STATE OF MICHIGAN
BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

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-21534 ALJ Sally L. Wallace

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DIRECT TESTIMONY OF ARJUN MAKHIJANI, Ph.D.

ON BEHALF OF

DETROIT AREA ADVOCACY ORGANIZATIONS

(SOULARDARITY AND WE WANT GREEN, TOO)

July 26, 2024

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<u>Introduction and Summary of Qualifications</u>

Q: Please state your name and business address.

A: My name is Arjun Makhijani. My business address is Institute for Energy and Environmental Research, P.O. Box 5324, Takoma Park, Maryland, 20913.

Q: By whom are you employed, and in what capacity?

A: I am employed by the Institute for Energy and Environmental Research (IEER); I am President of the Institute. IEER is a non-profit that aims to provide the public and policymakers with scientifically sound analysis of energy and environmental issues.

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

A: I am submitting this testimony on behalf of Soulardarity and We Want Green, Too, collectively known as the Detroit Area Advocacy Organizations (DAAO) in this proceeding.

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

A: I have a Bachelor of Engineering (Electrical) from the University of Bombay and a Ph.D. from the Department of Electrical Engineering and Computer Sciences from the University of California at Berkeley. I have done consulting work on energy and electricity issues for utilities, including the Tennessee Valley Authority, governmental institutions, including Lawrence Berkeley National Laboratory, several agencies of the United Nations, and the Edison Electric Institute, as well as environmental and community-based organizations. I am a member of the Mitigation Working Group of Maryland Commission on Climate

Change, an advisory body established by the State of Maryland. I have testified before the U.S. Congress, served on U.S. federal advisory committees, and been a member of a scientific group providing technical support to the Presidentially appointed Advisory Board on Radiation and Worker Health for the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health. I have authored or co-authored many studies, papers, reports, and books on energy-related issues over more than fifty years. I am the principal author of the first assessment of the energy efficiency potential of the U.S. economy (1971) as well as a relatively recent assessment of the prospects and costs of a transition to a renewable electricity system in a single state (*Prosperous, Renewable Maryland*, 2016). I am also the principal author or co-author of several studies on the energy transition that are centered on energy affordability and equity, including *Energy Justice in Maryland's Residential and Renewable Energy Sectors* (2015), *Pathways to Energy Affordability in Colorado* (2022), and *Energy Affordability in Maryland: Integrating Public Health, Equity, and Climate* (2023). Most recently, I authored *The Trouble with STRIDE: Meeting Climate Goals and Addressing Natural Gas System Stranded Costs* (2024). My CV is attached as Ex. DAO-251.

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

A: No.

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

A: Yes. Most recently, in 2022, I provided expert testimony before the North Carolina Utilities Commission regarding the Duke Energy Integrated Resource and Carbon Plans on behalf of the Environmental Working Group. In 2007, I provided expert testimony before the Georgia Public Service Commission on behalf of the Southern Alliance for Clean Energy. I have also provided expert testimony in matters before the Nuclear Regulatory Commission.

Q: Are you sponsoring any exhibits?

A: Yes. I am sponsoring the following exhibits:

DAO-251. Resume of Arjun Makhijani, Ph.D.

DAO-252. MARYLAND PUB. SERV. COMM., *In the Matter of the Potomac Edison Company D/B/A Allegheny Power's Energy Efficiency, Conservation and Demand Response Programs Pursuant to the Empower Maryland Energy Efficiency Act of 2008*, Case No. 9153, Order No. 87082 (July 16, 2015)

DAO-253. National Council on Aging, *Ending Stigma around Receiving Benefits*, (June 1, 2016)

DAO-254. HR Lineup, *Absenteeism in the Workplace: Impact, Causes, Policies & Solutions* (Dec. 19, 2023)

DAO-255. APPRISE, 2011 NATIONAL ENERGY ASSISTANCE SURVEY: FINAL REPORT (Nov. 2011)

DAO-256. APPRISE, 2018 NATIONAL ENERGY ASSISTANCE SURVEY, FINAL REPORT (Dec. 2018)

DAO-257. BROOKE SPELLMAN ET AL., COSTS ASSOCIATED WITH FIRST-TIME HOMELESSNESS FOR FAMILIES AND INDIVIDUALS (Mar. 2010)

DAO-258. Bureau of Labor Statistics, New Tenant Rent Index (Jan. 16, 2024)

DAO-259. ARJUN MAKHIJANI ET AL., ENERGY JUSTICE IN MARYLAND'S RESIDENTIAL AND RENEWABLE ENERGY SECTORS (Oct. 2015)

DAO-260. Monica Bharel et al., *Health Care Utilization Patterns of Homeless Individuals in Boston: Preparing for Medicaid Expansion Under the Affordable Care Act*, 103 AMERICAN J OF PUB. HEALTH 311 (Dec. 2013)

DAO-261. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS: MEDICAL CARE IN U.S. CITY AVERAGE

DAO-262. LIHEAP, Data Warehouse Custom Tables Tool, available at https://liheappm.acf.hhs.gov/datawarehouse/custom_reports

DAO-263. U.S. Energy Information Administration, State Electricity Profile for Michigan (last accessed July 12, 2024)

DAO-264. DTE Energy Co., Annual Report (Form 10-K) (Feb. 8, 2024)

DAO-265. Princeton Eviction Lab, Michigan and Wayne County 2018 reports

DAO-266. Bruce D. Meyer, et al., *Homelessness and the Persistence of Deprivation: Income, Employment, and Safety Net Participation* (Feb. 2, 2024)

DAO-267. U.S. DEPT. OF HOUSING AND URBAN DEVEL., GLOSSARY OF TERMS TO AFFORDABLE HOUSING

DAO-268. MATTHEW DESMOND, EVICTED: POVERTY AND PROFIT IN THE AMERICAN CITY (2016)

DAO-269. Yannai Kashtan et al., *Nitrogen Dioxide Exposure, Health Outcomes, and Associated Demographic Disparities Due to Gas and Propane Combustion by U.S. Stoves*, 10 Science Advances (May 3, 2024)

DAO-270. U.S. Energy Information Administration, EIA Form 861, spreadsheet entitled Sales_Ult_Cust2022, DTE Electric excerpt

DAO-271. NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY, NORTH CAROLINA CLIMATE RISK ASSESSMENT AND RESILIENCE PLAN (June 2020)

DAO-272. Lawrence Berkeley National Laboratory, Interruption Cost Estimate Calculator, available at https://icecalculator.com/home (last accessed on July 21, 2024)

DAO-273. FOOD AND DRUG ADMINISTRATION, FOOD AND WATER SAFETY DURING OUTAGES AND FLOODS (last accessed on July 12, 2024)

DAO-274. Jodi Thornton-O'Connell, *How Much It Costs to Stock the Average Family Refrigerator*, GO BANKING RATES (2017)

DAO-275. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS: FOOD IN U.S. CITY AVERAGE

DAO-276. BOARD OF GOVERNORS OF THE FEDERAL RESERVE, ECONOMIC WELL-BEING OF HOUSEHOLDS IN 2021 (May 2022)

DAO-277. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES BILLION-DOLLAR DISASTER EVENTS 1980-2022 (CPI-ADJUSTED) (Jan. 10, 2023)

DAO-278. Tucker Oddleifson et al., *Prefeasibility Analysis of Behind-the-Meter Distributed Energy Resources in Highland Park, MI: Highland Park Pathways to Power*, NAT. RENEW. ENERGY LAB. (Mar. 2024)

DAO-279. Patrick Gibbs, *Housing Characteristics and Energy Burden Analysis for Highland Park, Michigan*, NAT. RENEW. ENERGY LAB. (Mar. 2024)

DAO-280. Erik Pohl et al., *Distribution Grid Impact Study in Highland Park, Michigan: Understanding Rooftop Solar, Behind-the-Meter Energy Storage, Electric Vehicle Charging, and Building Electrification*, NAT. RENEW. ENERGY LAB. (Mar. 2024)

DAO-281. Mahkijani NREL-based calculations

DAO-282. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS

DAO-283. Rachel Brennan, *Does Home Insurance Cover Spoiled Food from a Power Outage?*, Policygenius (May 30, 2024)

DAO-284. EPA, REPORT ON THE SOCIAL COST OF GREENHOUSE GASES: ESTIMATES INCORPORATING RECENT SCIENTIFIC ADVANCES (Nov. 2023)

DAO-285. MICHIGAN COUNCIL ON CLIMATE SOLUTIONS, ENERGY PRODUCTION, TRANSMISSION, DISTRIBUTION, AND STORAGE WORKGROUP RECOMMENDATIONS (Oct. 2021)

DAO-286. MICHIGAN DEPARTMENT OF CLIMATE, GREAT LAKES, AND ENERGY, MI HEALTHY CLIMATE PLAN (April 2022)

DAO-287. DTE Electric Co., Reliability Performance and Power Quality Resolution Process: DTE Electric Report for 2022 (April 3, 2022)

DAO-288.	Parker Village ICE calculations
DAO-289.	Jeff St. John, *Massachusetts Kicks Off First Pilot to Shift Gas Utilities to Clean Heat*, CANARY MEDIA (June 4, 2024)
DAO-290.	REDWOOD COAST RENEWABLE ENERGY AIRPORT MICROGRID, FACTSHEET (Jan. 2020)
DAO-291.	NREL PVWatts Calculator for Detriot, Michigan scenarios

Q: What is the purpose of your testimony?

A: My purpose is to examine two issues, one related to affordability and the other to resiliency for communities in the face of worsening weather extremes.

With regard to affordability, I examine the costs of unaffordable energy not only to the low- and moderate-income households that experience them but also to non-low-income households, taxpayers, and the public at large. The other side of the cost coin is that by making energy affordable, most of these costs—and especially the most serious ones, such as the loss of housing due to rent-energy bill payment conflicts—can be greatly mitigated and largely or mostly avoided. This analysis will be under the rubric of "non-energy" benefits that need to be taken into account when considering the costs and benefits of making utility bills universally affordable as defined by 6% of gross income.

With regard to resilience, I focus on a single aspect—the technical and regulatory requisites for ensuring that continuous power supply is maintained during long outages for critical loads in communities in order to protect their health and well-being.

I. Non-Energy benefits of affordable energy

Q: What are non-energy benefits?

A: In the context of evaluating residential energy efficiency investments, experts refer to non-energy benefits, which are the kind of benefits that standard cost-benefit tests such as the Utility Cost Test or even the Total Resource Cost Test do not capture. The Utility Cost Test considers only direct costs and benefits to the utility, such as the cost of rebates and the benefit of reduced fuel costs for electricity generation. The Total Resource Cost Test is broader; it includes utility costs (such as rebates), participant costs (such as the balance of equipment costs not covered by rebates and incentives), utility benefits (such as reduction of fuel purchases for electricity generation and reduction of variable operation and maintenance costs), and reduction in participant energy bills.

However, the costs and benefits are much broader than those captured by these two tests. For the participants, they include a more comfortable home and better health. The argument for including non-energy benefits experienced by participants is that when their share of the costs is included, all of the benefits they experience, whether in their energy bills or otherwise, should also be included. Similarly, when the public share of cost (via ratepayers or taxpayers) is included, the public (or social) benefits, such as reduced pollution-associated health benefits, should also be factored into the accounting.

For instance, in Order No. 87082 (2015), the Maryland Public Service Commission ordered non-energy benefits to be included in considering whether investments in efficiency are justified—that is whether the benefit-to-cost ratio is greater than one. The order referred to this broader test including non-energy benefits as the "Societal Cost Test." (The Maryland Commission also maintained the most customary Total Resource Cost Test to enable continued comparison with other states that continue to rely on it.) A "failure" to include non-energy benefits skews decision-making, the Commission concluded, and would "ignore the codified intent of the General Assembly 'to provide affordable, reliable, and clean energy for consumers of Maryland.'"[1]

In this view, taking non-energy benefits is integral to the regulatory process and to achieving its goals. It is even more so in the context of the energy transition and worsening climate extremes with their impacts on ratepayers and society.

Q: How do non-energy benefits apply to affordability issues?

A: When considering how non-energy benefits apply to affordability issues, the concept of calculating costs and benefits remains exactly the same as that explained above for energy efficiency.

Making energy bills affordable for low-income households entails costs. These include the cost of direct assistance needed to lower energy bills that may be borne by non-low-income ratepayers, for instance. Some costs come via the federal Low-Income Home Energy Assistance Program (LIHEAP); these costs should also be included.

Making energy bills affordable for low-income households also brings benefits. Ratepayers would get some benefits since the number of utility bill defaults—which ratepayers must cover—would tend to decline, offsetting a part of the assistance costs. Assistance recipients would benefit by being better able to balance their household budgets for paying the rent or mortgage and for purchasing food and medicines. They would also

[1] Ex. DAO-252. MARYLAND PUB. SERV. COMM., *In the Matter of the Potomac Edison Company D/B/A Allegheny Power's Energy Efficiency, Conservation and Demand Response Programs Pursuant to the Empower Maryland Energy Efficiency Act of 2008*, Case No. 9153, Order No. 87082 (July 16, 2015) at 5–6.

be more secure in their homes by the simple fact that electricity shutoffs would be far less likely and far less frequent. Keeping the electricity on is a requirement of many rental contracts; this means that electricity shutoffs put many renters at risk of eviction.

As explained in the testimony of Witness Kinkhabwala,[2] energy affordability can be improved by a variety of investments, including building envelope improvements, electrification of heating with high-efficiency heat pumps, demand response infrastructure, and community solar at prices lower than residential rates. The investments represent costs, which are borne by some combination of taxpayers, ratepayers, and low- and moderate-income households. If the entire cost side of the ledger is included, the entire benefit side should also be included.

As with efficiency investments, there are several parties that benefit from affordability investments, including those who receive assistance and investment incentives; utilities, whose bills are paid more regularly and completely; ratepayers, because of reduced utility costs; mortgage providers, because of fewer defaults on loans; and state and federal taxpayers, because of fewer emergency room visits, reduced costs of shelter for those who become unhoused, etc.

Investments to structurally reduce bills also have more subtle but critically important non-energy benefits. Securing sufficient funding for low-income assistance programs is generally difficult; the amounts required to make energy bills universally affordable by assistance alone are about five times the presently available funds.[3] In addition, participation in energy bill assistance programs, including LIHEAP, is often low. There are many reasons for this; one frequent reason is the stigma associated with receiving

[2] *See generally* Kinkhabwala Direct Testimony.
[3] *Id.* at 12 (fig.2), 29 (fig.8).

financial assistance. For instance, the National Council on Aging found that "[t]he primary consequence of stigma is that low-income older adults do not apply for public benefits for which they are eligible, thereby foregoing a crucial form of financial assistance, which can impact levels of debt and, ultimately, their health and independence."[4] Investments that systematically lower energy bills significantly reduce the need for assistance to achieve the 6% affordability threshold. Through a suite of these investments, the number of LMI households that are customers of DTE Electric that pay more than 6% of their income for energy could be reduced from 430,000 to 240,000, and simultaneously the annual need for bill assistance would be reduced from $450 million (for households below 200% of the poverty level) to just $140 million.[5]

Q: What are the specific non-energy benefits of affordable energy bills?

A: These benefits are of two types. First, there are avoided costs; and second, there are positive benefits. Avoided costs to low-income households include the avoided costs of ill-health and of becoming unhoused, which happens by reducing conflicts over payments for essentials such as rent, medicines, food, and utility bills. Avoided costs to society include avoided costs of shelter for the unhoused, avoided costs of added emergency room visits, and avoided increases in taxes and health insurance premiums that these imply. Second, there are the positive benefits of better health, such as increased productivity for low-income persons at school and at work; these accrue both to the low-income persons themselves and to society at large.

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[4] Ex. DAO-253. National Council on Aging, *Ending Stigma Around Receiving Benefits* (June 1, 2016).
[5] Kinkhabwala Direct Testimony at 26.

Q: Can you quantify the non-energy benefits of affordable energy?

A: Quantifying non-energy benefits requires, first of all, an estimate of the costs in the absence of affordability. Some of the more important ones, such as the cost of shelter and added emergency room visits for those who become unhoused, can be approximately quantified. Calculating the benefits requires an estimate of the amount by which these costs would be reduced were energy cost burdens reduced to 6% or less of gross income. There is far less data on this; nonetheless, order of magnitude estimates of some of the most important non-energy benefits, such as reduced costs of added emergency room visits, can be made. Some positive benefits are even more difficult to estimate, such as higher productivity at work due to better health, since the needed survey data do not exist, to the best of my knowledge. High energy burdens create more ill-health; in turn, financial difficulties and ill-health are among the causes of absences from work.[6] Hence, reducing ill-health by reducing the conflicts between buying medicines and paying energy bills will likely result in higher productivity. It is not possible to quantify this benefit at present. It is one of my recommendations that the Commission take action to improve and make more comprehensive data on non-energy benefits of affordability, including this benefit to employees and employers.

Q: Please provide some examples of non-energy costs of unaffordable energy bills.

A: Examples include keeping a home at an unsafe temperature; using a stove or oven to provide heat; having electricity or natural gas cut-off; losing a home and moving in with friends or family; losing a home and becoming unhoused and moving to shelter; not filling

[6] *See generally* Ex. DAO-254. HR Lineup, *Absenteeism in the Workplace: Impact, Causes, Policies & Solutions* (Dec. 19, 2023).

prescriptions fully; going without medical or dental care; and going without food for at least one day, among others.

The National Energy Assistance Directors Association publishes a report containing survey data on these non-energy costs for the years 2011 and 2018.[7] The households surveyed are those that received LIHEAP assistance at least once in the five years prior to the survey. Data are for the year prior to the survey, except as indicated, where I have annualized five-year data for uniformity of presentation.

[7] Ex. DAO-255. APPRISE, 2011 NATIONAL ENERGY ASSISTANCE SURVEY: FINAL REPORT (Nov. 2011); Ex. DAO-256. APPRISE, 2018 NATIONAL ENERGY ASSISTANCE SURVEY, FINAL REPORT (Dec. 2018).

Table 1: Non-energy costs of unaffordable energy among LIHEAP-assistance recipients (based on surveys conducted in 2011 and 2018 regarding the year prior to the survey, except as noted)

Impacts	% in 2011[8]	% in 2018[9]	Comments
Kept home at unsafe temperature*	23	25	Increases ill-health among the vulnerable, such as older people
Used stove or oven to provide heat*	33	30	Increases indoor air pollution
Had electricity or natural gas cut-off*	11	15	Cut-off of electricity can result in violation of rental contracts and the threat of eviction
Lost home and moved in with friends or family**	2.8	3.4	Potential increase in costs to get to work and school; potential loss of jobs and change in school district; potential crowding and other negative social consequences
Lost home and became unhoused and moved to shelter**	0.8	1.2	Decline in life-expectancy if homelessness becomes chronic; increase in shelter costs to taxpayers, increase in health costs hospitals
Did not fill prescription fully**	6.8	6.2	
Went without medical or dental care**	7.4	8.2	
Went without food for at least one day**	5.8	7.2	
Notes: * indicates information from prior year ** indicates information from annual average of the five years prior to the survey			

This data shows a remarkable consistency over time in the harms experienced by low- and moderate-income families. It is important to keep in mind that these families received assistance *at least* once in the five years prior to the survey, so that their energy cost burdens were reduced at least once during that period.

[8] Ex. DAO-255 at i-iii.
[9] Ex. DAO-256 at i-iii.

Q: Can you provide some cost in dollars that would go into a societal cost test in estimating the cost of unaffordable energy on a statewide basis?

A: I will illustrate the costs of becoming unhoused in cases where families do not have recourse to the homes of family or friends. Nationally, this affects on the order of one percent of LIHEAP recipients (see Table 1 above). Most of these would be renters, but some would also lose homes they own because of foreclosures.

While I will focus on the quantification of the public costs below, I want to acknowledge at the start that becoming unhoused also has immediate and long-term financial and generational impacts on those who lose the homes that they own. It means loss of the equity in the home, i.e. the market value of the home minus the mortgage amount. It means a loss of financial security down the road since the family cannot refinance or borrow against the equity in the home in times of need. Future generations lose the possibility of inheriting that wealth. These effects can be catastrophic for low-income persons, families, and communities.

Apart from the harm to the family that loses their home, there are a variety of public costs associated with caring for the unhoused. I consider two costs in detail: (i) costs of shelter and (ii) cost of added medical care.

First, in 2010, the federal Department of Housing and Urban Development (HUD) examined the costs of three different types of shelter—emergency shelter, transitional housing, and permanent supportive housing—in three cities (Washington, D.C., Houston (TX), and Kalamazoo (MI)) and one region (Upstate South Carolina).[10] Table 2 shows the

[10] *See generally* Ex. DAO-257. BROOKE SPELLMAN ET AL., COSTS ASSOCIATED WITH FIRST-TIME HOMELESSNESS FOR FAMILIES AND INDIVIDUALS (March 2010).

HUD cost estimates updated to 2021 dollars[11] using the Bureau of Labor Statistics rent cost index for all rental housing.[12]

Table 2: Department of Housing and Urban Development Shelter Cost estimates for first-time homeless families, 2021 dollars per month

Family Sites	Emergency Shelter	Transitional Housing	Permanent supportive housing	2006 Fair Market Rent for Two-bedroom Unit[b]
Washington, D.C.	$3,519 - $5,214	$3,026 - $,3085	$1,764	$1,727
Houston	$1,961	$2,735 - $6,320	$1,127	$1,048
Kalamazoo	$2,276	$1,146	$1,242	$863
Upstate South Carolina	$3,199	$1,705	$932	$845 (Greenville Metro)

For the purposes of this testimony, I assume:

- That families would be in some mix of shelters over time. Costs of such shelters are higher in large cities, but those needing shelters may be in a wider range of areas. A mix of urban and rural may be better represented by Kalamazoo, which happens to be in Michigan.
- In a prior study, my colleagues at IEER and I found that the typical duration of homelessness could be about seven months, though the duration would be expected to vary significantly.[13]

Multiplying the average cost of the three shelter arrangements for two unhoused persons in Kalamazoo (about $1,560 per month) times the typical duration of homelessness

[11] Unless otherwise stated, all dollar values in my testimony are in 2021 dollars. This is for the sake of consistency with the resilience calculations, for which I have drawn on National Renewable Energy Laboratory calculations for solar photovoltaic costs, which are in 2021 dollars. The affordability values drawn from Witness Kinkhabwala's testimony are also in 2021 dollars.
[12] Ex. DAO-258. Bureau of Labor Statistics, New Tenant Rent Index (Jan. 16, 2024).
[13] Ex. DAO-259. ARJUN MAKHIJANI ET AL., ENERGY JUSTICE IN MARYLAND'S RESIDENTIAL AND RENEWABLE ENERGY SECTORS (Oct. 2015) at 164.

(seven months) would bring a typical housing cost to taxpayers and non-profits per homeless event of about $10,900 (rounded).

Second, healthcare expenditures also rise; the rise in emergency room visits relative to housed low-income households is largely responsible for the increase in costs. Careful estimates are available for this specific population from a non-profit called Boston Health Care for the Homeless Program (website: https://www.bhchp.org/); it is dedicated to quality health care for the homeless. A study compared people with housing with MassHealth insurance, which is the Medicaid and Children's Health Insurance Program in Massachusetts. Most unhoused people, as well as low-income people with housing, are eligible for MassHealth.[14] Their central finding pertinent to added non-energy costs of becoming unhoused was as follows:

> "Homeless individuals had high health care expenditures—$2,036 per member per month compared with $568 per month for all MassHealth members. Almost half of total annual expenditures were incurred by 10% of the study population…. The 2 highest categories of health care expenditure were hospitalizations and ED [Emergency Department] visits, which represented 40% and 11% of total expenditures, respectively."[15]

Adjusting for health care inflation by a factor of 1.24 between 2013 and 2021 using the urban health care Federal Reserve index,[16] the cost increment for unhoused persons as

[14] Ex. DAO-260. Monica Bharel et al., *Health Care Utilization Patterns of Homeless Individuals in Boston: Preparing for Medicaid Expansion Under the Affordable Care Act*, 103 AMERICAN J OF PUB. HEALTH 311 (Dec. 2013).
[15] *Id.* at 314.
[16] Ex. DAO-261. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS: MEDICAL CARE IN U.S. CITY AVERAGE.

compared to housed persons for two individuals for seven months would be about $25,400 in 2021 dollars.[17]

Combining the incremental healthcare costs with shelter costs yields a total cost increment per homelessness event of about $36,000 (rounded).[18]

In the five years from 2019 to 2023, inclusive, an average of 161,300 households received LIHEAP assistance in Michigan.[19] Based on the survey results presented in Table 1 above showing that about one percent of them become unhoused each year (average of 2011 and 2018 surveys),[20] the annual costs of shelter and added medical care would total about $58 million, based on the above estimates (2021 dollars).[21] About 31% of Michiganders who are eligible receive LIHEAP assistance.[22] If the rate of becoming unhoused for non-participants is the same as that for participants, then the total non-energy costs statewide for these two items would be about $190 million per year (rounded).[23]

Q: Can you estimate these two non-energy costs for the DTE service territory?

A: Yes, that can be approximately done.

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[17] The per person per month added cost for the unhoused = $2,036 - $568 = $1,468, which translates into $1,814 in 2021 dollars. This gives the added cost for two unhoused people for seven months of $1,814 * 7 * 2 = $25,400 (rounded).

[18] $10,900 in incremental housing costs plus $25,400 in incremental health costs equals approximately $36,000.

[19] Ex. DAO-262. LIHEAP, Data Warehouse Custom Tables Tool (custom report for Michigan), available at https://liheappm.acf.hhs.gov/datawarehouse/custom_reports. 31% of eligible households receive LIHEAP * 520,451 households that qualify for LIHEAP under Michigan definitions equals 161,340 households, or approximately 161,300 households.

[20] *See* Ex. DAO-255; Ex. DAO-256.

[21] $36,000 per incident of homeless times 1% of 161,300 households equals approximately $58 million.

[22] Ex. DAO-262.

[23] If the rate of becoming unhoused for non-participants is the same as that for participants, and if $58 million represents the costs of 31% of the affected population, then approximately $190 million represents the costs of 100% of the population. ($58 million / 0.31 = $187.3 million.)

Michigan, as a whole, has 5.04 million electricity customers, 89% of whom are residential customers.[24] DTE has 2.3 million customers in all,[25] or about 46% of the Michigan total.[26] A very approximate method for the DTE territory would be to attribute 46% of the non-energy costs to the DTE territory—about $87 million per year.[27]

However, there would be wide variations of this cost, depending on income and the number of LIHEAP-eligible households. One measure of this unevenness is the rate of eviction notices per 100 renters per year. The rate of eviction notices to renters in Michigan as a whole in 2018 was 16.7%, while that in Wayne County was 22.6%, about a third higher than the statewide level.[28] Of course, there are also wide disparities in Detroit itself since eviction notices would be expected to be concentrated in areas with larger proportions of low-income renters. Similarly, the proportion of homeowners who lose their homes to foreclosure would be larger in the same areas.

Taking these factors into account, it is likely that the share of Michigan costs attributable to DTE territory is likely to be significantly larger than 46%. To adjust the DTE total very approximately, I have used the ratio of Wayne County eviction notices to that in the whole state, which is 1.36, to get an estimate of $120 million per year for these two non-energy costs of unaffordable energy.[29] More precise estimates should be a major objective of policy and ratemaking, as I discuss in my recommendations below.

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[24] Ex. DAO-263. U.S. Energy Information Administration, State Electricity Profile for Michigan, at 15 (tbl. 8).
[25] Ex. DAO-264. DTE Energy Co., Annual Report (Form 10-K) (Feb. 8, 2024).
[26] 2.3 million divided by 5.04 million equals 45.6%, or approximately 46%.
[27] Approximately $190 million in annual non-energy costs quantified above times 46% equals approximately $87 million.
[28] Ex. DAO-265. Princeton Eviction Lab, Michigan and Wayne County 2018 reports at 4, 8.
[29] $87 million times the 1.36 ratio of Wayne County eviction notices to that in the whole state equals approximately $118.3 million, or approximately $120 million.

Q: What about non-energy costs to the customers who become unhoused?

A: The above discussion quantifies the costs to the larger society, including taxpayers, hospitals, and insurance companies (and hence to those who pay health insurance premiums). The costs to the customers who become unhoused themselves are in addition to social costs and need to be added to the above total. For instance, becoming unhoused may result in the loss of jobs and income. That, in turn, raises social costs due to loss of economic output and wage-related taxes to the federal, state, and local governments.

While I am not aware that these costs have been estimated for low- and moderate-income households in the context of unaffordable energy, data do exist on employment among both the sheltered and unsheltered homeless population. In an extensive survey involving 140,000 people, Meyer and others found "that a substantial share of the homeless population is drawn from the ranks of the working poor: about half of those in shelters and 40 percent of those at unsheltered locations had formal employment in 2010."[30] They also found that the jobs are held intermittently and the annual incomes are low. Among the sheltered homeless who have jobs and the poor who are housed, the annual income difference in 2016 was found to be $6,240 (in 2018 dollars), or about $6,730 in 2021 dollars.[31]

On this basis, the annual loss of income among the estimated 1,613 LIHEAP recipients who become unhoused would be about $11 million a year and roughly $35 million for all LIHEAP-eligible Michiganders (rounded), assuming the same rate of home

[30] Ex. DAO-266. Bruce D. Meyer, et al., *Homelessness and the Persistence of Deprivation: Income, Employment, and Safety Net Participation* (Feb. 2, 2024) at 3.
[31] *Id.* at 38 (derived from tbl.2a).

loss as documented in the LIHEAP surveys cited above.[32] Roughly half of that, or $16 million per year, would be in DTE territory.

In addition, loss of equity in homes that are foreclosed due to energy bill-mortgage payment conflicts should be added to customer costs. I do not have a quantitative estimate for these costs, which may well be substantial.

Q: Can all these non-energy costs be attributed to unaffordable energy?

A: No. Loss of homes is a complex phenomenon; people lose their homes for a variety of reasons, with poverty looming large among those causes. Financial stresses include conflicts between housing costs, utility bills, food costs, and costs of medicines; unexpected loss of a job or unexpected expenses such as the breakdown of a car necessary for commuting to work also play a role in some cases. Nonetheless, it is clear that financial stresses on low- and moderate-income households centrally involve conflicts between paying the rent or mortgage and paying utility bills—which is why utility bills and housing costs are considered together in the definition of affordable housing by the federal Department of Housing and Urban Development.[33] Further, rental contracts often include

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[32] 1,613 persons based on the survey data that indicates approximately 1% of approximately 161,300 Michigan LIHEAP recipients become unhoused. *See* discussion *supra* notes 19 and 20. 1,613 persons times $6,730 in approximate income difference equals $10.8 million, or approximately $11 million. $11 million divided by 31% of Michiganders who are eligible receive LIHEAP assistance, see Ex. DAO-262, equals approximately $35.48 million or approximately $35 million for the state of Michigan. $35 million times 46%, see *supra* note 26, equals $16.1 million, or approximately $16 million for the DTE territory.

[33] Ex. DAO-267. U.S. DEPT. OF HOUSING AND URBAN DEVEL., GLOSSARY OF TERMS TO AFFORDABLE HOUSING at 2.

clauses that require electricity connections to be maintained; disconnection can become a cause for eviction.

There is also direct evidence that the inability to pay utility bills and the inability to pay rent are connected. Matthew Desmond, who leads the Eviction Laboratory at Princeton University, documented that connection in his study of evictions in Milwaukee. Many low-income households defer paying utility bills in the winter when there is a moratorium on utility shutoffs. Bills pile up by the time the moratorium ends in the spring. In turn, forced to pay large, accumulated utility bills, many can no longer afford to pay rent and these accumulated bills simultaneously. As a result of this dynamic, summer becomes a foreseeable season of increasing evictions.[34]

There is also positive evidence of the connection between mortgage payments and utility bills. This is indicated by the results of a pilot project that took a whole-home approach to retrofitting in Baltimore homes of low-income homeowners. The program went beyond efficiency and weatherization and included home safety, indoor environmental improvement, and health risk reduction (such as abatement of lead) for the 580 houses that were involved. Before the program, 49 of the participating homeowners had received 57 foreclosure notices, with some owners receiving more than one notice. After the work was completed, only 6 homeowners got 7 foreclosure notices.[35] This 88% reduction in foreclosure notices involved a reduction of energy bills,[36] and hence energy

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[34] Ex. DAO-268. MATTHEW DESMOND, EVICTED: POVERTY AND PROFIT IN THE AMERICAN CITY, 15-16 (2016).

[35] *See* Ex. DAO-259 (discussing the Green and Healthy Homes Initiative) at 166.

[36] 57 foreclosure notices before minus 7 foreclosure notices after, divided by 57 foreclosure notices before equals 87.8%.

cost burdens, via efficiency investments. But it did not include increased energy bill assistance.

In sum, while the loss of homes has many causes, it is reasonable to assume that a large fraction involves rent/mortgage payment conflicts with utility bill payments. The other side of the coin is that making utility bills affordable has the prospect of greatly reducing these conflicts and related non-energy costs. It is not possible to estimate accurately the number of evictions or foreclosures that would be avoided, but the evidence cited above, indicates that it is likely to be large. Arriving at more accurate estimates of the non-energy benefits in this area (and other regards) for better policy-making is one of my recommendations.

Q: What about the non-energy costs resulting from those who become unhoused but find shelter with family or friends, and are therefore not counted as unhoused?

A: The customers and the families or friends they move in with experience real costs, such as crowding and social adjustment. There may also be increased transportation costs, dislocation from neighborhood and community, change of schools, and ill-health arising from crowding. Some of the people who move in with friends and family may eventually also become homeless. It is difficult to quantify these costs. Even if the per-family financial costs are smaller than for those who become unhoused, the number of families is larger. As reflected in the LIHEAP surveys, roughly three-fourths of those who lost their homes move in with friends and family (see Table 1 above), a ratio that was about the same in 2011 as it was in 2018.

Q: Can you characterize some of the other non-energy costs?

A: The inability to fill prescriptions fully or visit a doctor on time can exacerbate diseases, increase time lost from work, and increase the cost of treatment. Table 1 above shows that in the five years prior to the 2018 survey, about seven times as many households experienced the inability to visit doctors or dentists as were rendered unhoused and about five times as many could not fill prescriptions fully. Such problems increase the intensity of ill-health, increase the costs of health care, and increase emergency room visits. Thus, even if the rate of added medical expenses per household is lower for those who remain housed as compared to those who become unhoused, the number of households experiencing the increased problems is far larger.

The increased ill health caused by the use of gas stoves and ovens in about one-third of the homes of LIHEAP assistance recipients (see Table 1 above) must also be factored into the health cost equation. Such use of stoves and ovens increases indoor air pollution—including carbon monoxide, nitrogen dioxide, particulates, and benzene (from leaks of unburned gas)—aggravating or leading to a variety of diseases and health risks, including premature births and respiratory diseases. Moreover, African American, Indigenous, and Hispanic households and people who live in smaller homes suffer significantly greater exposures.[37] These health problems would all be aggravated by the use of gas stoves and ovens or portable fossil fuel heaters for heating. Ill health also leads to loss of work time and income. A full quantitative accounting would include these costs.

[37] Ex. DAO-269. Yannai Kashtan et al., *Nitrogen Dioxide Exposure, Health Outcomes, and Associated Demographic Disparities Due to Gas and Propane Combustion by U.S. Stoves*, 10 Science Advances (May 3, 2024) at 10.

Overall, it is reasonable to assume that the order of magnitude of added health costs by the large majority who remain in their homes is likely to be similar, and possibly greater, than for the minority that becomes unhoused.

Q: Are the non-energy costs of unaffordable energy restricted to the Michigan LIHEAP-eligible population?

A: No. The vulnerable population is far larger. The above estimates are based on the LIHEAP-eligible households by the criteria of the State of Michigan. That number averaged 521,451 in the 2019 to 2023 period (inclusive).[38] Federal LIHEAP criteria are more expansive and include more moderate-income households; states that administer the program are allowed to set more stringent eligibility criteria, and Michigan, like many other states, has done so. Were Michigan to adopt the federal criteria, the eligible population averaged over the same period would have been 1,136,860—more than double the state's eligible households.[39] Michigan actually used the federal criteria until 2002. Then the state tightened the criteria. Witness Kinkhabwala's analysis shows that there are about 180,000 households with incomes above the threshold of 150% of the federal poverty level who have energy bills above 6% of gross income.[40] His analysis also shows that most of the one- to two-thousand DTE customers who are disconnected each week are not assistance recipients.[41] Non-energy costs should be increased to include these households.

This is more than an academic matter of numbers. Disconnections are linked with evictions in rental contracts, as noted above. Thus, the inability to pay utility bills, which

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[38] Ex. DAO-262.
[39] *Id.*
[40] Kinkhabwala Direct Testimony at 12 (fig.1).
[41] *Id.*at 17 (fig.5).

eventually leads to disconnections, is structurally related to the problem of evictions. But simple extrapolation of the number of people who might become unhoused in the ineligible population would likely overestimate the numbers, since some of those who are disconnected are not eligible for assistance and have higher incomes than those who are. Thus more study is required to estimate these non-energy costs.

Q: Please discuss the non-energy benefits of making investments to systemically reduce the energy bills of low- and moderate-income households.

A: The biggest direct benefit is that the investments reduce the amount of energy bill assistance needed to make energy universally affordable for all households. While there is approximately $90 million per year in currently available assistance funds,[42] Witness Kinkhabwala's analysis indicates a total affordability gap in the DTE territory of about $400 million for households eligible for assistance (i.e. household income less than 150% of FPL) and $485 million including those not eligible (i.e. household income 150% of FPL or above).[43] Figure 8 in Witness Kinkhabwala's testimony shows that as a result of investments in energy efficiency, community solar, and demand response, the costs of assistance costs of universal affordability will decline to about $140 million per year by 2050.[44]

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[42] *Id.* at 9.
[43] *Id.* at 12 (fig.2).
[44] *Id.* at 26, 31 (fig.8).

Q: Can you sum up your discussion of non-energy costs of unaffordable bills and the benefits of making them universally affordable?

A: Yes. While exact estimates are not at present possible, it is safe to say that non-energy costs to society, including taxpayers and ratepayers, of unaffordable energy are likely to be of the same order of magnitude in the DTE service territory as the costs of assistance needed to make energy affordable; they may even be considerably greater when costs such as lost home equity and the costs of ill-health and lost income are more comprehensively included. Over time, as investments are made in building envelope improvements, community solar, demand response, and efficient electrification of heating, the need for assistance will decline. About a quarter of a million households who are energy-cost-burdened today will no longer need it because their bills will have become affordable due to the investments to reduce them.

Q: How should non-energy benefits be factored into this rate case?

A: This is, at once, a very simple and a very difficult question.

On the one hand, given that the principle of factoring in non-energy benefits is accepted for efficiency improvements in utility regulatory proceedings and that exactly the same economic principles and reasoning apply to the issue of universal affordability, there is a case for factoring in the costs of assistance and investments into rate cases. This is also an approach that is available to the Commission. But other approaches may be more equitable, such as progressive income taxes, or taxing the corporations that would benefit most, such as health insurance companies and hospitals that would have fewer uncompensated emergency room visits, or hedge funds that own large numbers of rental units which would recover rent more regularly and have lower turnover of tenants. If rates are the vehicle for funding the gap, it should be as an operating cost on all electricity sold, rather than only on residential electricity, given that a wide variety of non-low-income entities benefit. Overall, the affordability gap for the electricity portion alone in the DTE territory is about $380 million per year. Factoring out existing assistance, an additional $304 million would be needed to make electricity affordable for all DTE customers.[45] If the funds are raised via rates, the rate increase, based on 2022 sales to all ultimate customers, the rate increase would amount to 0.743 cents per kilowatt-hour,[46] which would amount to about $4.80 per month for the average residential bill in DTE territory.[47] The approach to and recommendation regarding financing this gap, as well as some other issues related to rates in this proceeding, are discussed in Witness Koeppel's testimony.[48]

Q: Why do you think the benefits might be even greater than those estimated by Witness Kinkhabwala?

A: The analysis of Witness Kinkhabwala as discussed above reflects reasonable short-term benefits and ensures that the bill reductions will not be overestimated, but I believe the benefits of demand response can grow even more over time. In the longer term, with universal broadband and internet-enabled appliances and electric vehicles, the scope will

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[45] *Id.*

[46] DTE data regarding total sales to ultimate customers, residential sales, number of residential customers, and total number of customers are from Ex. DAO-270, U.S. Energy Information Administration, EIA Form 861, spreadsheet entitled Sales_Ult_Cust2022, DTE Electric excerpt. $304,000,000 in additional funds divided by 40,897,642 DTE Electricity sales to ultimate customers in 2022 equals $7.43 per MWh, or 0.743 cents per kWh.

[47] The $7.43 per MWh times 15,844,478 in residential sales in MWh divided by 2,047,944 residential customers equals $57.48 per year, or $4.79 per month, rounded to $4.80.

[48] *See* Koeppel Direct Testimony.

be far larger. Besides, demand response provides households with a tool to control their energy bills without making significant investments other than those initially needed to enable participation. Among other things, low-income households would have a tool to ramp up demand response and reduce energy bills, for instance, when unanticipated financial stresses and expenses occur.

II. Resilience and Microgrids

Q: Please describe the aspect of resilience you are addressing in your testimony.

A: I will focus on issues related to limiting harms from long-duration outages by creating facilities that will ensure that communities' critical needs are met by the provision of uninterrupted power supply for the corresponding loads.

Q: What are the costs of power outages to customers?

A: People and communities experience a variety of harms during power outages. The 2020 North Carolina resilience plan has described many of them:

> Loss of power can create very cold indoor conditions for residents. Residents may try to heat their homes using alternative means, which runs the risk of carbon monoxide poisoning caused by improperly ventilated heating sources. In addition, dangerously cold temperatures increase the risk of wind chill, frostbite, and hypothermia. Another indirect impact is on public and private schools due to closings and delays due to the lack of power and heat. During times of extreme heat, air conditioning units work harder and require more electricity, making brownouts and blackouts possible if electricity demands exceed generation. Power outages occurring in the summer result in similar financial and societal impacts to the public and businesses."[49]

[49] Ex. DAO-271. NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY, NORTH CAROLINA CLIMATE RISK ASSESSMENT AND RESILIENCE PLAN, 15 (June 2020).

There are also a variety of other harms. For instance, refrigerated food may spoil. If gas stations lose power supply, people in the community would not be able to refuel their vehicles or may have to travel long distances and wait in long lines to do so, incurring costs in the process.

Q: Do costs vary according to the duration of outages?

A: Both outage duration and frequency affect costs. The Interruption Cost Estimate (ICE) Calculator model, designed by Lawrence Berkeley National Laboratory, enables the calculation of the costs for power outages for mixes of customers and various durations of outages.[50] Input information required includes data on two of three reliability indexes: the System Average Interruption Duration Index (SAIDI), the Customer Average Interruption Duration Index (CAIDI), and the System Average Interruption Frequency Index (SAIFI), since the third can be calculated once any two are specified.[51] The ICE model, which includes both outage duration and frequency information, is an important tool for estimating losses, such as loss of sales or loss of income, and is widely used.

However, the ICE Calculator model has some important limitations, including a major one relating to long-duration outages. To demonstrate those limitations for the resilience issues, I tested the model by comparing the cumulative losses it estimated for 12 one-hour outages for 2,000 residential sector customers in Michigan with a single 12-hour outage (SAIDI = 720 minutes in both cases; SAIFI = 12 in the first case and 1 in the second case). In other words, the overall outage time in the year was the same, but in the former

[50] Lawrence Berkeley National Laboratory, Interruption Cost Estimate Calculator, available at https://icecalculator.com/home.

[51] SAIFI = SAIDI / CAIDI.

scenario, I broke it into 12 equal amounts, whereas in the latter, I attributed all of the time to a single outage.[52]

Although the overall amount of time without power was the same in both scenarios that I tested, the damage results, shown in Table 3, were dramatically different. The loss per customer was 11.5 times larger when the outage duration was spread over 12 one-hour outages.

Table 3: Losses for cumulative outages of 12 hours (720 minutes) for Michigan residential customers as estimated by the Interruption Cost Estimate Calculator, adjusted for 2021 dollars[53]

	2,000 residential and 0 non-residential customers			
	SAIFI	**SAIDI**	**Total loss**	**Loss per customer per year**
Twelve one-hour outages	12	720	$139,713	$69.86
One twelve-hour outage	1	720	$49,445	$24.72

This is the inverse of what one would expect for critical residential sector harms. Generally speaking, one-hour outages spread over different days should be more tolerable for residential customers than a single twelve-hour outage. For instance, one-hour outages spread over different days over, say, three months of a very hot summer would not normally cause the loss of food and medicine. With suitable preparation, some light could be supplied safely with solar lamps or flashlights or both. The home temperature would rise to some extent, but in the vast majority of cases where air-conditioning was available, the temperature rise would likely not be to a level of serious discomfort or aggravation of an

[52] In technical terms, in the first case I used SAIFI = 12 and SAIDI = 720 minutes; in the second case, I used SAIFI = 1 and SAIDI = 720 minutes.

[53] Ex. DAO-272, Lawrence Berkeley National Laboratory, Interruption Cost Estimate Calculator (for the inputs specified in the table). Adjustments from 2016 to 2021 dollars based on a factor of 1.13; *see* Ex. DAO-282. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS.

illness. People would not have to seek shelter away from their homes to stay safe. The results show that while the model is sensitive to the number of outages per year, it is relatively insensitive to outage durations in the residential sector.

By contrast, a single long-duration outage, especially on a very hot or very cold day, could cause significant harm. A 12-hour outage may cause loss of meat stored in a refrigerator; spoilage may occur much sooner if it is opened frequently during an outage. A 24-hour outage may cause the contents of a half-full freezer to spoil; the same could occur in 48 hours in a full freezer.[54] Further, day-long or multi-day outages would cause many families to shelter away from homes without power to seek relief from extreme heat or cold and to meet other needs.

Q: Can you give quantitative examples of the cost of long-duration outages for low-income families?

A: Yes. A typical well-stocked modern refrigerator would hold about $250 worth of food in 2017 food cost dollars,[55] which amounts to about $325 when translated to food costs in April 2024 ($280 in 2021 dollars), using the Federal Reserve Index for food costs in urban areas.[56] This estimate does not include food in the freezer associated with the refrigerator and does not include medicines stored in the refrigerator. The actual value of food in refrigerators would be expected to vary; normally, they would not be fully stocked. I will assume $200 worth of food (2021 dollars) in a refrigerator and freezer at any given time,

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[54] Ex. DAO-273. FOOD AND DRUG ADMINISTRATION, FOOD AND WATER SAFETY DURING OUTAGES AND FLOODS.

[55] Ex. DAO-274. Jodi Thornton-O'Connell, *How Much It Costs to Stock the Average Family Refrigerator*, GO BANKING RATES (2017).

[56] Ex. DAO-275. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS: FOOD IN U.S. CITY AVERAGE.

with most of it in the refrigerator, as a reasonable value for purposes of an approximate calculation. I have not taken into account the value of medicines stored in refrigerators. A 12-hour outage, especially if the refrigerator door must be opened to retrieve supplies, could result in the loss of much of the food in the refrigerator. A two-day or longer outage might result in a loss of all its contents.

Q: Could you explain the consequences of the loss of a few hundred dollars to a low-income family?

A: The Federal Reserve does periodic studies of the economic well-being of households in the United States. It examines the ability of families to meet an unexpected $400 expense as part of its review. The following represents some of its findings in that regard:

> To understand more about covering household expenses, the survey asked about adults' ability to pay their monthly bills. As of October and November 2021, 24 percent of adults indicated that they had, or were close to having, difficulty paying bills for that month: 14 percent of adults had one or more bills that they were unable to pay in full, and an additional 10 percent said they would have been unable to pay their bills if faced with a $400 expense. The 24 percent having difficulty (or close to having difficulty) paying bills was down 3 percentage points from 2020 and down 4 percentage points from 2019. These declines are consistent with improvements seen in overall financial well-being.
>
> Lower-income adults were especially likely to face difficulty paying bills. Half of adults with a family income less than $25,000 had one or more bills that they were unable to pay in full that month or were one $400 financial setback away from being unable to pay them, compared with 5 percent for adults with a family income of $100,000 or more.[57]

While the above analysis, the most recent available, shows some improvement in 2021 relative to prior years, conditions have since deteriorated. (The improvement in 2021

[57] Ex. DAO-276. BOARD OF GOVERNORS OF THE FEDERAL RESERVE, ECONOMIC WELL-BEING OF HOUSEHOLDS IN 2021, 36 (May 2022).

was in large measure due to the assistance provided to families during the COVID-19 epidemic by the Federal Government, which has since ended.) Food and many other costs have greatly increased due to inflation. Even in 2021, an unexpected $400 expense would cause half of families with incomes below $25,000 to be unable to pay some of their bills. Thus, for low-income households, the loss of a few hundred dollars of food or the inability to get to work during a multiday outage due to child-care needs with schools closed would likely be very difficult and could send some of them into a crisis.

As another example of the differential impact on low-income families, wealthier households can go to a hotel in an area with power for a couple of days to shelter from the heat or cold; if working remotely, they could work from there. Low-income families generally do not have such options.

In sum, long-duration outages can have serious financial and health impacts on low-income families that need to be considered in utility planning and also in compensation for outages. It is also critical to take measures to avoid those losses to the extent possible. I therefore turn to my next topic—microgrids to increase community resilience during long outages.

Q: How is resilience connected to reducing the harms from long-duration outages?

A: Resilience has many aspects, including making the grid more robust—fewer outages, shorter outages, and quicker recovery from the effects of outages—and, recognizing that outages will occur, ensuring that essential services for residents and for the community have uninterrupted power supply even during long outages. For instance, community shelters would be among the loads that would have uninterrupted power. Providing electricity to the shelter would ensure that there would be heating and cooling at the facility and that there is power for charging phones, operating medical devices, and running refrigerators and freezers where people could store valuable perishables during outages. In that way, a small but non-negligible fraction of the normal power supply could reduce meaningfully the health and financial damage from long-duration outages. This aspect of resilience is growing in importance because the frequency of high-damage climate-related events has been increasing with climate change, including those related to severe storms and cyclones.

Figure 1 shows the total annual damage from billion-dollar-plus disasters; it has grown significantly in the last two decades relative to previous ones.[58]

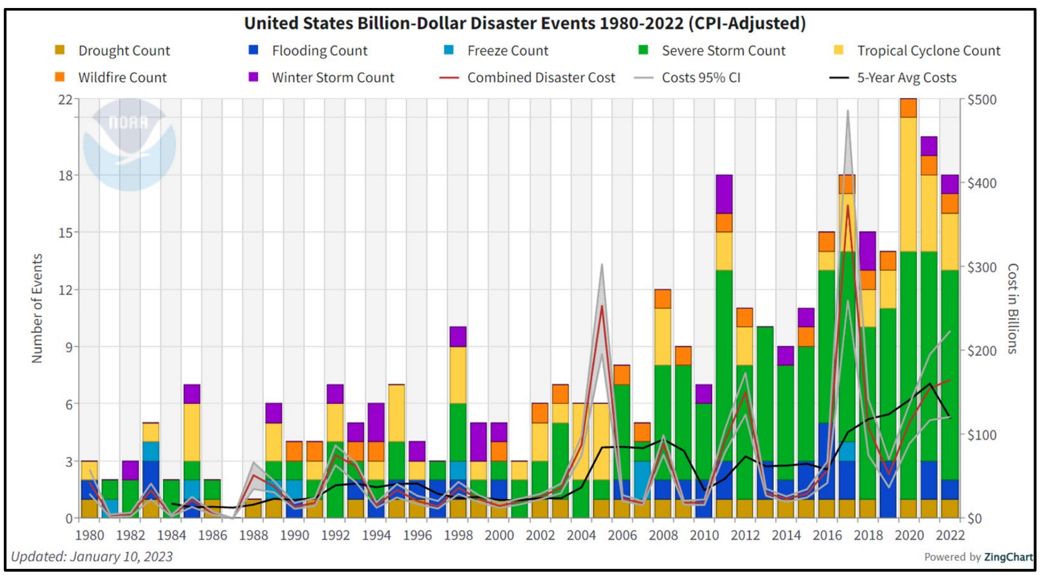

Figure 1: Disasters in the United States, counting only those that cost more than $1 billion each. Note the growing prominence of severe storms and cyclones in the total damage amounts since about 2008.[59]

[58] Ex. DAO-277. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES BILLION-DOLLAR DISASTER EVENTS 1980-2022 (CPI-ADJUSTED) (Jan. 10, 2023).
[59] *Id.*

Q: How can this aspect of resilience be operationalized?

A: Critical functions within a community that need uninterrupted power supply must be identified and investments must be made to ensure that power to them is uninterrupted. From an electricity system point of view, these functions come to represent "critical loads"; uninterrupted power supply to them will operationalize the concept so far as the electricity system is concerned. Basically critical loads are those that would enable communities to avoid severe disruption, maintain essential functions, and avoid ill-health during prolonged outages. They include power supply for emergency shelters, food and fuel suppliers, emergency response facilities, hospitals, and communications and medical devices.

Q: Who determines critical loads?

A: The community must be an essential part of decision-making to identify critical loads. People in the community and community-based organizations are best positioned to know the best grocery stores and gas stations to keep open using community resilience power supply, what community facilities might best serve as shelters, what the food storage requirements in shelters are likely to be, and how many people are likely to be served well by specific existing facilities during long-duration outages. Utility participation is also necessary to help determine feasibility and economics, including what the expected duration of outages might be, given the steps to reduce such durations. Public Service Commission oversight is necessary to ensure fairness and reasonable cost, especially since the utility portion of the investments would be supported by all ratepayers.

Q: How can continuous power supply to critical loads be achieved during prolonged outages?

A: At present, onsite emergency diesel generators power a few critical loads, such as those necessary for allowing hospitals to operate during outages. These generators do not operate when there is power supply from the grid, other than during periodic testing to ensure availability in case of an outage. Individual homes and businesses also sometimes have emergency generators, which typically run on fossil fuels.

Microgrids are also coming into increasing use. These are electricity supply systems for individual buildings or campuses that have a single connection point to the electricity distribution system. They interoperate with the grid during normal times, importing or exporting electricity according to need and economics; they disconnect from the grid automatically (called "islanding") and continue to supply the pre-designated critical loads that are wired for uninterrupted power. Normal operation with the grid is resumed at the end of the outage. These are "behind-the-meter" microgrids, since the power supply (and any associated storage) is on the customer's side of the meter.

Q: What is the electricity supply for the behind-the-meter resources?

A: The energy supply is often fossil fuels; however, solar-plus-storage power supply have also come into increasing use as costs have declined and because of the imperatives of decarbonizing the electricity system. Further, using solar-plus-storage systems would avoid the air pollution that would result from more pervasive fossil fuel generation, given the resilience requirements for far more distributed generation.

Q: Please describe how behind-the-meter microgrids assure the supply of electricity to critical loads during outages.

A: As noted, behind-the-meter microgrids operate behind building or campus meters where critical loads are designated in advance; the loads on designated circuits draw power from the campus generation resources, while other loads are disconnected during outages. The length of time for which the system can supply these loads depends on a number of factors, including the size and nature of the distributed resources, concurrent investments in efficiency, the available fuel supply and the capacity to replenish fuel supply (such as diesel storage tanks), and, in the case of solar-plus-storage, the size of the system and the state of charge of the battery at the moment the outage occurs. Seasonal factors also affect solar-plus-storage systems and are factored into their design. Normally, the design specifies the maximum length of outage and the critical loads to be served.

Q: What are the benefits of maintaining a continuous power supply to critical loads during prolonged outages?

A: Losses of the type discussed above can be greatly mitigated. Lower losses of food, continuous operation of medical devices, the ability to work remotely and to communicate by being able to charge cell phones would be substantial benefits that can be achieved with a behind-the-meter microgrid for a single apartment building. Emergency shelters can provide heated or air-conditioned spaces during periods of cold or hot weather, preventing illness and providing safer emergency shelter. If there are gas stations that have power supply, people can fuel their cars and get to work and school.

Q: Have microgrid studies been performed for the Highland Park area?

A: Yes.

Q: Please describe how microgrids would improve resilience in Highland Park.

A: The National Renewable Energy Laboratory (NREL) published a study in March 2024[60] describing the technical features and costs of three types of behind-the-meter microgrids in the Highland Park area using its own REopt (Renewable Energy Optimization) model. The first type examined typical residential and commercial buildings. The second analyzed the Ernest T. Ford Recreation Center as a resilience hub. And the third was for a larger-scale microgrid in Parker Village, a community in Highland Park that is being built.

NREL also published two other companion studies in the same month. One was focused on energy burdens;[61] the other was focused on electrification of fossil fuel loads (vehicles, heating), distributed solar, and the ability of the distribution grid to adapt to these new conditions.[62] These studies were also focused on Highland Park.

Q: What were the goals of the NREL microgrid analysis?

A: The REopt model uses investment costs, operating and maintenance costs, electricity rates, the amount of behind-the-meter generation, and the size of the microgrid to calculate the net present value of the installation. The model allows for the exploration of ways to

[60] Ex. DAO-278. Tucker Oddleifson et al., *Prefeasibility Analysis of Behind-the-Meter Distributed Energy Resources in Highland Park, MI: Highland Park Pathways to Power*, NAT. RENEW. ENERGY LAB. (Mar. 2024).

[61] Ex. DAO-279. Patrick Gibbs, *Housing Characteristics and Energy Burden Analysis for Highland Park, Michigan*, NAT. RENEW. ENERGY LAB. (Mar. 2024).

[62] Ex. DAO-280. Erik Pohl et al., *Distribution Grid Impact Study in Highland Park, Michigan: Understanding Rooftop Solar, Behind-the-Meter Energy Storage, Electric Vehicle Charging, and Building Electrification*, NAT. RENEW. ENERGY LAB. (Mar. 2024).

optimize costs, clean energy generation, and resilience.[63] A positive net present value over the calculation period means that the installation will be profitable; this means that an increase in resilience has been achieved and, simultaneously, the cost of electricity has declined. A negative net present value means its costs will be greater than the output value, which, in effect, means higher costs for electricity. This is not necessarily bad; it just means that the resilience required will result in a net cost.

NREL described the rationale for the Highland Park REopt study as follows: "Highland Park, Michigan, community members face *frequent, long-duration power interruptions* due largely to the aging distribution system serving the area and the legacy design standards used in its construction."[64] The analysis was sought by the Highland Park community and was done "with key insight from the community stakeholders"[65] as a component of Highland Park's participation in the Department of Energy's Community Local Energy Action Planning (LEAP) program.[66] I understand that the Commission provided a letter of support for the NREL work.

Q: Describe the principal features of the resilience aspects of NREL's Highland Park modeling.

A: Besides computing the net present value of financial benefits and costs, NREL's modeling also estimated the fraction of the year for which critical loads could be met during four-hour outages and "how many hours the energy system can meet the critical load for all hours of the year." The Highland Park community defined the critical loads. The residential

[63] Ex. DAO-278, slide 13.
[64] *Id.* slide 8 (emphasis added).
[65] *Id.*
[66] *Id.* slide 2.

building modeled was a 2,200 square-foot home; critical loads included one-fourth of space heating and air-conditioning, a refrigerator, a freezer, and 400 watts of plug loads for loads such as portable electronics, lighting, and wifi. The critical load was assumed to be 25% of the normal load for both the "typical" residential and commercial buildings analyzed. The resilience modeling aimed to meet the critical load during a 24-hour outage.[67]

The modeling did not include the "value of lost loads;" for instance, it did not include the value of food that would be prevented from spoiling because power was maintained to refrigerators and freezers. NREL recommended evaluating these benefits of resilience in the future.[68] NREL's analysis also did not include the climate value of carbon-free solar generation. I will attempt to estimate some of these benefits approximately.

Q: What were the main findings of the NREL microgrid analysis?

A: While NREL modeled both resilience and non-resilience cases,[69] I discuss only the resilience cases in my testimony. NREL included both batteries and standby diesel generators in its resilience analysis. For typical residential and commercial buildings, the longest outage considered was 24 hours. For the Ernest T. Ford Recreation Center, it was 72 hours (three days). For Parker Village, it was 120 hours (five days).

Table 4 shows some of the principal results of the NREL modeling and additional calculations I have performed. NREL's study period was 25 years, a typical timeframe for solar generation studies, and I have translated NREL's 25-year net present values into

[67] *Id.* slide 29.
[68] *Id.* slide 19.
[69] For instance, NREL modeled the economics of solar without storage and solar with cost-optimal storage, in addition to the resilience cases, in which the aim would be to ensure power supply to critical loads during long-duration outages.

monthly values. Table 4 shows the monthly net present values, as well as the net present monthly value per home served. Ernest T. Ford Recreation Center would serve as a resilience hub, and I have assumed it would shelter 90 households, based on the NREL REopt study estimate that it could shelter 200 people.[70] I base my analysis on the case in which there is no limit on the solar system capacity for the Center. For the Parker Village calculations, I attributed only half the cost of the Parker Village microgrid to the per-home monthly cost, since the residential load is only about 40% of the total.

[70] *Id.* slide 47.

Table 4: Simplified summary of resilience cases analyzed by NREL[71]

	Solar/battery/diesel size, kW/kWh/kW	Monthly net benefit (cost), $/month (Note 1)	Benefit/(cost) per home, $/month (Note 2)	% of year protection, long outages	Comment
Typical residential building 2,200 sq. ft.), Slide 31	4.62/27.7/0	($28.65)	($28.65)	97% (24 hr.)	
Typical commercial Building (33,000 sq. ft.), Slide 32	60.25/44.9/0	$55.67	N/A	96% (24-hr.)	
Ernest T. Ford Recreation Center, solar + battery, Slide 48	100/1,110.5/0	($1,383.34)	($15.37)	96% (72-hr)	hub for 90 homes
Ernest T. Ford Recreation Center, solar +diesel	100/0/69	($151.87)	($1.69)	100% (72-hr.)	hub for 90 homes
Parker Village, solar + battery	2,626.85/8,990.3/0	($13,528.23)	($193.26)	96% (72 hr.); 91% (120-hr.)	28 homes (assigned 40% of cost)
Parker Village, solar + diesel	202.89/0/684	($1,837.55)	($26.25)	100% (72-hr); 95% (120-hr.)	28 homes (assigned 40% of cost)

From this analysis, it is evident that in all cases except a typical commercial building, increasing resilience incurs net costs when benefits such as food not lost, shelter provided, and avoided CO_2 emissions are not included. The picture changes significantly when they are.

[71] *Id.* slides 31, 32, 47, 48, 60, and 67. *See also* Ex. DAO-281 Makhijani NREL-based calculations.

Q: How do the net costs change if the analysis takes into account some of the benefits of resilience?

A: The net costs change the picture fundamentally in most cases when the benefits of renewable energy-powered resilience, such as the value of avoided CO_2 emissions, the food saved, and shelter provided for a two-day outage, are considered. I calculated the approximate present values of these benefits at the same discount rate (5.64%) and used the same period, 25 years, used by NREL. Then I computed the net benefit or cost by adding the benefits to the net present values estimated by NREL to illustrate the impact of taking quantifiable benefits of resilience into account. NREL uses 2021 dollars for the cost of PV. I have done the same in my calculations using the Federal Reserve Consumer Price Index.[72]

I assume that food saved will be $100 per family served per year (2021 dollars).[73] This is on the order of half the value of food that might be found in a typical partially full refrigerator-freezer (see above). I use middle values from EPA's most recent social cost of carbon calculation, which it estimates at $190 per metric ton in 2020, rising by $4 per year (in 2020 dollars);[74] I converted these to 2021 dollars.

I took an approximate account of the declining carbon intensity of the grid by assuming that the amount of CO_2 per unit of electricity generation would decline over time. This is a complex calculation, in large measure because of the uncertainty of the pace at

[72] Ex. DAO-282. FEDERAL RESERVE BANK, ST. LOUIS ECONOMIC DATA, CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS.

[73] This is a rather modest value to use. Many homeowner insurance policies provide up to $500 as compensation for lost food during power outages. Ex. DAO-283 Rachel Brennan, *Does Home Insurance Cover Spoiled Food from a Power Outage?*, Policygenius, May 30, 2024.

[74] Ex. DAO-284. EPA, REPORT ON THE SOCIAL COST OF GREENHOUSE GASES: ESTIMATES INCORPORATING RECENT SCIENTIFIC ADVANCES (Nov. 2023).

which Michigan's electricity sector CO_2 emissions will decline. The state's working group on the matter recommended a 76% reduction in electricity sector emissions by 2030 relative to 2018.[75] Based on this, and assuming a linear decline, the 2022 rate of CO_2 emissions should have been 0.395 metric tons per megawatt-hour of electricity generated; however, it was actually 0.497 mt/MWh.[76] Michigan's climate plan aims for net-zero greenhouse gas emissions by 2050.[77] Given that electricity sector emissions sector must decline more rapidly to enable the achievement of low emissions in other sectors, I assumed zero emissions in the electricity sector in 2040 and calculated the net present value of the avoided social cost of carbon from 2026 to 2040; there is no carbon benefit of the resilience solar installations after that since the entire grid is assumed to have zero emissions.

For the Ernest T. Ford Recreation Center, I assumed that once each year, during a long-duration outage, 90 families would save $100 on food that otherwise would be lost and would be sheltered for two nights at $100 per family per night. The NREL modeling includes two industrial-scale refrigerators to enable the preservation of food during outages.

NREL does not provide first-year solar output for the Ernest T. Ford Center or the Parker Village cases. I estimated those solar outputs as follows. The commercial building solar installation has a tilt of 25 degrees, and the Ford and Parker Village installations have

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[75] Ex. DAO-285. MICHIGAN COUNCIL ON CLIMATE SOLUTIONS, ENERGY PRODUCTION, TRANSMISSION, DISTRIBUTION, AND STORAGE WORKGROUP RECOMMENDATIONS (Oct. 2021).
[76] Calculated from Ex. DAO-263. U.S. Energy Information Administration, State Electricity Profile for Michigan (last accessed July 12, 2024).
[77] Ex. DAO-286. MICHIGAN DEPARTMENT OF CLIMATE, GREAT LAKES, AND ENERGY, MI HEALTHY CLIMATE PLAN (April 2022).

a tilt of 23 degrees.[78] I used NREL's PVWatts solar estimator[79] to calculate the output of the 60.25 kW commercial building installation at 25 degrees and 23 degrees. The ratio of the NREL study to the PVWatts result was 1.014 when the PV tilt was 25 degrees. The ratio of the commercial building PVWatts result at 23 degrees to that at 25 degrees was 0.9944. This gives a net adjustment to the PVWatts result for first-year solar output of 1.008 (1.014 times 0.9944). These are very minor adjustments overall.

Table 5 shows the results of this partial accounting.

Table 5: Net benefits (costs), without and with some resilience benefits[80]

	Annual solar generation MWh/y	Avoided social cost of carbon	Food saved benefit	Shelter value	25-year NPV benefit (cost) from NREL, no non-energy benefits	Net 25-year NPV benefit (cost) with benefits, rounded
Typical residential building (2,200 sq. ft.)	5.6	$2,947	$1,300	$2,600	($8,596)	($1,700)
Typical commercial Building (33,000 sq. ft.)	75.3	$39,720	N/A	N/A	$16,700	$56,400
Ernest T. Ford Recreation Center, solar+battery	124	$65,193	$117,000	$238,200	($415,002)	$5,400
Ernest T. Ford Recreation Center, solar +diesel	124	$65,193	$117,000	$238,200	($45,561)	$374,800
Parker Village, solar+battery	3,246	$1,712,299	$36,400	$74,100	($4,058,469)	($2,235,700)
Parker Village, solar +diesel	267	$140,713	$36,400	$74,100	($551,265)	($300,100)
* Benefits are defined as carbon benefit, food saved benefit, and shelter value						

[78] Ex. DAO-278, slides 32, 42, and 59.
[79] *See* Ex. DAO-291. NREL PVWatts Calculator for Detroit, Michigan. I used the tilts and other parameters (including losses) as specified in Ex. DAO-278 (14% losses and 180 degrees azimuth), and I compared tilts at 23 degrees and 25 degrees.
[80] *See* Ex. DAO-281. Makhijani NREL-based calculations.

Including these key benefits at even modest levels per household for a single two-day outage annually changes the net present value of resilience microgrids from negative to positive, or close to it, in most cases. The residential case has a slightly negative value of $5.67 per month;[81] however, this takes no account of the value of living at home during outages and the lower disruption of daily life, including, for instance, school work and remote professional work. The notable exceptions are the Parker Village microgrids. However, the above calculation of benefits does not include the significant economic value of resilience to the commercial sector envisaged for Parker Village.

Q. How would your analysis apply to the commercial sector?

A: The commercial sector would also derive significant value by having critical loads served continuously. Since a substantial cost of the Parker Village microgrid is associated with the commercial sector, I used the Lawrence Berkeley Laboratory calculator to estimate the benefits of reducing outages from the five-year DTE average in the 2018-2022 period of 1.37 outages per year, averaging 563 minutes per year to one outage of 30 minutes per year,[82] since all families and businesses would stay in their homes and open their businesses given the robust resilience assumptions (coverage of critical loads outages as long as five days in almost all cases—Table 4 above) made by NREL for Parker Village in the scenario considered in my testimony. The results are shown in Table 6, again converted to 2021 dollars (the model gives outputs in 2015 dollars). To be consistent with the prior calculations, I used 2026 as the starting year for the analysis.

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[81] $1,700 divided by 25 years divided by 12 months equals $5.67.

[82] Ex. DAO-287. DTE Electric Co., Reliability Performance and Power Quality Resolution Process: DTE Electric Report for 2022 (April 3, 2022).

Table 6: Parker Village microgrid costs without and with co-benefits (as calculated using NREL's estimator for costs of interrupted loads) plus avoided carbon costs[83]

	Carbon benefit	ICE calculated benefits (Note 1)	NREL NPV, no benefits, slide 67	Net NPV, avoided CO2 + outage cost
Parker Village, solar + battery	$1,712,299	$ 1,257,486	($4,058,469)	($1,088,684)
Parker Village, solar + diesel	$140,713	$ 1,257,486	($551,265)	$846,934

In this calculation, Parker Village's resilience microgrid with diesel and a modest amount of solar has a substantial positive net present value, but the solar + storage case remains in negative territory. However, it is important to note that almost all (99.3%) of the benefits estimated by the model are in the commercial sector.[84] The model estimates a very low benefit per residential customer of only $319 over 25 years (2021 dollars), which is just $1.06 per month.[85] This means that thousands of dollars of benefits in terms of shelter and food saved from spoilage per household are not included; there are 28 residences existing and planned in Parker Village. Roughly $100,000 in benefits should be added, if the same rate as the residential sector benefits shown in Table 5 is included.[86] This would still leave the solar + storage with a negative NPV of about one million dollars over 25 years. Attributing 40% of this to the residential sector (its approximate share of

[83] *See* Ex. DAO-288. Parker Village ICE calculations.
[84] Six businesses of various sizes are envisaged for Parker Village—a small security office 9320 sq. ft.), a "community resource center" 4,521sq. ft.), the Lyn Townsend Center (20,000 sq. ft.) and a three story building (are on each floor 8,922 sq. ft.) with different businesses on each floor. There are thus six businesses (counting the shared workspace as one business), including the security office, which would presumably be even more important to keep open during long outages. However, the office itself is very small. Therefore, I used five businesses as input for the ICE benefit calculation. The ICE Calculator default is to convert this to four small and one merdium-to-large business—in the present case that would be the Lyn Townsend Center. Ex. DAO-278, slides 57 and 60.
[85] Ex. DAO-288. $319 divided by 25 years divided by 12 months equals $1.06 per month.
[86] $36,400 in food saved benefits plus $74,100 in shelter benefits equals $110,500, or roughly $100,000.

electricity consumption projected for Parker Village), the net present value would be in the red by about $47 per household per month.[87]

NREL modeled air-source heat pumps for providing heat in Parker Village, but geothermal heat pumps could be a better alternative. Electrification is a critical part of reducing greenhouse gas emissions; coupling electric space heating with renewable energy, such as solar, eliminates CO_2 emissions. Geothermal heat pumps are far more efficient than air-source heat pumps, though individual ones also cost more. Several states are examining geothermal networks to increase efficiency while electrifying heating, among other objectives.[88] This approach has the added value to the electricity system (and therefore to all ratepayers) of reducing peak loads relative to air-source heat pumps, a benefit that could be very great as heating is electrified and peak loads shift to the winter, including winter nights. It may also change the net-present value of the solar-plus-storage resilience microgrid in Parker Village, which in its present configuration requires a very large battery (nearly nine megawatt-hours). However, it is beyond the scope of my testimony to examine the economics of underground geothermal heating networks.

Q: What conclusions do you draw from this extended review of NREL's analysis and the additional benefits that you identify of resilience from microgrids in Highland Park?

A: It is essential to take into account the significant benefits of increasing that aspect of resilience that provides uninterrupted electricity to critical loads. When that is said and

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[87] ($1,088,684) NPV plus $100,000 in benefits equals ($988,684). ($988,684) divided by 28 residences divided by 25 years divided by 12 months * 40% residential equals $47.08, or approximately $47 per household per month.

[88] Ex. DAO-289. Jeff St. John, *Massachusetts Kicks Off First Pilot to Shift Gas Utilities to Clean Heat*, CANARY MEDIA (June 4, 2024).

done, almost all of the resilience cases have positive net present values. Communities are going to need uninterrupted power supply to critical loads even more as climate extremes worsen. In other words, the value of resilience installations is likely to increase significantly.

Q: How should the non-energy benefits of serving critical loads be calculated when assessing microgrids?

A: This question is analogous to the one concerning the non-energy benefits of affordable energy. As far as the benefit of avoided CO_2 emissions, these can be reflected directly in electricity bills of solar-plus-storage systems that are designed for resilience, i.e. at least 24 hours for individual homes and commercial buildings and at least 72 hours for resilience hubs and community resilience microgrids like the one studied for the Ernest T. Ford Recreation Center. The amount credited can be adjusted over time to reflect DTE system CO_2 emissions as they evolve and updated values of the social cost of carbon as calculated by the EPA.

Q: The above examples all deal with behind-the-meter distributed energy resources for microgrids. Are there other approaches to resilience microgrids?

A: Yes. Area-wide microgrids that have front-of-the-meter solar and storage that include critical loads at different meters. The Redwood Coast Airport Renewable Energy Microgrid in northwestern California is an example. The project is "the first multi-customer, front-of-the-meter microgrid with generation owned by a local CCA (Redwood Coast Energy Authority) and the microgrid circuit owned by an IOU [Investor-Owned

Utility] (Pacific Gas & Electric). It [provides] low carbon resiliency to a commercial airport and U.S. Coast Guard Air Station, which are among the most critical facilities in the host community."[89] The front of the meter 2.2 MW solar and 2.2 MW-AC battery normally sells power into the California wholesale market; it supplies power to critical loads for extended periods during outages.[90] A much smaller complementary net-metered behind-the-meter solar (without storage), 320 kW-AC supplies low-cost electricity to the airport.[91]

Q: What are the advantages of an area-wide resilience microgrid?

A: An area-wide resilience microgrid can combine a variety of essential loads into one facility design that may be located in different places and at different meters. For instance, gas stations, grocery stores, and emergency response facilities can be included in a single area-wide microgrid. As a result, a single area-wide microgrid can handle a more comprehensive set of critical loads in a community than can an individual behind-the-meter microgrid.

Q: What are the ownership characteristics of the Redwood Coast Airport Microgrid?

A: The solar and storage installations are owned by the Redwood Coast Energy Authority ("Energy Authority"), which is comprised of tribal, city, and county governments in the region. The Energy Authority is a "Community Choice Aggregator;" it owns generation installations and purchases wholesale electricity to supply its customers. The wires it uses to do so, including when it supplies critical loads during outages, are owned by PG&E, an investor-owned utility. This particular arrangement is common in California and is enabled

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[89] Ex. DAO-290. REDWOOD COAST RENEWABLE ENERGY AIRPORT MICROGRID, FACTSHEET (JAN. 2020).
[90] *Id.*
[91] *Id.*

by a state law enabling community choice aggregation. As a result, state law sets the parameters according to which community ownership of generation installations (including storage) can use utility-owned transmission and distribution wires. While this legal framework clarifies institutional relationships, it was still necessary to address the structure of investments needed for the microgrid; the resolution was that PG&E owns the necessary microgrid circuitry.

Q: Could a similar front-of-the-meter microgrid to supply critical loads across many meters and buildings be built in the DTE region?

A: In principle, such a microgrid could be built in the DTE service area. Islanding critical loads in such a situation requires significant investment, but it is not a bar to building such a microgrid. However, Michigan does not have a law enabling community choice aggregation. This makes a similar ownership arrangement much more complicated. The terms of the use of DTE-owned wires would need to be worked out, should a community such as Highland Park wish to own the generation.

Q: Is there an alternative way of approaching a front-of-the-meter community resilience microgrid in the DTE service area?

A: Yes. The generation could be owned by DTE, which already owns the wires.

Q: What are the issues with such an approach?

A: DTE ownership would simplify institutional and financial issues, but it means that the ownership and control of an installation vital to the community would be in the hands of a regulated for-profit entity. Thus, DTE ownership would deprive the community of the opportunity to own the solar and storage installations and potentially to get the electricity and the resilience at lower cost and with greater control.

III. Conclusions

Q: Please summarize your main findings regarding the non-energy benefits of affordable energy.

A: My main findings regarding the non-energy benefits are as follows:

- Unaffordable energy seriously harms families who experience it; it also creates large costs for non-low-income ratepayers and taxpayers as well as social institutions.
- Many of the harms are difficult to quantify, but even a partial accounting indicates that the non-energy costs to society, such as those arising from the need to shelter those rendered homeless and to cover a variety of added medical costs, are very large and may be of the same order of magnitude as the costs of bill assistance needed to make bills universally affordable, or possibly even greater.
- Many costs are difficult or impossible to quantify at present. For instance, about three-fourths of the families who become unhoused due to conflicts between paying rent, paying utility bills, and buying food and medicines find shelter with friends and family. The costs of adverse health impacts of not being able to fill prescriptions fully and using gas stoves and ovens for heating are also impossible to quantify at present, as there is lost income due to missed work from these impacts. The costs of such social, health, and economic disruptions are difficult or impossible to estimate at present.

- While there are many causes of becoming unhoused, there is evidence that conflicts between rent or mortgage payments and utility bill payments play a major and direct role. As a result, affordable energy can help people pay rent and make mortgage payments, significantly benefiting taxpayers, ratepayers, landlords, lenders, hospitals, and health insurance companies.

Q: Please summarize your findings regarding increasing resilience in the sense of maintaining uninterrupted power supply to critical loads.

A: My main findings are as follows:

- Long-duration outages cause significant harm to families and communities. These harms are increasing as climate extremes worsen.
- Resilience microgrids designed to provide uninterrupted power to critical loads can greatly reduce those harms and prevent the worst ones.
- It is important for communities to define the loads that are critical as discussed above in my testimony above.
- The analysis done by the National Renewable Energy Laboratory indicates that renewable power (solar energy) to critical loads using behind-the-meter microgrids can be achieved at various scales ranging from individual residential and commercial buildings, to public service buildings, like the Ernest T. Ford Recreation Center, to an entire housing-commercial development, like Parker Village. Good design can enable the supply of power to all or almost all critical loads in community microgrids for up to three-to-five day outages.

- My analysis indicates that it is essential to account for non-energy benefits such as the value of shelter and avoided food loss and, for renewable microgrids, the avoided social cost of carbon. Without this more complete accounting, most resilience microgrids that would enable sustainable communities as climate extremes worsen may be rejected or may impose costs on communities even though much larger populations benefit.
- It is also possible to create front-of-the-meter resilience microgrids that can cover a wider range of critical loads in a single facility. However, under the present regulatory and legislative conditions in Michigan, creating such microgrids faces significant obstacles unless they are owned by DTE. That limits the options of communities to own and control an essential resource and avoid the costs associated with profits associated with ownership by an investor-owned utility.

IV. Recommendations

Q: What are your principal recommendations regarding incorporating non-energy benefits of affordable energy into this rate case?

A: I have six major recommendations in this regard:

1. It is essential to include the non-energy benefits of affordable energy into ratemaking. The data may be scattered and incomplete, but everything indicates that non-energy benefits are huge.
2. I strongly recommend that the Michigan Public Service Commission conduct or commission a comprehensive study that would quantify non-energy benefits. The results must include the costs of unaffordable energy as much as possible and estimate the benefits of achieving universal affordability. The assessment should include all the

costs and harms that are discussed in the surveys of the National Energy Assistance Directors Association cited in my testimony. That said, such a study should not delay the implementation and universalization of affordable electricity, given the magnitude of the non-energy costs of unaffordable energy.

3. Evidence indicates that the non-energy costs of unaffordable energy can be greatly reduced if energy is made affordable. The Commission should devote resources to quantifying and tracking non-energy benefits experienced by those whose energy has become affordable, especially among those who now have very high energy burdens (above 15%) and also those experienced by society in the form of reduced costs of social and medical services. Ratepayers and taxpayers get real value for assistance money; they deserve to know to the extent possible what the dollars-and-cents component of that value is.

4. The affordability gap for electricity bills alone is about $380 million.[92] About $304 million is needed to make electricity bills affordable (3% of income for households with non-electric primary heating and 6% for households with electric primary heating).[93] Given the magnitude of the benefits, I recommend that this gap be filled with suitable revenue sources as soon as feasible. The specifics of the funding issue are addressed in the testimony of Witness Koeppel.

5. I recommend that universal enrollment be made as simple as possible to reduce the burdens on potential applicants, to provide easy access to assistance to all who need it, and to deliver the benefits of universal energy affordability both to low-income households and to society at large.

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[92] Kinkhabwala Direct Testimony at 6.
[93] *Id.* at 19.

6. It is essential to prioritize investments to reduce energy burdens systemically as discussed in the analysis of Witness Kinkhabwala. This will allow the portion of the rates devoted to universal affordability to be reduced over time; it would also reduce the need for public assistance.

Q: What are your principal recommendations for incorporating resilience microgrids in this rate case, notably as regards low- and moderate-income communities, including Highland Park.

A: I have five recommendations in this regard:

1. Long-duration outages, especially day-long or multi-day outages, cause significant harm. Utility compensation for outages should, in part, be geared to the duration of the outages. It should include a standard compensation for loss of food, which should be set by the Commission in consultation with the community. Where suitable, safe public shelter is not available during day-long and multi-day outages, compensation should include the costs of alternative shelter. This is a key reason also to ensure that suitable and sufficient emergency shelter spaces are available for everyone, with high priority in low-income communities, where residents do not have the financial option of using hotels. The Commission should consider progressive bill crediting. It should significantly expand bill credits for outages, especially when it concerns long-duration outages, to reflect the value of food and shelter lost. My calculations in this regard are illustrative of the losses, but do not account for all losses, such as loss of medicines or loss of work. Bill credits that reflect these losses may be substantially greater than those

estimated in my testimony, especially in census tracts or zip codes with high proportions of low- and moderate-income households.

2. Renewable resilience microgrids that provide uninterrupted electricity to community-defined critical loads appear to be economical in almost all the Highland Park cases studied by NREL when the non-energy benefits, such as avoided CO_2 emissions, avoided food spoilage, provision of emergency shelter, and avoided loss of business are taken into account, to the extent quantifiable. As a result, microgrids should be widely implemented. Given that Highland Park has suffered long-duration outages, which hit low-income communities especially hard, as I have discussed in this testimony, the Commission should set the conditions to make building microgrids in Highland Park and other similar areas as simple and as efficient as possible. For instance, net metering and compensation for exported electricity should reflect the fact that the entire region benefits when people are sheltered and that businesses can maintain critical services like selling food and fuel. I recommend that all three resilience microgrids considered by NREL with the resilience durations as discussed above be built, should the Highland Park community so desire, and that the utility facilities needed to make that possible be factored into the rate base.

Three other resilience microgrids have also been identified by the community—City Hall, the fire station, and the Senior Building. These should also be built, given that the Ernest R. Ford Community Center will not be able to accommodate most families in Highland Park during long-duration outages. It would also be substantially more efficient and beneficial to provide resilience for seniors in their places of residence. The value of doing so should be taken into account, in consultation with the community.

I want to be clear that my recommendation for ratepayer support applies only to resilience microgrids that would provide uninterrupted power to critical loads during multi-day outages. The NREL analysis indicates that normal residential and commercial building behind-the-meter resilience facilities can stand on their own, the former if carbon credits are included and the latter even without them.

3. The Commission should conduct or commission a study to quantify the benefits of behind-the-meter community resilience microgrids, with special attention to the disproportionate costs of long-duration, i.e., day-long or multi-day, outages on low- and moderate-income households. This effort should also examine the economics of such installations when efficiency investments are made to reduce the need for power, especially to reduce the electricity needed to provide heating and cooling to shelters during outages.
4. I recommend that an underground geothermal network be evaluated as a pilot project for at least one resilience microgrid in Highland Park, with community participation as to its location, possibly Parker Village.
5. Front-of-the-meter microgrids could serve a larger variety of critical loads, possibly at a lower cost. The Commission should initiate an analysis of the ways that that might be done in Michigan, including particularly ways that will allow for community ownership of the distributed generation and storage resources and the terms under which they would have access to DTE's distribution system. DTE ownership of such microgrids should also be studied for comparison, including cost. The ways in which

the community could have control over such essential facilities that it does not own, such as with special governing boards, should be examined for their feasibility and practicality.

Q: Does this conclude your written Direct Testimony?

A: Yes.