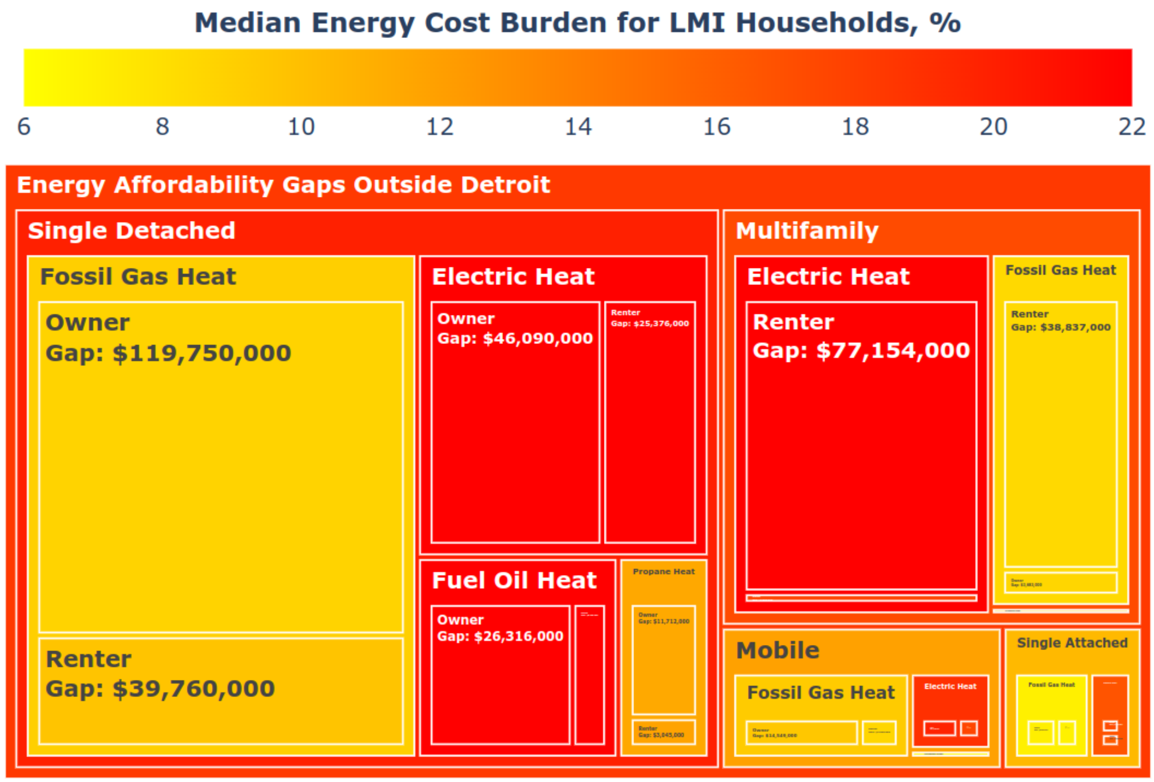


Figure 5: Total LMI energy affordability gap in DTE territory by income bracket as a percent of the federal poverty level.

Q17. How does the energy affordability gap vary by fuel type, home type, and renter status?

A17. **Figure 6** illustrates the size of the energy affordability gap for LMI households broken down by three different subcategories—heating fuel type, home type, and renter status. The rectangle areas in the figure are proportional to the energy affordability gap for the specific subset of households, while the color shading represents the median household energy cost burden for the same subset of households. This somewhat busy figure, then, illustrates the interplay between the two key energy equity metrics: energy cost burden and the energy affordability gap. Large yellow blocks have lower median energy cost burdens than red ones, but the total bill assistance needs are reflected in the block size. The Detroit area accounts for roughly a quarter of the total annual energy affordability gap in DTE territory, despite containing only 14 percent of DTE's residential customers.



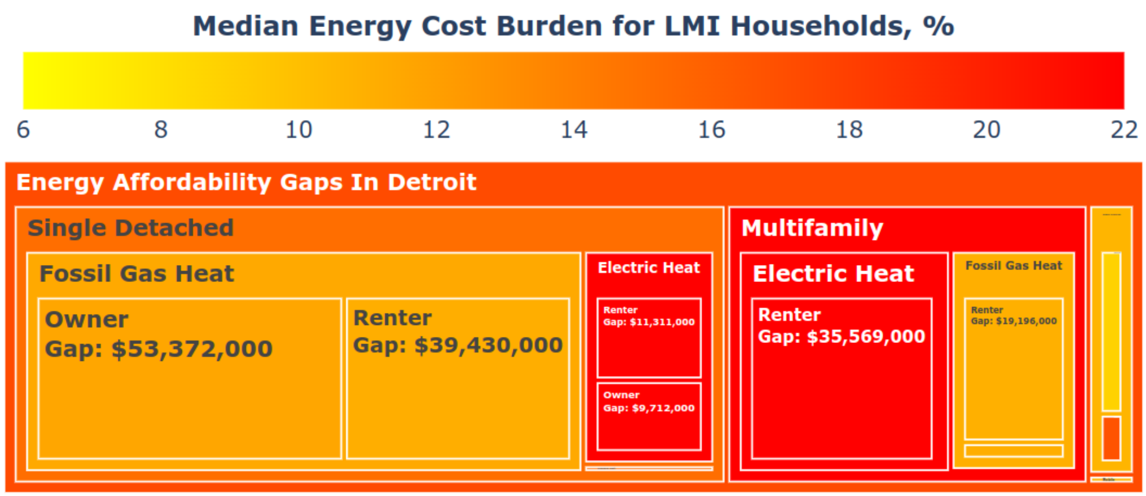


Figure 6: Treemap of the breakdown of the total energy affordability gap for low- and moderate-income households **(top)** in DTE territory outside Detroit and **(bottom)** in Detroit categorized by home type, fuel used for space heating, and renter versus owner-occupied status. Color shading indicates the median energy cost burden and the size of the rectangles are proportional to the total energy affordability gap for each subset of households.

V. Reducing Energy Cost Burdens and the Affordability Gap Through Integrated Resource Planning

Q18. What are the different ways to reduce energy cost burdens and lower the total energy affordability gap?

A18. There are two main ways of addressing high energy cost burdens and shrinking the annual energy affordability gap:

- One is direct bill assistance.
- The other is investments in energy upgrades such as energy efficiency, weatherization and clean energy technologies that can lead to long-term reductions in energy bills.

Direct energy bill assistance payments can reduce energy cost burdens immediately. They play a critical role in achieving energy equity goals by improving energy affordability in the short term. However, direct bill assistance is also a "symptomatic" treatment that does not fundamentally change the scale of the energy equity problem—if assistance is suddenly dropped, energy cost burdens and the affordability gap would immediately revert back to the previous status quo. In addition, this approach does not help achieve climate and clean energy goals and continues to cost significant resources in the long run. We estimate that the total annual funding currently available for bill assistance in DTE territory (inclusive of state and federal programs) is about $140 million.[27]

[27] *Assistance Programs and Credits Diagram FY20. MPSC.* https://www.michigan.gov/mpsc/-/media/Project/Websites/mpsc/workgroups/eaac/FY20_Assistance_Programs_and_Credits_diagram.pdf?rev=eb14bfb163e14f9495a4afa317164678&hash=A09FADA587B5E26924567BE518521D26

In contrast, direct investments in clean energy upgrades and housing retrofits for LMI households, including weatherization, electrification, community solar and demand response, take time but also bring about systemic long-term reductions in energy cost burdens that can lower the energy affordability gap while simultaneously helping achieve climate and public health goals. Over time, this approach reduces the total annual amount of funding needed for bill assistance and thus reduces overall societal costs by helping bring down the energy affordability gap.

Q19. What is the role of LMI weatherization, electrification, community solar and demand response ("DR") in reducing energy cost burdens and promoting energy equity and environmental justice?

A19. Investments in LMI weatherization, electrification, community solar, and DR can provide long-term reductions in energy cost burdens for the neediest households while simultaneously reducing greenhouse gas emissions and bringing health co-benefits.

Weatherization and building efficiency can lower energy bills for LMI households by reducing overall energy use and the need for heating or cooling. Weatherization and energy efficiency strategies for buildings include measures such as installing insulation in walls, floors, ceilings, ducts, and pipes, installing smart control systems and thermostats for heating and cooling, replacing inefficient appliances and lights, sealing windows and doors or installing double-pane windows, improving ventilation, and others. Because such measures often require significant upfront investments, they are difficult for LMI homeowners to finance without access to capital (in the absence of grants, on-bill financing, or public programs such as the federal Weatherization Assistance Program). In addition, more than half of all LMI households in DTE's territory are renters and the vast majority of these households are responsible for paying their own utility bills, creating a classic split incentive problem where renters pay for energy used while landlords are responsible for energy-saving upgrades. All this can limit access to building efficiency measures for LMI, renter, and BIPOC communities, leading to a vastly inequitable distribution of these resources.

Beneficial electrification of homes using efficient heat pump technology can also result in significant bill savings. **Figure 7** shows our estimated savings in annual energy bills for every single household within DTE territory (assuming all homes were instantly outfitted with efficient heat pumps).[28] We assume conversion to a cold-weather heat pump results in average annual heating energy savings of 72 percent, which corresponds to a heat pump seasonal coefficient of performance (SCOP) value of 3.0, replacing thermal heating sources with efficiencies of 85 percent. Using the 2021 fuel rates in **Table 1** results in all electric-resistance and propane-heated homes experiencing annual energy bill savings. The average annual savings of switching from electric resistive or propane heating to efficient cold-weather heat pumps are $1,500 and $80 respectively. Switching from natural gas to heat pumps may not be currently economical for many households in DTE territory because of the relatively high electricity rates, low gas prices, and the cold winter climate in Michigan. However, this is unlikely to remain true in the near future, given that gas prices have been rising faster than electricity rates and are projected to continue to do so.

[28] These costs exclude conversion costs and only consider annual energy usage.

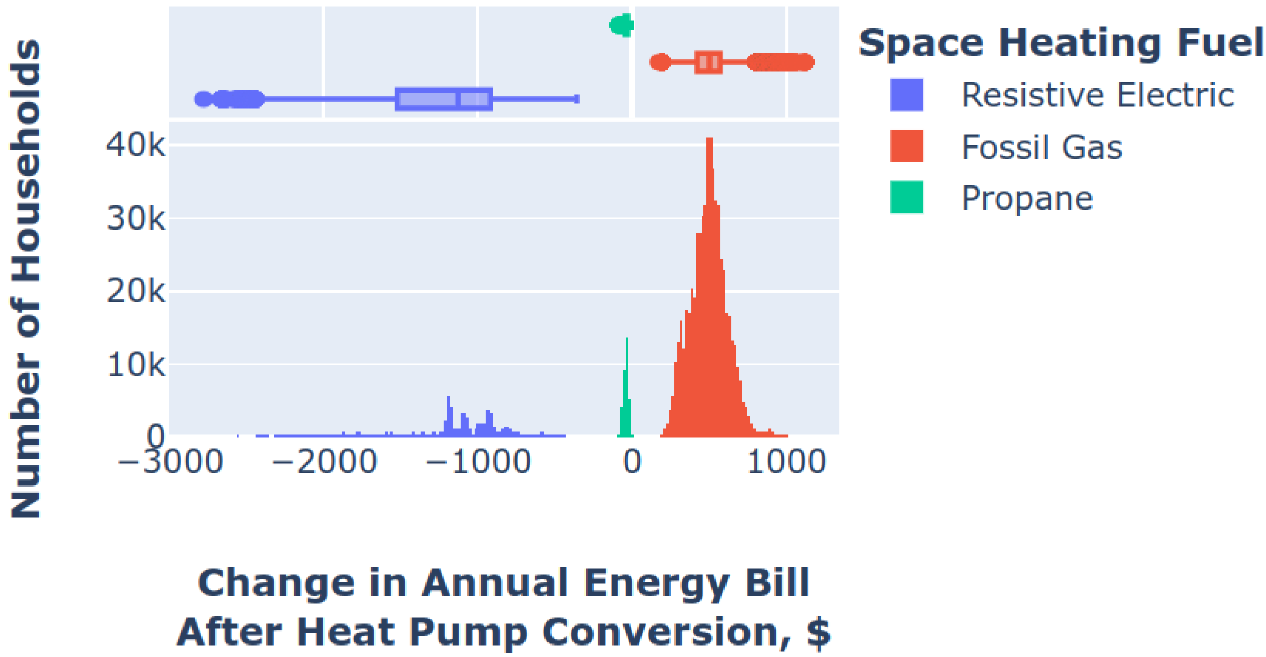


Figure 7: Changes in annual energy bills for all households in DTE territory after immediate conversion to efficient heat pumps, broken down by fuel type at 2021 rates.

The above cost comparison of heat pumps with other heating technologies also does not include some of the other benefits of heat pump electrification: indoor humidity is better controlled with heat pumps, providing cleaner and healthier indoor air in humid environments; heat pumps provide space cooling that many homes currently lack—but which they will increasingly need as the climate warms—or more efficient cooling where cooling does exist; and heating with heat pumps instead of fossil fuels reduces the overall climate impacts of residential heating.[29]

In addition, the electrification of household appliances located within living spaces, such as gas stoves and ovens, can eliminate combustion-related emissions that contribute to

[29] *IEA, Relative CO_2 emissions from the operation of air-source heat pumps compared with the most efficient condensing gas boilers by region in the Net Zero Scenario, 2010-2030, IEA, Paris https://www.iea.org/data-and-statistics/charts/relative-co2-emissions-from-the-operation-of-air-source-heat-pumps-compared-with-the-most-efficient-condensing-gas-boilers-by-region-in-the-net-zero-scenario-2010-2030, IEA. Licence: CC BY 4.0*

poor indoor air quality and increased health risks. Studies have shown that the 1-hr national ambient air quality standard for NO_2 (100 ppb) can be exceeded within minutes of gas stove usage, particularly in small kitchens with poor ventilation.[30,31] Leakage from gas stoves and ovens not in use can also result in concentrations of benzene (a known carcinogen) exceeding the California EPA 8-hour and chronic reference exposure level and in some cases comparable to tobacco smoke.[32] Roughly one-eighth of childhood asthma in the United States may be attributable to the use of gas stoves.[33]

Community solar and demand response can bring additional bill savings for LMI households. Virtual net metering is a valuable strategy for providing discounted electricity and reducing energy cost burdens, the more so as homes are electrified. Enabling LMI households to participate in demand response through broadband access and smart appliances can also help bring costs down even further. In this IRP, demand response is considered as a resource for reducing system peak load. However, through financial incentives paid to customers, it can also serve as a method to decrease annual energy bills for energy-cost-burdened households, while still benefitting the overall system through peak load reduction.

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30 Lebel, E. D., Finnegan, C. J., Ouyang, Z., & Jackson, R. B. (2022). Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes. *Environmental Science & Technology*, 56(4), 2529–2539. https://doi.org/10.1021/acs.est.1c04707

31 Singer, B. C., Pass, R. Z., Delp, W. W., Lorenzetti, D. M., & Maddalena, R. L. (2017). Pollutant concentrations and emission rates from natural gas cooking burners without and with range hood exhaust in nine California homes. *Building and Environment*, 122, 215–229. https://doi.org/10.1016/j.buildenv.2017.06.021

32 Lebel, E. D., Michanowicz, D. R., Bilsback, K. R., Hill, L. L., Goldman, J. S. W., Domen, J. K., Jaeger, J. M., Ruiz, A., & Shonkoff, S. B. C. (2022). Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California. *Environmental Science & Technology*. https://doi.org/10.1021/acs.est.2c02581

33 Gruenwald, T., Seals, B. A., Knibbs, L. D., & Hosgood, H. D. (2023). Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. *International Journal of Environmental Research and Public Health*, *20*(1), Article 1. https://doi.org/10.3390/ijerph20010075

We emphasize community solar rather than rooftop solar because it is accessible to those who do not own their own rooftops and can be a more cost-effective strategy than rooftop installations owned by individual homeowners. Historically, rooftop solar has been disproportionately adopted by higher-income households due to the high upfront costs and other barriers to entry.[34,35] Consequently, low-income, renter, and other cost-burdened populations have been unable to reap the bill-stability and cost-reduction benefits of rooftop solar enjoyed by higher-income, solar-adopting households.

Additionally, as weather extremes become more common due to climate change, community solar paired with battery storage can be a valuable resource for conferring additional resilience benefits to vulnerable communities. Community solar plus storage can be used in lieu of polluting back-up generators to ensure reliable access to energy during disasters and may be particularly impactful for groups that would benefit from enhanced resilience for health reasons. For more detail on the value of community solar refer to the testimony of CEO Witness James Gignac and DAAO Witness Jackson Koeppel.

Q20. What are the combined energy equity benefits of weatherization, electrification, community solar and demand response when applied sequentially?

A20. When implemented sequentially, these four interventions can lead to drastic and long-term reductions in energy cost burdens. The box and whisker plots in **Figure 8** start on

[34] Lukanov, B. R., Krieger, E. M. (2019). Distributed Solar and Environmental Justice: Exploring the Demographic and Socio-Economic Trends of Residential PV Adoption in California. *Energy Policy* 134, 110935. https://doi.org/10.1016/j.enpol.2019.110935

[35] *G. Barbose, et al. "Income Trends of Residential PV Adopters: An Analysis of household-level income estimates". April 2018. https://eta-publications.lbl.gov/sites/default/files/income_trends_of_residential_pv_adopters_final_0.pdf*

the left with the 2021 distribution of energy cost burdens for each income bracket within DTE territory. Proceeding to the right, we can see how each sequential intervention, starting with weatherization, then heat pump installation (for non-gas heated homes only under current economic conditions, see above), community solar, and demand response, impacts the energy cost burden distribution when applied to all LMI households in DTE territory. At the end point, we see that the majority of gas-heated LMI households with incomes above the federal poverty level have energy cost burdens below the 6 percent threshold **Figure 8 (left)**.

The energy cost burden reductions are even more dramatic for non-gas-heated LMI households **Figure 8 (right)** due to the additional step of switching from resistive heating or propane heating to efficient heat pumps, although the majority of these households still have energy cost burdens near or slightly above the 6 percent threshold. Energy cost burdens are reduced most dramatically for households with incomes below the federal poverty level. However, the vast majority of these households still remain above the 6 percent threshold after all interventions, despite the much greater proportional decrease in their energy cost burdens. While energy-related measures can help reduce energy cost burdens, it is difficult to imagine how such measures alone could accomplish the energy affordability goal for households with incomes at only 20 to 30 percent of the federal poverty level—only a simultaneous increase in income can do that.

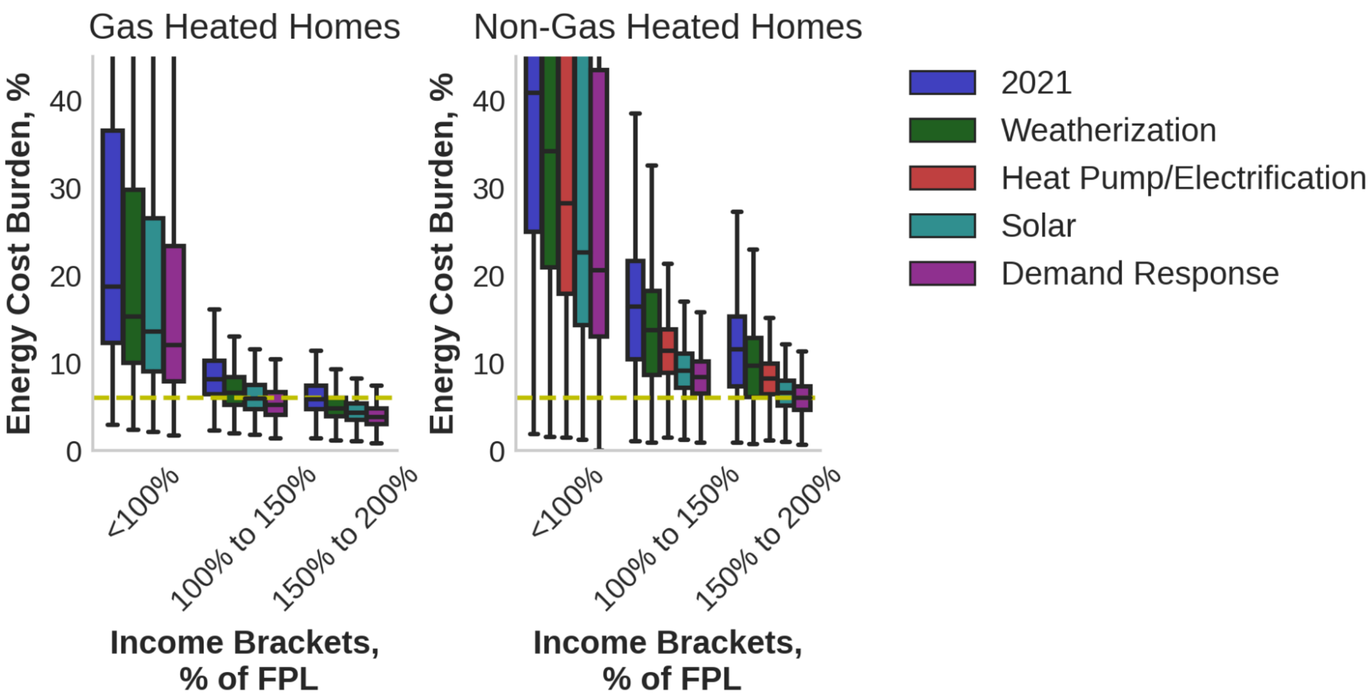

Figure 8: Combined impacts of weatherization, electrification, discounted community solar and demand response on the distribution of energy cost burdens in DTE territory.

Several important assumptions were made to create **Figure 8**. We estimate the cost and energy savings of LMI weatherization using data from a report tracking energy savings after such interventions.[36] The costs of LMI weatherization were roughly uniformly distributed from $500 to $10,000, so we use the same trend for the analysis presented here. The average amount of investment in weatherization is $5,250 which corresponds to about 18 percent energy savings.[37] Community solar is assumed to provide a 20 percent

[36] *Michael Blasnik, Greg Dalhoff, David Carroll, Ferit Ucar, Dan Bausch. Evaluation of the Weatherization Assistance Program During Program Years 2009-2011 (American Recovery and Reinvestment Act Period): Energy Impacts for Single-Family Homes 2009-2011, Oak Ridge National Laboratory, March 2015, at https://weatherization.ornl.gov/wp-content/uploads/pdf/WAPRecoveryActEvalFinalReports/ORNL_TM-2014_582.pdf*

[37] Note that the y-intercept for the roughly linear relationship between cost and savings is not zero, so we set a minimum spending of $500. This captures the reduced efficiency gains for increased levels of spending.

discount on utility electric rates for all LMI households. We further assume demand response can provide a $150 reduction in annual energy bills on average.[38]

Q21. What is the role of this IRP case in addressing high energy cost burdens and the overall energy affordability gap?

A21. Executive Directive 2020-10 explicitly required IRP cases in Michigan to address environmental justice ("EJ") concerns. EJ concerns related to the health impacts of the Proposed Course of Action (PCA) are partially addressed by DTE Witness Marietta's testimony, and, to a fuller extent, by my colleague, CEO Witness, Kelsey Bilsback's testimony. The health impact assessment of the PCA, however, does not encompass the full breadth of the energy equity and environmental justice landscape within DTE territory. Alleviating disparities in energy cost burdens is a critical component of energy equity and environmental justice and has the potential to fundamentally reduce the energy affordability gap in historically disadvantaged and non-White communities while also redressing historic inequities. DTE entirely failed to perform an analysis of how the PCA impacts the distribution of energy cost burdens and the size of the energy affordability gap. This testimony corrects that omission. Going forward, the Commission must prioritize evaluation of energy cost burdens and the affordability gap in an effort to mitigate and eliminate them over time.

This IRP case will also set a resource portfolio that includes multiple factors that would influence the distribution of energy cost burdens and the evolution of the annual energy

[38] *Inferred from Gerke, B.F., et. al. (2020). The California Demand Response Potential Study, Phase 3: Final Report on the Shift Resource through 2030. Lawrence Berkeley National Laboratory. Figure ES-3, pdf p. 21 and the range $50 to $100 per kilowatt-year (pdf p. 26), at https://eta-publications.lbl.gov/sites/default/files/ca_dr_potential_study_-_phase_3_-_shift_-_final_report.pdf*

affordability gap. While energy cost burdens are also affected by rate cases, there are at least two additional factors to consider here in the context of this IRP:

- Resources such as LMI EWR programs and discounted community solar for LMI homes can substantially reduce energy cost burden disparities (as illustrated in **Figure 8** above) and thus can lower the overall size of the energy affordability gap. By considering the energy and capacity benefits of these resources, the IRP case can open the door for these resources to be expanded in other proceedings with duplicating resource buildout, and can be coupled with stronger LMI programs in general.
- These resources can also reduce the need for investment in potentially more expensive supply-side resources, such as the proposed CCGT with CCS in DTE's PCA, and transmission and distribution investments, as well as reduce the total amount of ratepayer-funded resources needed for bill-assistance programs such as a full Percent of Income Payment Plan ("PIPP") to immediately address the energy affordability gap in DTE territory.

Because LMI EWR and community solar are generally more expensive resources compared to non-LMI EWR and utility-scale solar, one could argue that including such resources in IRP modeling would result in a tradeoff between reducing energy cost burdens on the one hand and achieving lower greenhouse gas emissions and lower total resource costs on the other hand. The total resource cost of the energy resource portfolio selected and optimized under the PCA, however, does not represent the total *societal cost* of this portfolio and omits critical market externalities such as health-impact costs and the size of the energy affordability gap (the latter representing the total cost of achieving energy equity and affordability). These full societal costs are real and are borne by ratepayers and taxpayers, whether by paying for increased healthcare costs associated with air pollution, or by funding bills-assistance programs needed to achieve full energy affordability across the board (assuming we are truly serious about energy equity and environmental justice). It is important to point out that IRPs already serve the dual purpose of guaranteeing resource adequacy at minimized costs while also meeting statutory climate targets. It is therefore reasonable to expect IRPs to serve the triple purpose of meeting both climate and environmental justice goals while also guaranteeing resource adequacy at minimized *societal* costs, inclusive of energy affordability gap projections and health impact assessments. In fact, the most reasonable and prudent plan should accomplish all three of these goals.

Q22. Can you project the evolution of the energy affordability gap under the PCA scenario? How does it compare to a scenario focused on increased investments in LMI and EJ communities such as LMI EWR and community solar?

A22. Implementing the interventions highlighted above (LMI EWR, electrification, discounted community solar, and DR) for all LMI homes in DTE territory, would take time. In **Figure 9**, we develop a scenario in which all low- and moderate-income homes are provided the interventions described above over a 15-year time period, with the highest energy-cost-burdened households prioritized first and equal numbers of homes retrofitted each year.

The black dashed line shows the evolution of the energy affordability gap according to the current version of the PCA. Equivalently, this line also represents the total annual funds needed in bill assistance under the PCA to bring energy cost burdens below the 6 percent threshold system-wide across the entire DTE service territory. We have included investments of about $30 million per year in LMI EWR (in 2021 dollars) budgeted under the PCA.[39]

The gray shaded area represents the evolution of the energy affordability gap under a modified scenario, in which DTE's investments in LMI EWR are **increased five-fold** to around $150 million per year. These additional investments in LMI communities are shown by the orange shaded area.[40]

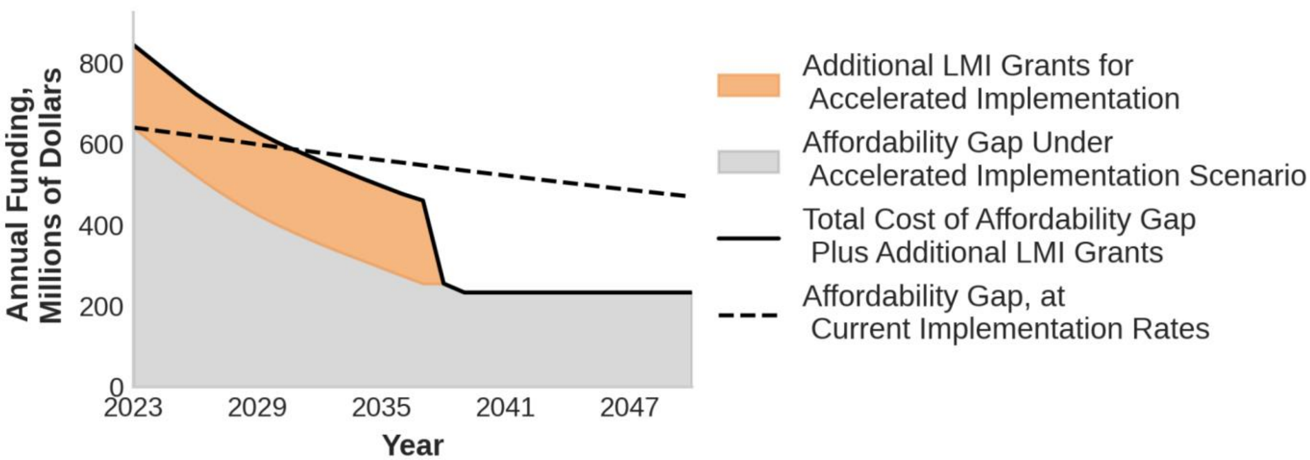

Figure 9: Combined impacts of weatherization, electrification, discounted community solar and demand response on the distribution of energy cost burdens in DTE territory. This projection only considers households with incomes less than twice the federal poverty level.

[39] For simplicity, we have assumed a constant number of LMI households helped and constant energy costs. In practice, changes in income, housing standards for new housing, changes in the cost of renewable energy and natural gas, and changes in utility rates will affect the affordability gap—in both directions. The estimates derived from this exercise are approximate, but satisfactory for setting policy directions and determining the magnitude of resources needed to meet a universal affordability criterion.

[40] The electrification of LMI households with efficient heat pumps is assumed to be covered entirely by the recently passed Inflation Reduction Act ("IRA"), which has drastically changed the cost-benefit analysis for electrification. For details, see the High-Efficiency Electric Home Rebate Act ("HEEHRA"): https://www.rewiringamerica.org/policy/high-efficiency-electric-home-rebate-act

The gray shaded area and the dashed line both start at about $650 million—the current level of the energy affordability gap for LMI households in DTE territory. In the PCA trajectory (dashed line), the energy affordability gap decreases to about $550 million by 2050 given current rates of LMI EWR funding. At this pace, it would take over 100 years for EWR interventions to reach all LMI households, a pace inconsistent with Michigan's building decarbonization targets outlined in the MI Healthy Climate Plan, developed to meet the state's goal of economy-wide carbon neutrality by 2050.

The solid black line shows the evolution of the energy affordability gap plus the proposed five-fold increase in additional grants for all LMI households that would continue until 2038. By 2038, the energy cost burdens of a large fraction of households with incomes above 100 percent of the federal poverty level would be reduced to below six percent (per **Figure 8** above). As total new investments grow and continue to reduce energy cost burdens, the total of new grants (orange) plus the energy affordability gap (gray) declines to a level well below the projected PCA energy affordability gap had there been no expanded investments. The white area between the dashed black line and the solid black line then represents the savings, which start to grow after 2030 and increase to about **$300 million** annually by 2038, once interventions have reached all LMI households. At that point, the basic investments in LMI households will have been made and the average annual savings from the reduced energy affordability gap would average about **$260 million annually** until 2050 (and beyond). The total savings by 2050 amount to over $1.4 billion (at a 3 percent discount rate). Some funds will still be needed to electrify gas-heated LMI households and to replace older heat pumps after their 15-year estimated life.

More importantly, energy cost burdens in DTE territory would be reduced dramatically and LMI households would be participating in the clean energy transition from the get-go.

This analysis makes multiple assumptions, including that energy prices, incomes, retrofitting costs, and population remain at their values in 2021. A more sophisticated approach would need to account for projections of all of those factors but would be unlikely to change the major trend shown here that a more rapid investment in LMI homes would provide significant savings in the near future if the energy affordability gap is properly accounted for.

VI. Summary and Recommendations

Q23. What are the implications of the above analysis?

A23. Energy cost burden and demographic data can be sliced and diced in many ways, and the implications can be manifold.

First, the above analysis implies that expanding investments in energy-cost-burdened populations can save DTE ratepayers and Michigan taxpayers hundreds of millions of dollars annually (down the line) by shrinking the energy affordability gap and the equivalent need for bill-assistance, while simultaneously helping meet Michigan’s emissions reduction targets for the residential buildings sector. The savings can be achieved through a five-fold increase in funding for LMI EWR programs within this IRP, coupled with funding available for LMI electrification through IRA, and provisions for discounted community solar and DR for LMI households. Thus, the most reasonable and prudent course of action in this case includes adding these investments.

Second, this approach would require giving first priority to LMI households for EWR and fuel switching programs. This goes contrary to the conventional approach of waiting for the costs of clean energy technologies and LMI EWR to decline. We have shown here that it is advantageous to invest in energy-cost-burdened households from the get-go if we consider total societal costs, inclusive of the need to achieve energy equity goals. We should also recognize the fact that all homes, inclusive of LMI households, must reach increasing levels of energy efficiency and electrification over the next 20 to 30 years to meet Michigan's climate goals. Not prioritizing LMI households early on would simply push the need for investments in these households further down the line, thus either completely foregoing energy equity and environmental justice goals, or incurring significant net societal costs in the form of increased bill assistance needed in the long term.

What's more, unless the clean energy transition directly addresses existing inequities in the fossil fuel-based energy system, we risk exacerbating them. For instance, as climate policies and market forces continue to drive clean energy adoption, wealthier households will tend to electrify their homes earlier, leaving people on the lower end of the income spectrum picking up the huge tab for maintaining an aging legacy natural gas infrastructure over time, and taking the brunt of the health impacts associated with the continued use of fossil fuels in their homes.

Ultimately, this is an ethical and environmental justice issue. In recent years, researchers have worked to develop a conceptual framework for energy justice and energy equity.[41]

[41] Sovacool, B. K., Heffron, R. J., McCauley, D., & Goldthau, A. (2016). Energy decisions reframed as justice and ethical concerns. Nature Energy, 1(5), 1-6.

This framework delineates an energy system that distributes the benefits and costs of energy services and resources fairly, corrects for historic and systemic inequities, and contributes to a fully representative and impartial decision-making process. By incorporating increased investments in EWR, electrification, community solar, and DR in communities facing the greatest challenges paying their energy bills, the Commission can fashion orders in IRP cases like this one to save ratepayers and taxpayers money while supporting a healthier, more just energy system.

Q24. Can you sketch a basic framework for how to incorporate energy cost burden and energy affordability gap considerations in this and other IRP cases under MPSC's jurisdiction?

A24. The two metrics discussed in this testimony—energy cost burden and the energy affordability gap—provide a useful, and more importantly, a quantifiable way of thinking about energy affordability and energy equity. It is therefore critical that the Commission require DTE and other Michigan utilities to incorporate these two metrics in their energy equity and EJ analyses in order to understand how their decisions will impact affordability for those who struggle the most to pay their energy bills. This IRP process is an opportune moment to do so.

As a first step, the Commission should require DTE (and other Michigan utilities) to perform the analyses described here by analyzing the distribution of energy cost burdens within their utility service territory and across various demographic groups, quantifying the size of the energy affordability gap, and projecting these two metrics across scenarios modeled in the IRP and as part of the total societal cost for each scenario.

As a second step, specific requirements for energy cost burden and energy affordability gap reductions over time can (and should) be imposed as constraints within the IRP modeling and optimization, in analogy to constraints reflective of greenhouse gas emission reductions targets. Then, resources such as LMI EWR and community solar can become viable options within resource portfolios and modeled scenarios as they can help meet energy equity targets and fulfill the imposed constraints while simultaneously reducing overall societal costs, despite the potentially higher individual resource costs.

Finally, there is an urgent need to develop new capacity expansion and decarbonization models that provide utilities and decision-makers with the ability to set societal goals up front and include information needed to design effective policies that realize health, equity, and resilience benefits along with the deep greenhouse gas emission reductions needed to mitigate climate change. These new models need to integrate environmental health and energy equity impacts—the market externalities that typically burden some of the most disadvantaged communities—and need to optimize for overall societal costs inclusive of these market externalities.

Utility companies like DTE already have access to detailed energy use data at the customer level that can be anonymized and aggregated on the census tract level and can be used to evaluate the energy affordability gap and the landscape of energy cost burdens while skipping the complex step of modeling energy consumption at the household level that was required for the purposes of this testimony. This and the other considerations already highlighted above suggest that energy cost burden and energy affordability gap analyses can (and should) be explicitly engineered into the IRP process and should be required of utilities to evaluate and submit for approval. The goal should be to incorporate these analyses into the IRP process in a way that can meaningfully reduce energy cost burden disparities over time and lead to a cleaner and more equitable energy system.

Q25. Does this complete your testimony?

A25. Yes.

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Education

Yale University, School of Engineering and Applied Science, New Haven, CT
Ph.D. in Mechanical Engineering and Materials Science, May 2013

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M.S. in Mechanical Engineering and Materials Science, May 2008

Wesleyan University, Middletown, CT
B.A. in Physics, Astronomy, May 2004

Current Work and Research

Physicians, Scientists and Engineers for Healthy Energy (PSE), Oakland, CA, Jan 2017 – Present
Senior Scientist, *Clean Energy Program*

- Advancing the transition to clean and renewable energy resources; developing energy transition pathways to realize equity, health, environmental, and resilience co-benefits.
- Translating and disseminating scientific information related to the public health, equity, environmental, and climate impacts of energy production and use for policymakers, advocacy groups and the general public.
- Leading a CARB-funded project in Richmond, CA to provide reliable, hyper-local air quality data to regulators and the community, and to incorporate air quality data into decision-making efforts related to local, regional and statewide air quality policies.
- Developing data visualization and computational tools; conducting numerical and data analyses in energy science and policy.
- Researching, drafting, and publishing technical reports, peer-reviewed papers, articles and commentaries.

Past Research

Reservoir Engineering Research Institute (RERI), Palo Alto, CA, July 2013 – March 2016
Postdoctoral Researcher: *Micelles, Nanoparticles, Electrolytes – Firoozabadi Research Group*

Developed molecular thermodynamic computational models for surfactant aggregation and micelle formation in complex fluids. Analyzed ion-specific effects on the self-assembly of amphiphilic molecules in brine and the phase behavior of microemulsions. Modelled surfactant adsorption at fluid-fluid and solid-fluid interfaces.

School of Engineering and Applied Science, Yale University, New Haven, CT, 2007 – 2013
Graduate Researcher: *Atomic/Electronic Structure of Surfaces – Altman Research Group*

Characterized the nanostructure of surfaces and thin films at the atomic level using scanning tunneling microscopy, electron diffraction, electron spectroscopy and first-principles theory, with applications in advanced transistor technology, photovoltaics, and photoelectrochemistry.

Department of Physics, Wesleyan University, Middletown CT, September 2004 – December 2005
Research Assistant: *Supercooled and Glassy Water – Starr Research Group*

Developed molecular dynamics simulations of supercooled and glassy water; investigated the interplay between the glass transition and the liquid-liquid phase transition in water.

Department of Astronomy, Wesleyan University, Middletown, CT, Summer 2004
Research Assistant: *Star and Planet Formation – Herbst Research Group*

Analyzed Hubble space-telescope images; performed theoretical calculations related to planetary and star formation.

Teaching

Wesleyan University and Yale University, Spring 2002 – Fall 2012

Teaching fellow and guest lecturer for several physics, math and astronomy courses, including *General Physics Laboratory I & II, Classical and Statistical Thermodynamics, Electricity and Magnetism, Special Relativity, Vector Calculus*, *The Universe*

Other Work

Department of Engineering, Yale University, New Haven, CT, Fall 2011 – Spring 2013

Graduate Assistant: Assisted Prof. Abbas Firoozabadi in writing a chapter for a graduate-level textbook on thermodynamics; prepared and solved sample problems in various chapters to illustrate key concepts in the textbook.

Climate Culture LLC, New York, Summer 2008

Energy Analyst: Developed algorithms for calculating energy and carbon footprints of various activities and products; performed life-cycle assessments.

Publications

Peer-Review Journal Articles and Technical Reports

- Makhijani, A., Kinkhabwala, Y., Jaeger, J., Bilsback, K. R., Hill, L. L., Peltier, L., **Lukanov, B. R.**, Krieger, E. M. Energy Affordability in Maryland: Integrating Public Health, Equity, and Climate. Technical Report. *PSE Healthy Energy and IEER*, 2023.
- **Lukanov, B.**, Shetty, K., Smith, A., Hill, L., Sugrue, R., Butler, J., Preble, C., Kirchstetter, T. Understanding Air Quality Trends in Richmond-San Pablo, California: Results from the Richmond Air Monitoring Network. Technical Report. *PSE Healthy Energy*, 2022.
- Bilsback, K. R., Krieger, E. M., **Lukanov, B. R.,** Shetty, K., Smith, A. Incorporating Health and Equity metrics into the Minnesota Power 2021 Integrated Resource Plan. Technical Report. *PSE Healthy Energy*, 2022.
- **Lukanov, B. R.**, Makhijani, A., Shetty, K., Kinkhabwala, Y., Smith, A., Krieger, E. M. Pathways to Energy Affordability in Colorado. Technical Report. *PSE Healthy Energy*, 2022.
- E. Krieger, **B. Lukanov**, A. McPhail, A. Smith and A. Dillon. Equity-focused climate strategies for New Mexico. Technical Report. *PSE Healthy Energy*, 2021.
- E. Krieger, **B. Lukanov**, A. McPhail, A. Smith and A. Dillon. Equity-focused climate strategies for Nevada. Technical Report. *PSE Healthy Energy*, 2021.
- E. Krieger, **B. Lukanov**, A. McPhail, A. Smith and A. Dillon. Equity-focused climate strategies for Colorado. Technical Report. *PSE Healthy Energy*, 2020.
- **Boris Lukanov** and Elena Krieger, "Distributed Solar and Environmental Justice: Exploring the Demographic and Socioeconomic Trends of Residential PV Adoption in California." *Energy Policy* **134**, 110935 (2019).
- Elena Krieger, Arjun Makhijani, **Boris Lukanov**, MV Ramana. A Clean Energy Pathway for New Jersey. Technical Report. *PSE Healthy Energy*, 2017.
- **Boris Lukanov** and Abbas Firoozabadi, "Molecular Thermodynamic Modeling of Reverse Micelles and Water-in-Oil Microemulsions." *Langmuir* **32**, 3100 (2016).
- Atefeh Khoshnood, **Boris Lukanov**, Abbas Firoozabadi, "Temperature Effect on Micelle Formation: Molecular Thermodynamic Model Revisited." *Langmuir* **32**, 2175 (2016).
- **Boris Lukanov** and Abbas Firoozabadi, "Specific ion effects on the self-assembly of ionic surfactants: a molecular thermodynamic theory of micellization with dispersion forces." *Langmuir* **30**, 6373 (2014).
- **Boris Lukanov**, Kevin Garrity, Sohrab Ismail-Beigi, and Eric I. Altman "Formation and atomic structure of ordered Sr-induced nanostrips on Ge (100)." *Physical Review B* **89**, 155319 (2014).

- **Boris Lukanov**, Kevin Garrity, Sohrab Ismail-Beigi, and Eric I. Altman, "Deciphering the atomic structure of a complex Sr/Ge (100) phase via scanning tunneling microscopy and first-principles calculations." *Physical Review B* **85**, 195316 (2012).
- Nicolas Giovambattista, Thomas Loerting, **Boris R. Lukanov**, and Francis W. Starr, "Interplay of the Glass Transition and the Liquid-Liquid Phase Transition in Water." *Scientific Reports* **2,** 390 (2012).
- **B. R. Lukanov**, J. W. Reiner, F. J. Walker, C. H. Ahn, and E. I. Altman, "Formation of alkaline-earth template layers on Ge (100) for oxide heteroepitaxy: Self-organization of ordered islands and trenches." *Physical Review B* **84,** 075330 (2011).
- Marvin Cummings, Sebastian Gliga, **Boris Lukanov**, Eric I. Altman, Matthias Bode, Enrique V. Barrera, "Surface interactions of molecular C_{60} and impact on Ni (100) and Co (0001) film growth: A scanning tunneling microscopy study." *Surface Science* **605,** 72 (2011).

Commentaries, Blogs, Briefs

- Arjun Makhijani and **Boris Lukanov**. Aligning climate and affordability goals can save states billions. Opinion. *Utility Dive*. March 2022. Available at: https://www.utilitydive.com/news/aligning-climate-and-affordability-goals-can-save-states-billions/621233/
- Lee Ann Hill, Audrey Smith, Karan Shetty, Angelica Ruiz, **Boris Lukanov**. Richmond Air Monitoring Network insights: Using hyperlocal data to evaluate neighborhood trends in air pollution. Blog Article. *PSE Healthy Energy*. September 2021. Available at: https://www.psehealthyenergy.org/news/blog/richmond-air-monitoring-network-insights-using-hyperlocal-data-evaluate-to-neighborhood-trends-in-air-pollution/
- Audrey Smith and **Boris Lukanov**. Bringing Health and Equity to Decarbonization. Blog Article. *PSE Healthy Energy*. August 2021. Available at: https://www.psehealthyenergy.org/news/blog/bringing-health-and-equity-to-western-states-deep-decarbonization/
- **Boris Lukanov** and Audrey Smith. Richmond, CA air monitors show cleaner air during Bay Area COVID-19 lockdown, with a catch. Blog Article. *PSE Healthy Energy*. April 2020. Available at: https://www.psehealthyenergy.org/news/blog/richmond-monitoring-coronavirus/
- **Boris Lukanov** and Lee Ann Hill. The Power of Data from Urban Air Quality Monitoring Networks. Commentary. *Meeting of the Minds*. September 2019. Available at: https://meetingoftheminds.org/the-power-of-data-from-urban-air-quality-monitoring-networks-31545
- Elena Krieger, **Boris Lukanov** and Seth Shonkoff. Net Zero Carbon California by 2045: What Will It Take? Blog Article. *PSE Healthy Energy*. October 2018. Available at: https://www.psehealthyenergy.org/news/blog/net-zero-carbon-california-by-2045-what-will-it-take/

- **Boris Lukanov** and Lee Ann Hill. Why Local Air-Quality Monitoring is Important. Blog Article. *PSE Healthy Energy*. July 2018.
  Available at: https://www.psehealthyenergy.org/news/blog/air-quality-ab-617/
- **Boris Lukanov**. Energy Efficiency is the Key to NJ's Clean-Energy Future (Part I and II). Blog Article. *PSE Healthy Energy*. January 2018. Available at: https://www.psehealthyenergy.org/news/blog/energy-efficiency-is-the-key-to-new-jerseys-clean-energy-future-part-i/
- **Boris Lukanov**. Heat Pumps and Their Role in a Clean Energy System. Technology Brief. *PSE Healthy Energy*. July 2017. Available at: https://www.psehealthyenergy.org/wp-content/uploads/2017/09/HeatPumps.pdf

Interactive Data Tools and Visualizations

- **Boris Lukanov.** The California Solar Map. Available at: https://www.psehealthyenergy.org/our-work/interactive-tools/california-solar-map/
- **Boris Lukanov.** Richmond Emissions Inventory and Sensitive Populations mapping tool. Available at: https://www.psehealthyenergy.org/our-work/interactive-tools/
- **Boris Lukanov**. Solar on Multifamily Affordable Housing in California (SOMAH) map. Available at: https://www.psehealthyenergy.org/our-work/interactive-tools/somah-map-and-data/

Presentations, Talks

- **Boris Lukanov**. "Alleviating energy cost burden disparities: how investments in low-income energy efficiency and electrification can help narrow the energy equity divide." Talk, CEEJH Symposium, UMD, MD. (2022)
- **Boris Lukanov.** "Alleviating the Energy Cost Burden: Regulatory Approaches to Supporting Affordability." Talk, NARUC Innovation Webinar. (2022)
- **Boris Lukanov**, Audrey Smith and Karan Shetty. "Measuring the Spatial and Temporal Variations of Air Pollution in Complex Urban Environments: Results from the Richmond Air Monitoring Network." Poster, ASIC Conference, Pasadena, CA. (2022)
- Audrey Smith, Rebecca Sugrue, Karan Shetty, James Butler, Chelsea Preble, Thomas Kirchstetter, **Boris Lukanov**. Network Calibration and Wildfire Data Correction for Low-Cost Air Quality Sensors: Lessons Learned from the Richmond Air Monitoring Network. Poster, ASIC Conference, Pasadena, CA. (2022)
- **Boris Lukanov** and Elena Krieger, "Distributed Solar and Environmental Justice: Exploring the Demographic and Socioeconomic Trends of Residential PV Adoption in California." Talk, BECC Conference, Sacramento, CA. (2019)

- **Boris Lukanov** and Elena Krieger, "Distributed Solar and Environmental Justice: Exploring the Demographic and Socioeconomic Trends of Residential PV Adoption in California." Poster, ERSS Conference, Tempe, AZ. (2019)
- **Boris Lukanov** and Abbas Firoozabadi, "Predicting the Phase Behavior of Microemulsions." Talk, RERI XXVI Annual Workshop, Palo Alto, CA. (2015)
- **Boris Lukanov** and Abbas Firoozabadi, "Molecular Thermodynamic Modeling of Reverse Micelles and W/O Microemulsions." Talk, RERI XXVI Annual Workshop, Palo Alto, CA. (2015)
- **Boris Lukanov** and Abbas Firoozabadi, "Molecular Modeling of Ion-Specific Effects on the Micellization of Ionic Surfactants." Talk, RERI XXV Annual Workshop, Palo Alto, CA. (2014)
- **Boris R. Lukanov**, Fred J. Walker, and Eric I. Altman, "Crystalline Oxide-Semiconductor Epitaxial Heterostructures for Photocatalytic and Photovoltaic Applications." Talk, MRS Spring Meeting, San Francisco, CA. (2014)
- **Boris Lukanov**, Kevin Garrity, Fred J. Walker, Sohrab Ismail-Beigi, and Eric I. Altman, "Strain and Shape-Driven Self-Organization of Atomically Abrupt Junctions on Patterned Ge (001) Surfaces." Talk, APS March Meeting, Baltimore, MD. (2013)
- **Boris R. Lukanov**, Kevin F. Garrity, James, W. Reiner, Fred J. Walker, Sohrab Ismail-Beigi, and Eric I. Altman, "The Formation of Alkaline Earth Template Layers for Heteroepitaxial Growth on Semiconductor (100) Surfaces." Poster. APS March Meeting, Boston, MA. (2012)
- **Boris R. Lukanov**, Kevin F. Garrity, James, W. Reiner, Fred J. Walker, Sohrab Ismail-Beigi, and Eric I. Altman, "The Formation of Alkaline Earth Template Layers for Heteroepitaxial Growth on Semiconductor (100) Surfaces." Poster. MRS Fall Meeting, Boston, MA. (2011)
- **Boris R. Lukanov**, Kevin F. Garrity, James, W. Reiner, Fred J. Walker, Sohrab Ismail-Beigi, and Eric I. Altman, "Formation of Alkaline Earth Template Layers for Oxide Heteroepitaxy on Semiconductor (100) Surfaces." Talk, Physical Electronics Conference, Albany, NY. (2011)
- **Boris R. Lukanov**, Kevin F. Garrity, James, W. Reiner, Fred J. Walker, Sohrab Ismail-Beigi, and Eric I. Altman, "Atomic-Scale View of the Interaction of Alkaline Earths with Ge (100)." Talk, Langer Symposium, Yale University, New Haven, CT. (2011)
- **Boris R. Lukanov**, Kevin F. Garrity, James, W. Reiner, Fred J. Walker, Sohrab Ismail-Beigi, and Eric I. Altman, "Alkaline Earths as Template Layers for Epitaxial Growth on Semiconductor (100) Surfaces." Talk, CMOC Symposium, New Haven, CT. (2011)

Conferences, Symposia, Workshops

- 2022 Symposium on Environmental Justice and Environmental Health Disparities, UMD, MD
- 2022 Air Sensors International Conference, Pasadena, CA
- 2020 Conference on Health, Environment and Energy–ACEEE. New Orleans, LA
- 2019 Behavior, Energy and Climate Change Conference, Sacramento, CA

- 2019 International Conference on Energy Research & Social Science, Tempe, AZ
- 2019 EPIC Symposium: Accelerating Energy Innovation. Sacramento, CA
- 2018 Air Sensors International Conference, Oakland, CA
- 2018 Energy Innovation Accelerator, Rocky Mountain Institute, Sundance, UT
- 2018 California Efficiency and Demand Management Spring Symposium, Berkeley, CA
- 2018 Pathways to 100% Renewable Energy International Conference, Berkeley, CA
- 2017 Grid Edge World Forum, San Jose, CA
- 2017 Carbon Free California Conference, Sacramento, CA
- 2016 Central and Eastern Europe Energy Efficiency Forum, Balchik, Bulgaria
- 2016 Western Balkans Sustainable Policies towards EU Integration Conference, Kosovo
- 2015 RERI XXVI Annual Workshop, Palo Alto, CA
- 2014 MRS Spring Meeting, San Francisco, CA
- 2013 APS March Meeting, Baltimore, MD
- 2011 Physical Electronics Conference, Albany, NY
- 2011 CMOC Symposium, New Haven, CT

Awards and Honors

Faculty of Engineering Fellowship, School of Engineering, Yale University, 2007
Littell Prize, Astronomy Department, Wesleyan University, 2004
Siver Scholarship, Physics Department, Wesleyan University, 2002, 2003, 2004
Johnston Prize, Physics Department, Wesleyan University, 2001
McNeill-Nott Award, American Alpine Club, 2011

STATE OF MICHIGAN
MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of DTE Electric Company for approval of its Integrated Resource Plan pursuant to MCL 460.6t, and for other relief.	)))))	Docket No. U-21193 Administrative Law Judge Sharon Feldman

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PROOF OF SERVICE

I hereby certify that a true copy of the foregoing *Testimony of William D. Kenworthy, Chelsea Hotaling, James Gignac, and Boris Lukanov on Behalf of The Environmental Law & Policy Center, The Ecology Center, Union of Concerned Scientists and Vote Solar* was served by electronic mail upon the following Parties of Record, Thursday, March 9, 2023.

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