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LEGAL

July 25, 2024

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

Via E-File

RE: MPSC Case No. U-21534

Dear Ms. Felice:

Attached please find the enclosed documents for filing:

- Direct Testimony and Exhibits of David L. Gard on behalf of Citizens Utility Board of Michigan, Michigan Environmental Council, and Natural Resources Defense Council (Exhibits CUB-20 through CUB-29); and
- Proof of Service.

Thank you for your assistance in this matter. If you have any questions, please feel free to contact me.

Sincerely,

Digitally signed by Christopher Bzdok
DN: cn=Christopher Bzdok,
o=Troposphere Legal,
email=chris@tropospherelegal.com,
c=US
Date: 2024.07.25 17:25:04 -04'00'

Christopher M. Bzdok
chris@tropospherelegal.com

CC: Parties to Case No. U-21534

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **DTE ENERGY 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.	U-21534

DIRECT TESTIMONY OF DAVID L. GARD

ON BEHALF OF

CITIZENS UTILITY BOARD OF MICHIGAN,
MICHIGAN ENVIRONMENTAL COUNCIL,
NATURAL RESOURCES DEFENSE COUNCIL

July 25, 2024

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I. INTRODUCTION & QUALIFICATIONS

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

A. My name is David L. Gard. I am a senior consultant at 5 Lakes Energy, a Michigan limited liability corporation, located at Suite 218, 220 MAC Avenue, East Lansing, Michigan 48823.

Q. On whose behalf is this testimony being offered?

A. I am testifying on behalf of Citizens Utility Board of Michigan (CUB), Michigan Environmental Council (MEC), and Natural Resources Defense Council (NRDC).

Q. Please summarize your experience in the field of utility regulation.

A. I have worked for 5 Lakes Energy since November 2014. In this role, I have done extensive modeling in support of resource planning and building decarbonization. Previously I directed the Michigan Environmental Council's energy policy program for more than a decade. My work experience is summarized in my resume, provided as Exhibit CUB-20.

Q. Please summarize your professional development coursework in the field of utility regulation.

A. I have completed this NRRI Regulatory Training Initiative course: Regulating Public Utility Performance (January 10, 2022 to March 28, 2022). I have also completed these EUCI courses: Utility Forecasting Techniques & Applications (March 22-23, 2021); Electric Cost-of-Service: Essential Concepts for a Changing Industry (July 15-16, 2019); Natural Gas Physical & Financial Markets (May 9, 2018); Introduction to the Natural Gas Industry, Infrastructure and Regulations (May 8, 2018); and Evolution of Electricity Markets: Disruptive Innovation & Economic Impacts (January 29-30, 2018). I also completed the MSU Institute for Public Utilities course Accounting and Ratemaking (September 21-23, 2020).

Q. Have you testified before this Commission or as an expert in any other proceeding?

A. I have previously testified before the Michigan Public Service Commission (Commission) in the following cases:

- Case U-20561 (DTE Energy Company 2019 General Rate Case);
- Case U-20963 (Consumers Energy Company 2021 General Rate Case);
- Case U-21090 (Consumers Energy Company 2021 Integrated Resource Plan Case).

In addition, I prepared written testimony based on my review of electric and gas utility energy efficiency potential studies in cases D.P.U. 18-110 through D.P.U. 18-119 before the Commonwealth of Massachusetts Department of Public Utilities.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibits:

Exhibit CUB-20:	Resume of David L. Gard
Exhibit CUB-21:	8760-hour load profiles for ResStock single-family and multi-family
Exhibit CUB-22:	CP and NCP performance of ResStock single-family, ResStock multi-family, and DTE 2018 residential
Exhibit CUB-23:	CP and NCP radar plots for ResStock single-family, ResStock multi-family, and DTE 2018 residential
Exhibit CUB-24:	Description of Modeling Analysis to Investigate Increased Building Electrification and Other Measures on Residential Hourly Load

Exhibit CUB-25:	8760-hour load profiles for eight scenarios
Exhibit CUB-26:	Annual energy results for eight scenarios
Exhibit CUB-27:	CP and NCP performance of eight scenarios
Exhibit CUB-28:	CP radar plots for eight scenarios
Exhibit CUB-29:	NCP radar plots for eight scenarios

II. SUMMARY

Q. What topics are you addressing in your testimony?

A. On behalf of CUB, MEC, and NRDC, I am addressing the following three topics:

- Comparing load profile shapes of single-family and multi-family residential customers;
- The importance of realistic building electrification projections;
- Simulating increased building electrification and other measures.

III. COMPARING LOAD PROFILE SHAPES OF SINGLE-FAMILY AND MULTI-FAMILY RESIDENTIAL CUSTOMERS

Q. Does the Company include all residential customers in a single class?

A. Yes.

Q. Why might this be inappropriate?

A. If subcategories of residential customers were shown to have meaningfully different cost of service characteristics, then it would be inappropriate to treat them within the same customer class.

Q. Describe your comparison of single-family and multi-family load profiles in Southeastern Michigan.

A. Using the National Renewable Energy Laboratory's (NREL) realistic building load profiles available in its ResStock dataset, I created a representation of the Company's residential load by aggregating data for the five Southeastern Michigan counties of Lapeer, Macomb, Oakland, St. Clair, Wayne. Because ResStock data are reported separately for different building types, I was able to deconstruct the 5-county total residential electricity load profile into separate load profiles for single-family and multi-family residential subcategories.

Q. How do the 8760-hour load profiles compare?

A. Exhibit CUB-21 shows the 8760-hour load profiles for the single-family and multi-family residential subcategories. These are noticeably different. For instance, the single-family load profile shape demonstrates higher summer peaks and less wintertime load than the multi-family load profile shape.

Q. How do cost of service (COS) parameters compare?

A. Exhibit CUB-22 presents COS factors which were computed for ResStock single-family, ResStock multi-family, and DTE residential using the Company's 2018 COS results obtained from filed document "Part III Attachment 5 (29) COMPLETE".[1] To facilitate a more intuitive visual comparison, this same information is presented in a series of radar

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[1] 2018 COS results were used for consistency with ResStock which reflects weather year 2018.

plots in Exhibit CUB-23. The differently shaped plots for single-family and multi-family households are readily apparent for both critical peak (CP) and noncoincident peak (NCP) COS parameters. Also, the close similarity between the ResStock single-family and DTE 2018 residential plots is plain to see, suggesting that the unique multi-family load profile shape is largely hidden within the Company's residential customer class.

Q. What do you recommend based on your analysis?

A. Given this strong evidence that single-family and multi-family residential customers have meaningfully different COS characteristics, I recommend that the Michigan Public Service Commission require the Company to conduct a similar analysis of its residential customers to determine whether continuing to combine single-family and multi-family customers within a single class is justified.

IV. THE IMPORTANCE OF REALISTIC BUILDING ELECTRIFICATION PROJECTIONS

Q. Please define the term "building electrification."

A. According to the U.S. Green Building Council, "Building electrification—also known as beneficial electrification or building decarbonization—describes the shift to using electricity rather than burning fossil fuels like oil, gas and coal for heating and cooking." I consider this to be a good working definition of the term.[2]

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[2] See https://www.usgbc.org/articles/building-electrification-why-it-matters, last checked July 17, 2024.

Q. Is it reasonable to assume more building electrification within the Company's service territory over time?

A. Yes, I expect to see more building electrification in Southeast Michigan in the years ahead. Among various indicators of this trend are these:

- Mitsubishi and other manufacturers have made recent advances in heat pump technology. Cold-climate air source heat pumps are now available which operate more efficiently at lower ambient temperatures than older models.
- There is growing interest among Michigan communities in electrification as a strategy to reduce carbon emissions and improve local resilience. For example, the City of Ann Arbor has a program to promote home electrification.[3]
- The State of Michigan has embraced a goal to "reduce emissions related to heating Michigan homes and businesses by 17 percent by 2030."[4]
- Michigan Public Act 229 of 2023 Section 71(6) includes this provision for building electrification: "Beginning January 1, 2025, an electricity provider shall file its energy waste reduction plan as part of a customer energy optimization plan. A customer energy optimization plan shall include an energy waste reduction plan and may include an efficient electrification measures plan."

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[3] See https://www.a2gov.org/departments/sustainability/Sustainability-Me/Families-Individuals/Pages/Home-Electrification.aspx, last checked July 17, 2024.

[4] MI Healthy Climate Plan, Michigan Department of Environment, Great Lakes, and Energy, p. 5, April 2022.

Q. **Has the Company acknowledged the potential for more building electrification in the future?**

A. Yes. I found references or allusions to anticipated building electrification in the Company's testimony on the following pages:

- Witness Deol: SSD-6, SSD-13, SSD-26, SSD-81, SSD-83
- Witness Hartwick: SMH-45, SMH-94, SMH-137, SMH-183
- Witness Kryscynski: AJK-25, AJK-31, AJK-34, AJK-35, AJK-76.

Q. **Why is it important for the Company to include realistic projections of building electrification in its load forecasting?**

A. Converting end uses such as space and water heating to electricity can cause significant changes in annual electricity use and in the size and timing of peak loads. Realistic projections of these changes are needed to properly plan the future distribution system. In addition, fair and effective rate design depends on such projections to inform the cost of serving customers who adopt building electrification.

V. SIMULATING INCREASED BUILDING ELECTRIFICATION AND OTHER MEASURES

Q. **Briefly describe the simulation analysis you conducted for this case.**

A. I created an Excel spreadsheet model (described in detail in Exhibit CUB-24) to simulate the effects of building electrification and other measures on residential hourly load. By focusing on the single-family detached building type, the effort was kept manageable while still reflecting a large number of customers in the Company's service territory. I used this model to evaluate several scenarios compared to a baseline. The results are indicative of load shape changes in response to greater adoption of these building measures.

Q. Why did you conduct this analysis?

A. My purpose was to demonstrate the type of simulation that should be required of the Company to study the impacts of future building electrification on the distribution system and on cost of service.

Q. Which specific simulations did you run?

A. Table 1 lists eight combinations of building electrification (BE) adoption, electric vehicle (EV) adoption, and on-site photovoltaic (PV) production which I simulated. The BE adoption level of 44 percent, computed using outputs from Witness Graham Woolley's transformer aging model, represents the scale of building electrification possible on the system without exceeding the distribution transformer network's present design capacity (as explained in Exhibit CUB-24). The magnitude of this result suggests that a sizeable amount of building electrification could be accommodated without significant upgrades to the transformer network's capacity. This needs further study.

Table 1. Modeling Scenarios

Scenario Name	Building Electrification Adoption Rate	Number of EVs per Household	On-Site PV Production (Portion of Annual Load)
Baseline	0%	0	0%
44% BE	44%	0	0%
100% BE	100%	0	0%
44% BE_1 EV	44%	1	0%
44% BE_2 EV	44%	2	0%
44% BE_2 EV_5% PV	44%	2	5%
44% BE_2 EV_15% PV	44%	2	15%
44% BE_2 EV_25% PV	44%	2	25%

Q. What are the results of running these eight simulations?

A. Exhibit CUB-25 compares the resulting 8760-hour load profiles for all eight scenarios using a common y-axis scale. As building electrification increases, much of the additional load occurs during the winter heating season with the annual peak eventually shifting to winter. Adding EVs further increases load throughout the year with the general shape of the profile still being largely determined by the amount of building electrification. This is signified by the negative kWh in some hours in the last three graphs.

Exhibit CUB-26 shows the annual load in each case. Note thatthe 100% BE scenario results in slightly less annual load than adding one EV to the 44% BE scenario although the annual peak is noticeably greater in the 100% BE case. This more complicated result points to the need for simulating realistic combinations of building electrification and other measures such as EV charging when studying future load.

It is also instructive to examine the performance of each scenario relative to the Company's 2018 COS metrics. Exhibit CUB-27 presents these numerical results for CP and NCP. Exhibits CUB-28 and CUB-29 show this information in a series of radar plots. These plots show that critical peaks in colder months tend to increase with building electrification while those in warmer months tend to decrease slightly. This latter result can be explained by the model's application of simulated building envelope upgrades reducing air conditioning load. (See Exhibit CUB-24, p. 3 for an explanation.)

Q. What do you take away from these results?

A. As we look ahead to more building electrification, EV charging, and on-site PV production, load profiles can change dramatically depending on the choices customers make in adopting these technologies. It is important not to discourage these choices with rate designs that do not accurately reflect COS. The radar plots, in particular, clearly suggest that load profiles for households which install electric heating equipment are noticeably different. A consequence of applying identical COS factors, based on a summer peak, to both non-electric and electric heating customers is that those with electric heating will be relatively overcharged, and the benefit of their annual peak occurring during winter when more system capacity is available will not be fully captured.

Q. What do you recommend based on this observation?

A. I recommend that the Michigan Public Service Commission direct the Company to provide a robustly time-differentiated rate structure that is available to electric heating customers and treat these customers as a separate class for the purpose of COS analysis and rate design.

Q. What else do you recommend based on the modeling analysis you conducted?

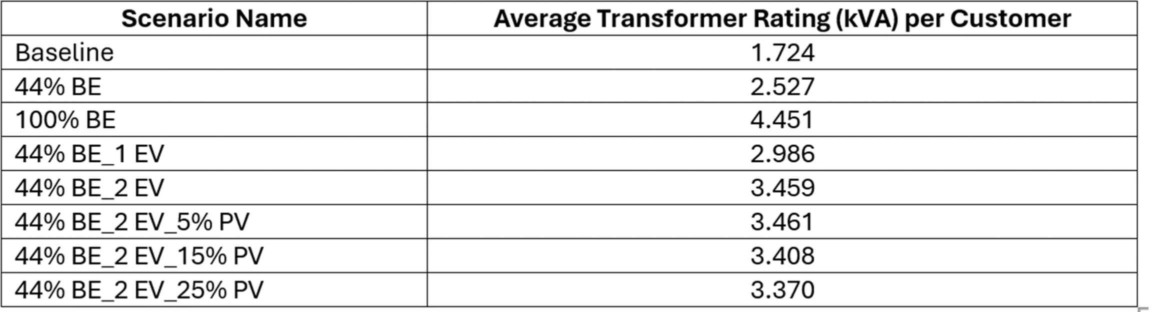
A. I recommend that the Michigan Public Service Commission require the Company, in its next distribution plan, to rigorously investigate the ability of its distribution system to handle higher levels of electric heating before significant capacity upgrades are needed.

Q. Are there other results you wish to highlight?

A. Yes. I would like to present a set of findings that Witness Graham Woolley's model produced using the eight scenario load profiles depicted in Exhibit CUB-25. We imported these profiles into his transformer aging model to estimate the degree to which each scenario impacts the expected life of typical distribution transformer equipment. These findings appear in the form of average transformer rating per customer in Table 2.

Incidentally, comparing the third and fourth scenarios in this table to Exhibit CUB-26 suggests that total annual load is not the primary driver of transformer degradation.

Table 2. Average Transformer Rating per Customer by Scenario



Scenario Name	Average Transformer Rating (kVA) per Customer
Baseline	1.724
44% BE	2.527
100% BE	4.451
44% BE_1 EV	2.986
44% BE_2 EV	3.459
44% BE_2 EV_5% PV	3.461
44% BE_2 EV_15% PV	3.408
44% BE_2 EV_25% PV	3.370

VI. RECOMMENDATIONS

Q. Please summarize your conclusions and recommendations to the Commission.

A. On behalf of CUB, MEC, and NRDC, I recommend that the Commission:

(1) Direct the Company to conduct an analysis of its residential customers to determine whether treatment of single-family and multi-family customers in separate classes is justified.

(2) Direct the Company to provide a robustly time-differentiated rate structure that is available to electric heating customers and to treat these customers as a separate class for the purpose of COS analysis and rate design; and

(3) Direct the Company, in its next distribution planning case, to rigorously investigate the ability of its distribution system to handle potentially much higher levels of electric heating before significant capacity upgrades are needed.

Q. Does that complete your testimony?

A. Yes.

David Gard
Senior Consultant
dgard@5lakesenergy.com

Expertise

Building energy use & decarbonization; electricity system modeling; life cycle assessment; energy project financing options.

Selected Projects

- **Low Carbon Energy Infrastructure Development.** Led a multi-partner team that developed an analytical toolkit to help communities evaluate the costs and benefits of potential local building electrification projects, across a comprehensive range of cost, environmental, climate, economic, and other considerations. Funded through a contract with the Michigan Public Service Commission, this 5LE-directed initiative also involved engaging residents and other stakeholders in seven Michigan cities in identifying, evaluating, financing, and implementing electrification plans that emerge from project-led community conversations.
- **Grand Haven community cliamte and energy plan**. Served as 5LE's lead team member in a collaboration with Michigan Energy Options (MEO) and local stakeholders to develop a clean energy plan for the service territory of Grand Haven Board of Light and Power in west Michigan. Responsibilities for the project included using EPA's local GHG inventory tool to establish a baseline multi-sector emissions profile–including electricity use, onsite fuel combustion, waste management, land use, and transportation–and make future projections.
- **Traverse City Light and Power (TCLP) decarbonization planning.** Supported 5LE's work to advise TCLP—a municipal utility in the northwest Lower Peninsula of Michigan—on the best strategies and action plans for decarbonizing the power it provides its customers. Among others, contributions to the project included deploying hourly energy modeling and forecasting to assess options for electrifying the utility's natural gas/heating load and how those options would guide/impact its renewable energy generation and purchases, internal costs and customer pricing, and other aspects of its operations.
- **Heat-pump rate design modeling.** Applied National Renewable Energy Lab (NREL) end-use load profile data in hourly energy modeling to support a partnership with Rocky Mountain Institute (RMI) and Natural Resources Defense Council (NRDC) that focused on determining how ratepayer tariffs can be designed—and other such strategies can be adopted—to accelerate the uptake of air source heat pumps in cold weather climates.
- **Michigan Energy Efficiency Contractors Association (MEECA).** As a member of the 5LE team, serves as MEECA's part-time Executive Director, providing organizational leadership and development support and helping the industry expand its capacity, develop its future workforce, and speak with an effective voice in public policy arenas and debates.

Past Employment

- **Executive Director |The Oberlin Project** | 2013-2014
- **Energy Program Director | Michigan Environmental Council** | 2002-2013
- **Senior Design Engineer | Dematic** | 1995-1998
- **Division Officer| U.S. Navy, USS Mount Whitney** | |1991-1995

Education

- **MBA and MS, Environment and Sustainability (dual degree program) | University of Michigan** | 2001
- **BS, Mechanical Engineering | Northwestern University** | 1991

Service, Affiliations, and Awards

- **External Advisory Board | University of Michigan, Center for Sustainable Systems** | 2005-Present
- **Board of Directors | Michigan Energy Options** | 2012-2021
- **Fellow | University of Michigan, Tauber Institute for Global Operations** | 1998-2001
- **3M Prize for Outstanding Achievement in Industrial Ecology** | 2001

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Ex CUB-21 | Source: D. Gard
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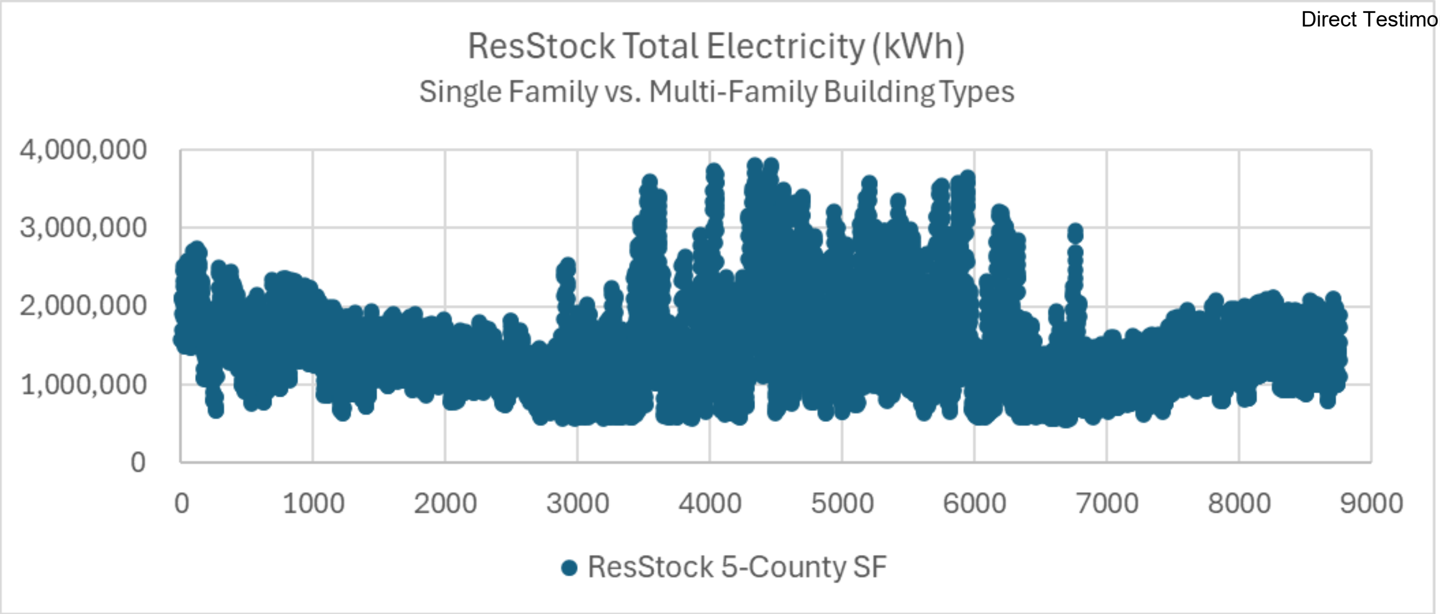

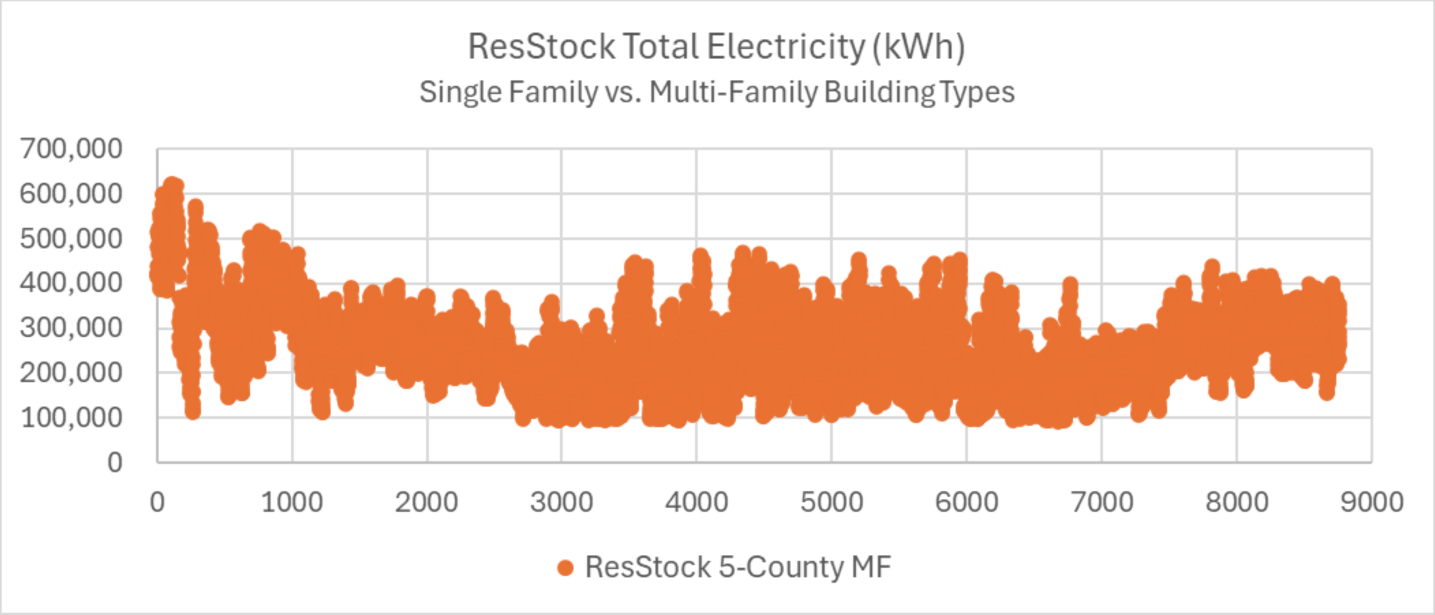

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Ex CUB-22 | Source: D. Gard
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COS Metric	**COS Metric/Annual Energy**		
	ResStock 5-County SF	**ResStock 5-County MF**	**DTE 2018 Residential**
1CP	0.00029	0.00020	0.00029
4CP	0.00029	0.00020	0.00029
12CP_January	0.00020	0.00027	0.00017
12CP_February	0.00017	0.00021	0.00015
12CP_March	0.00015	0.00017	0.00013
12CP_April	0.00011	0.00011	0.00009
12CP_May	0.00026	0.00019	0.00025
12CP_June	0.00029	0.00020	0.00029
12CP_July	0.00030	0.00020	0.00031
12CP_August	0.00027	0.00020	0.00028
12CP_September	0.00028	0.00020	0.00028
12CP_October	0.00023	0.00018	0.00016
12CP_November	0.00015	0.00017	0.00014
12CP_December	0.00015	0.00017	0.00015

COS Metric	**COS Metric/Annual Energy**		
	ResStock 5-County SF	**ResStock 5-County MF**	**DTE 2018 Residential**
1NCP	0.00029	0.00021	0.00032
4CNP	0.00028	0.00021	0.00031
12NCP_January	0.00019	0.00025	0.00018
12NCP_February	0.00017	0.00022	0.00016
12NCP_March	0.00015	0.00017	0.00014
12NCP_April	0.00014	0.00016	0.00013
12NCP_May	0.00027	0.00020	0.00029
12NCP_June	0.00029	0.00021	0.00032
12NCP_July	0.00029	0.00021	0.00032
12NCP_August	0.00028	0.00020	0.00030
12NCP_September	0.00028	0.00020	0.00029
12NCP_October	0.00020	0.00017	0.00017
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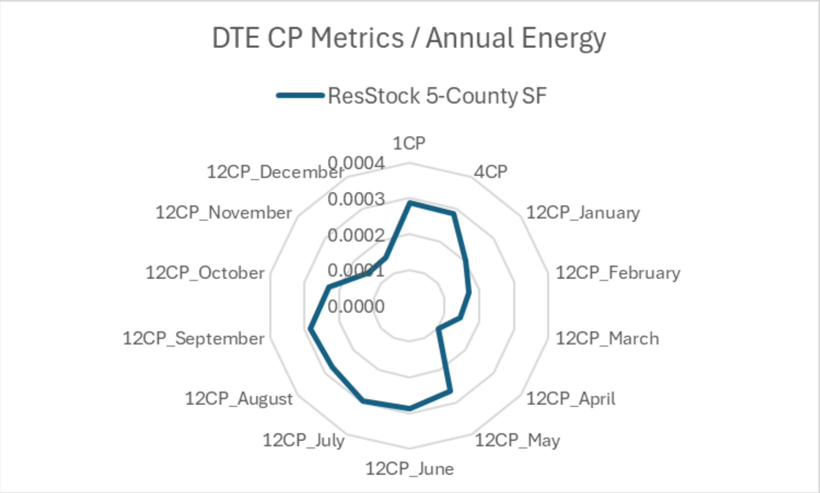
12NCP_December	0.00016	0.00017	0.00016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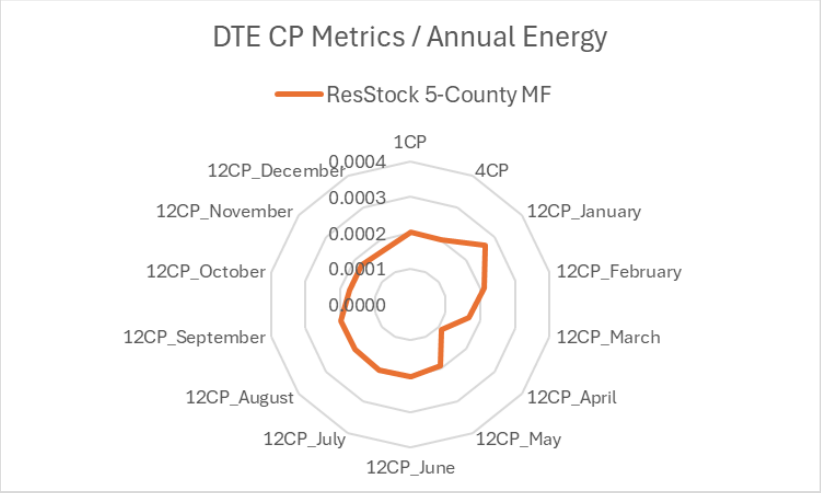
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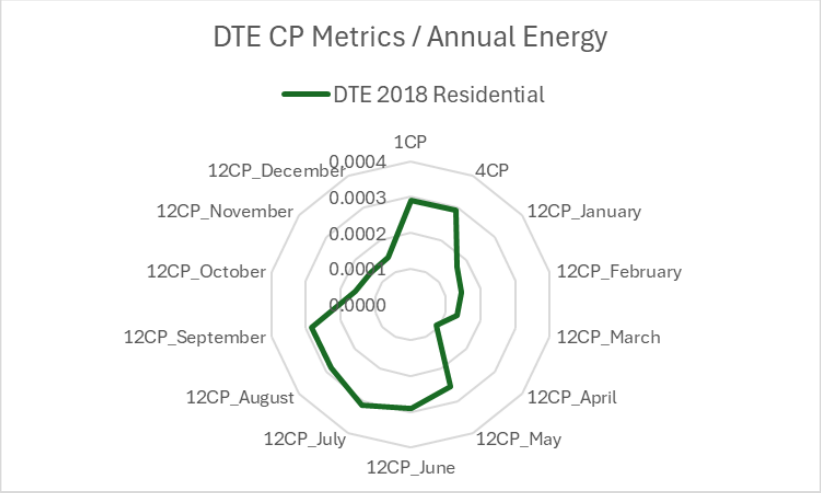
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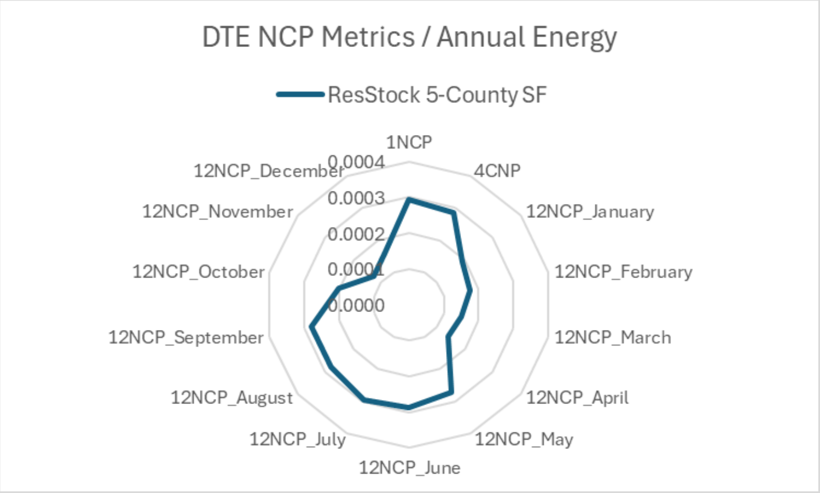
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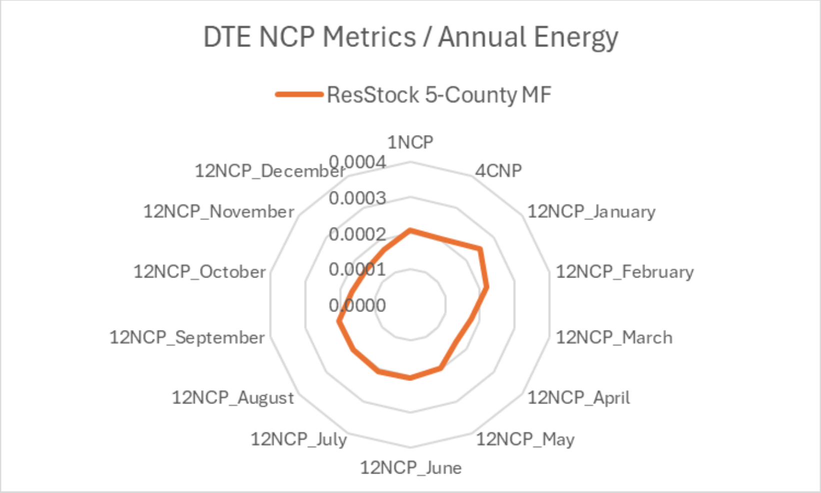
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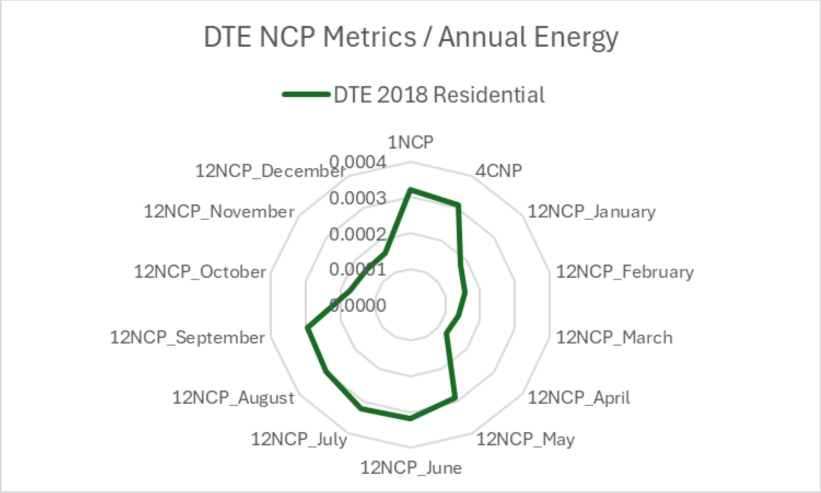
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DESCRIPTION OF MODELING ANALYSIS TO INVESTIGATE IMPACTS OF INCREASED BUILDING ELECTRIFICATION AND OTHER MEASURES ON RESIDENTIAL HOURLY LOAD

Model Summary

An Excel spreadsheet model was created to simulate the effects of building electrification and other measures on hourly load. This model was used to evaluate several scenarios compared to a baseline representation of customer load in Southeast Michigan. The results are indicative of changes in load shape in response to greater adoption of these building measures.

ResStock Data Source

The model relies heavily on end-use load profiles developed by the National Renewable Energy Laboratory (NREL). These profiles, available in the ResStock and ComStock datasets, can be downloaded in 15-minute interval times series at various levels of aggregation including national, state, county, and sub-county geographies.

While the Company reports total electricity load profiles for each customer class, these lack sufficient granularity for this analysis. By comparison, the NREL load profiles reflect specific end uses and fuel types, not just total electricity load. For example, NREL data allows the user to isolate hourly natural gas consumed for water heating apart from other natural gas uses and other water heating fuels.

This an appropriate application of the NREL load profiles. Published guidance from NREL explicitly mentions Electrification Planning as one of seven use cases for its end-use load profiles. The other six use cases discussed are Integrated Resource Planning, Long-term load forecasting, Transmission planning, Distribution system planning, Demand-side management planning, and Bill impacts and rate design.[1]

This analysis only considered the residential sector. NREL hourly profiles are available for residential and commercial customer types, but the amount of time needed to gather and organize the data is nontrivial. Knowing that preparing ResStock data would involve significantly less effort than ComStock data, and that the pattern of results for the residential and commercial sectors would be similar, it was decided to focus exclusively on residential load for this analysis.

NREL followed a rigorous methodology to develop its nationwide ResStock and ComStock datasets. The process involved extensive sampling of building types reflecting multiple characteristics, physics-based energy modeling of representative buildings, and calibration using U.S. census and utility operations data. NREL load profiles down to the county level are meant to provide a reasonable representation of actual load in U.S. buildings as it occurred in weather year 2018.

To select the ResStock aggregation level for this analysis, a straightforward visual comparison was made of total electricity load shapes at various ResStock scales to the actual 2018 residential load shape which were retrieved from the Company's previously filed workpaper "U-20516_Part III

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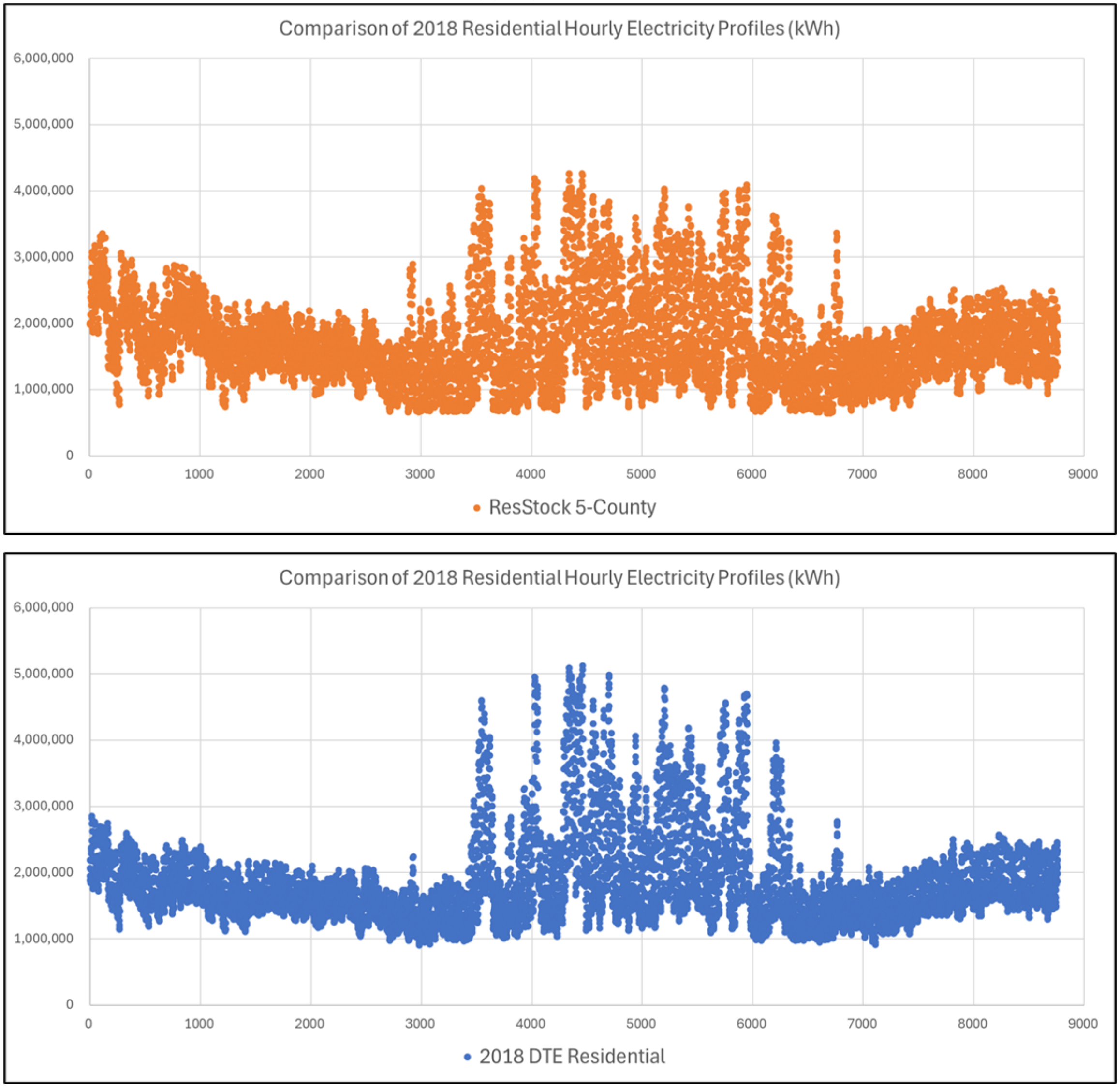
[1] NREL, "End-Use Load Profiles for the U.S. Building Stock: Practical Guidance on Accessing and Using the Data," p. 20, December 2022.

Attachment 5 (28) Final." From this process it was determined that aggregating ResStock data across the five Southeast Michigan counties of Lapeer, Macomb, Oakland, St. Clair, Wayne achieved a reasonable visual match. This visual comparison is shown in Figure 1.

Figure 1. Visual Comparison of ResStock Aggregated Profile and DTE 2018 Residential Load



Although the priority was to achieve a similar load shape and not necessarily a precise match of load size, the 5-county dataset does get fairly close to the Company's 2018 residential load in this regard.

ResStock data are reported separately for five building types: Single-family detached, single-family attached (duplex), mobile home, multi-family (2-4 units), and multi-family (5 or more units). It was decided to limit the analysis to the single-family detached building type. This kept the modeling workload manageable while still accounting for 78.1 percent of ResStock load at the 5-county aggregation level. In addition, the single-family detached building type can be considered a "worst case" given that its load tends to be more weather-sensitive than multi-family building types.

Model Structure and Operation

The model simulates changes in hourly load due to building electrification by converting various building end use load profiles from on-site fuel combustion to electric equipment in response to user inputs. Notable details of the model's basic structure and operation include the following:

- The model is populated with two sets of load profiles from the 5-county aggregation of ResStock data for the single-family detached building type. One set represents pre-conversion baseline conditions; the other set represents the application of enhanced building envelope upgrades which the model applies at the same rate as building electrification (following the assumption that envelope upgrades co-occur with installation of air source heat pumps).
- The user selects an adoption rate from 0.0% to 100.0% for building electrification. The model converts all non-electric end uses including space heating, water heating, cooking, clothes drying, and several others at this rate.
- To convert each non-electric end use, the load profile is adjusted, in proportion to the adoption rate, to actual heating demand using an assumed equipment efficiency. The amount of heating demand to be electrified is then converted to electricity using an algorithm specific to each end use. The space heating algorithm computes air source heat pump coefficient of performance hourly as a function of ambient air temperature. It also simulates backup heating and operation of the defrost mode, as needed. By comparison, the algorithms for water heating and other end uses apply constant efficiencies for conversion to electric.
- Given the prevalence of air conditioning, energy for space cooling is assumed to remain constant with building electrification and is therefore neglected in the model.
- The model sums the separately derived post-conversion end use electricity load profiles to a total electricity hourly profile. The resulting post-conversion total electricity load profile is reported both in aggregate and normalized to the number of households to yield the unit load profile of a representative customer.

EV Charging and On-Site PV Generation Modules

Because building electrification is likely to occur alongside other measures which impact customer load shape, users of the model can also simulate the adoption of EV charging and on-site PV generation, both of which are becoming increasingly popular with utility customers.

To represent EV charging in the model, a representative EV charging profile was constructed using U.S. DOE's EVI-Pro Lite modeling tool. This profile reflects weekday and weekend results for 32, 50 and 68 degrees (Fahrenheit) which were spliced throughout the year based on day of week and average monthly ambient air temperature. The selected EVI-Pro Lite home charging strategy included home charging levels 1 and 2 set at "immediate, as slow as possible (even spread)." The EVI-Pro Lite charging profile was imported into the model where it is multiplied by the number of EVs per household selected by the user. The resulting hourly charging profile is added directly to the post-conversion building electrification profile.

To represent on-site PV generation, an hourly solar generation shape for Detroit was created with NREL's System Advisor Model (SAM) and imported this unit profile shape into the model. The user can set the amount of annual PV production equal to some portion of total annual load from 0.0% to 100.0%. The SAM profile shape is multiplied by this percentage and by the total hourly load profile. The resulting PV generation profile is then subtracted from the total hourly profile to yield a net post-conversion total hourly load profile. This is the model's primary output.

Modeling Distribution Transformer Aging Capacity

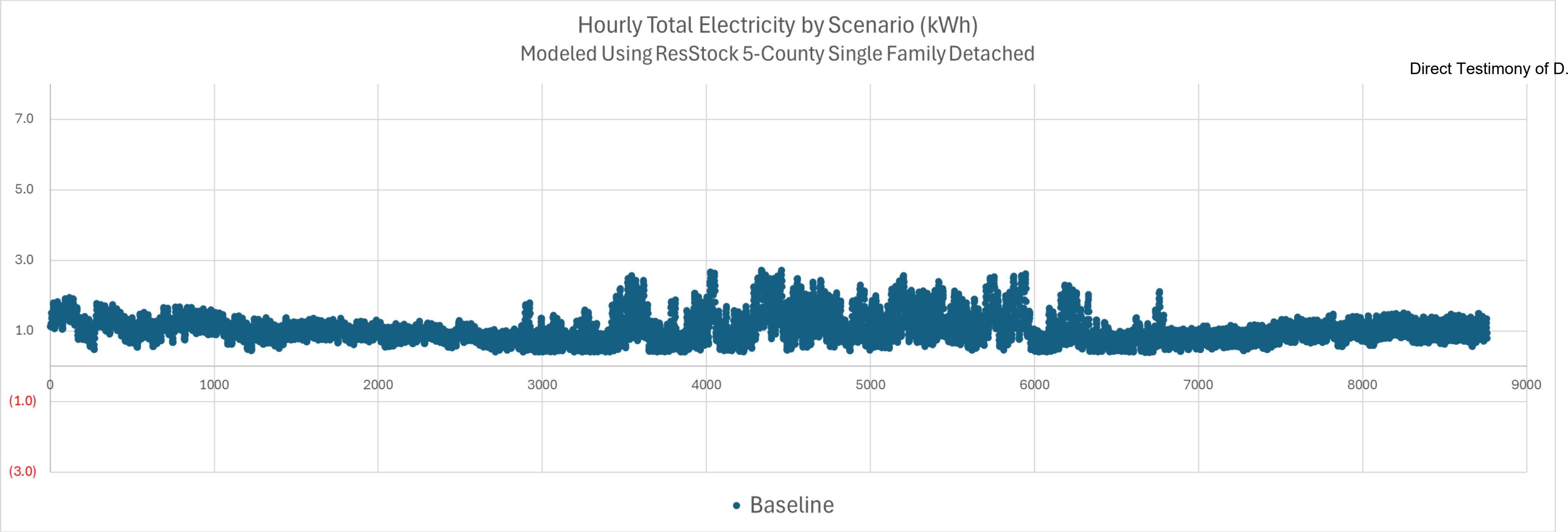
Transformer aging capacity is treated in the model by estimating the maximum allowable customer load in each hour while staying within the existing distribution transformer network's design capacity. To compute this, Witness Graham Woolley calibrated the tool described in his testimony using the ResStock 5-county, single-family detached load profile, normalized to a unit household. He then produced an hourly profile equal to load as a fraction of effective transformer rating. The building electrification model divides this result into the baseline profile to yield the maximum allowable customer load profile mentioned above. Exceeding the maximum allowable customer load profile in any hour has the effect of aging the transformer equipment prematurely.

Adoption Level of Building Electrification Within Existing System Capacity

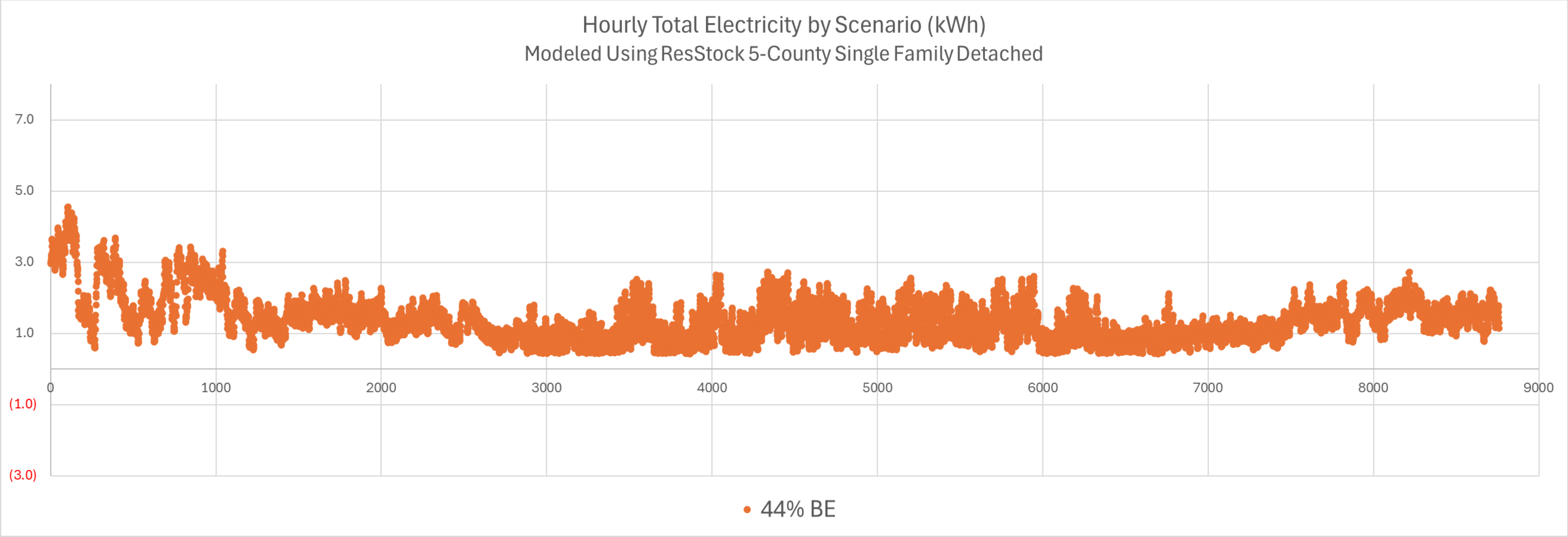
The feature of the model described in the previous section can be used to find the adoption rate of maximum building electrification—expressed as maximum allowable customer load in each hour—within the existing transformer network's design capacity which is sized to a summer peak. As the model user increases building electrification, a level is reached at which the total peak load in winter matches the size of the baseline summer peak. This point is reached at 44.28 percent adoption of building electrification.

The model's ability to accommodate such a high level of building electrification within existing transformer capacity has two drivers. One is the existing gap between summer and winter peaks, providing headroom for the winter value to increase up to the summer value. The second relates to the variable degradation of transformer equipment across a range of ambient temperatures. Lower temperatures seen during winter months permit greater current through a transformer without increasing the aging effect. Both of these factors contribute to the significant amount of building electrification possible within the existing transformer network's capacity.

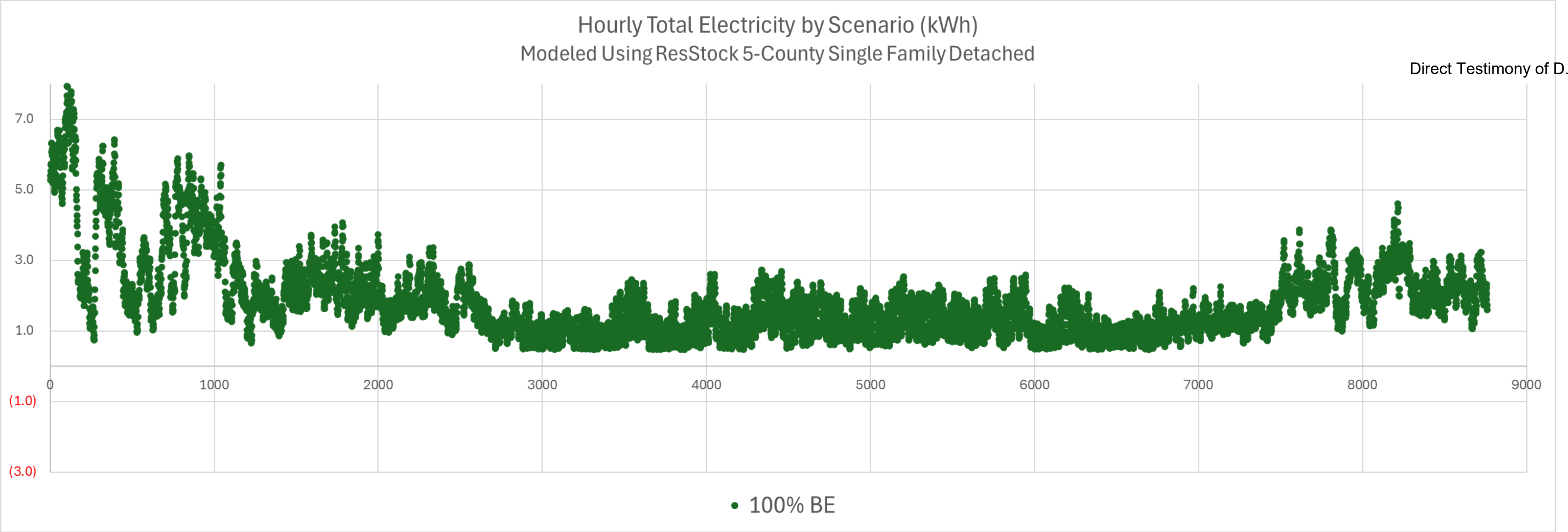
The two decimal places in the 44.28 percent figure should not be misconstrued. This level of precision simply reflects the exact number at which a single parameter (building electrification adoption rate) delivers a winter peak equal to summer peak in the model. There are multiple sources of uncertainty behind this result which must be acknowledged. These include the use of ResStock to represent the Company's residential load, various simplifying assumptions inherent in any modeling exercise of this kind, and the artificial case of adjusting the level of building electrification while holding all else constant. In the real world, 44.28 percent might or might not be fairly accurate. The key conclusion to be drawn is that this figure is significantly above the existing level of electric heating in the Company's service territory so as to warrant further analysis. This calls for the Company to rigorously investigate the ability of its distribution system to handle higher levels of electric heating before significant capacity upgrades might be needed.

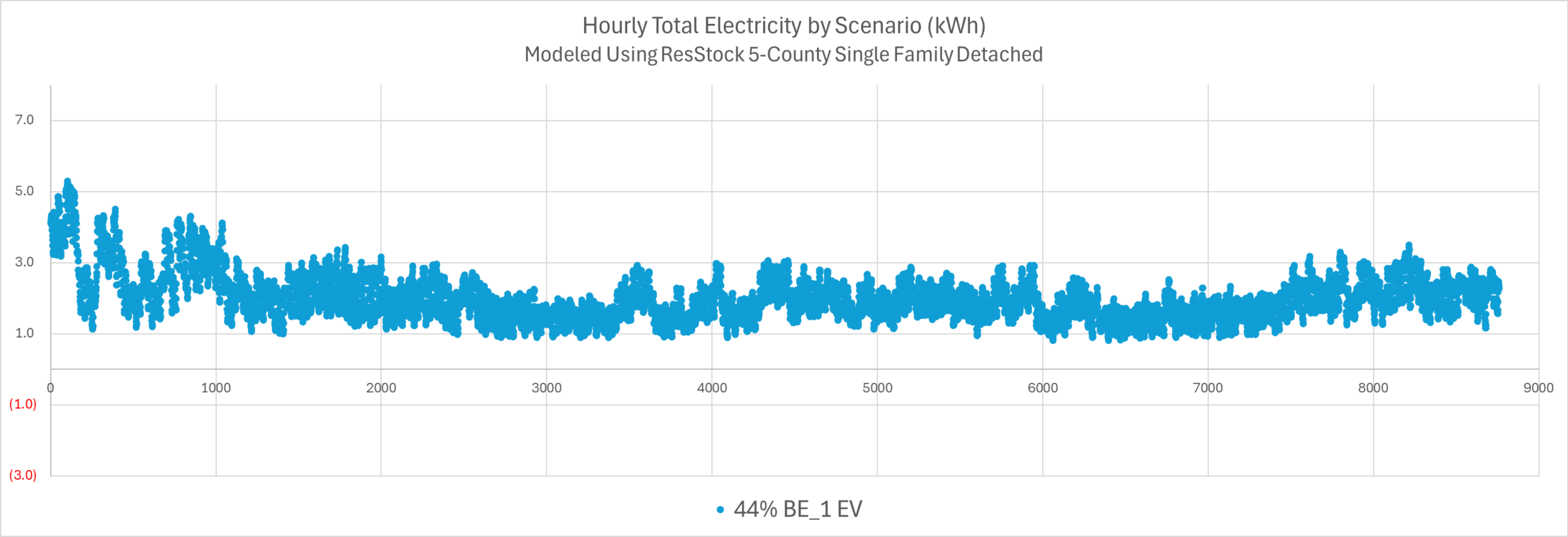


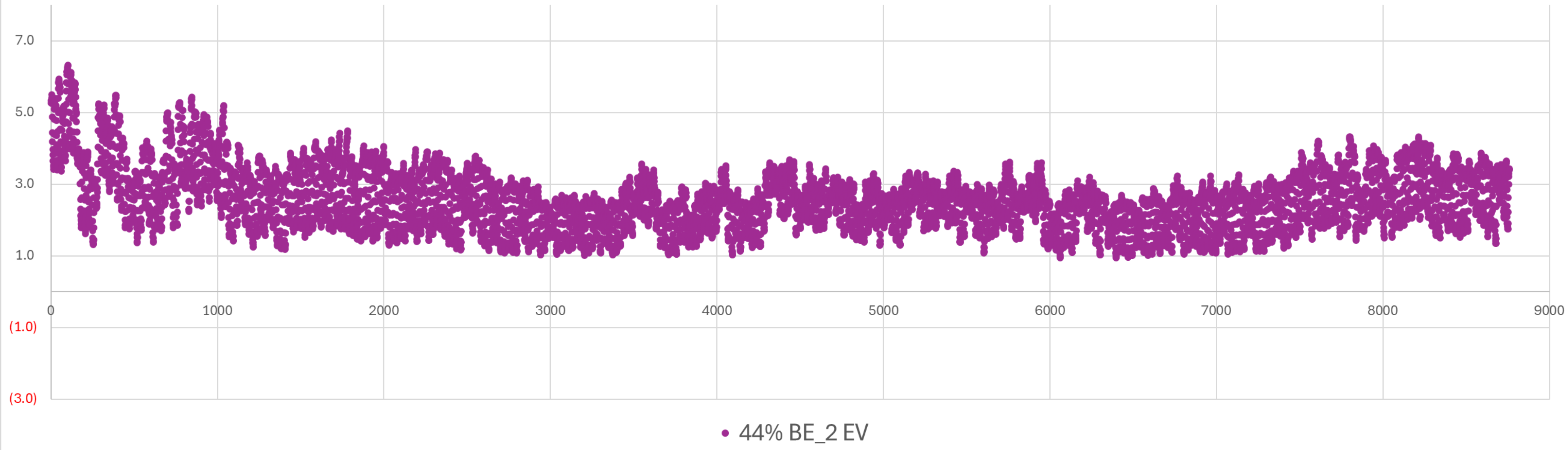
Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached



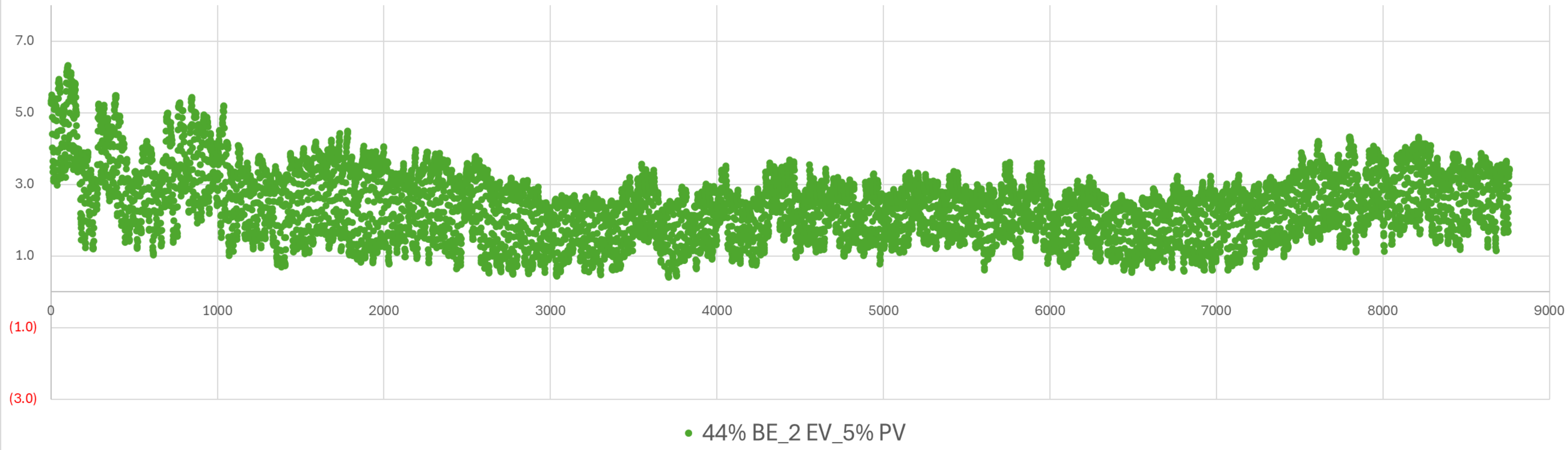
Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached


Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached

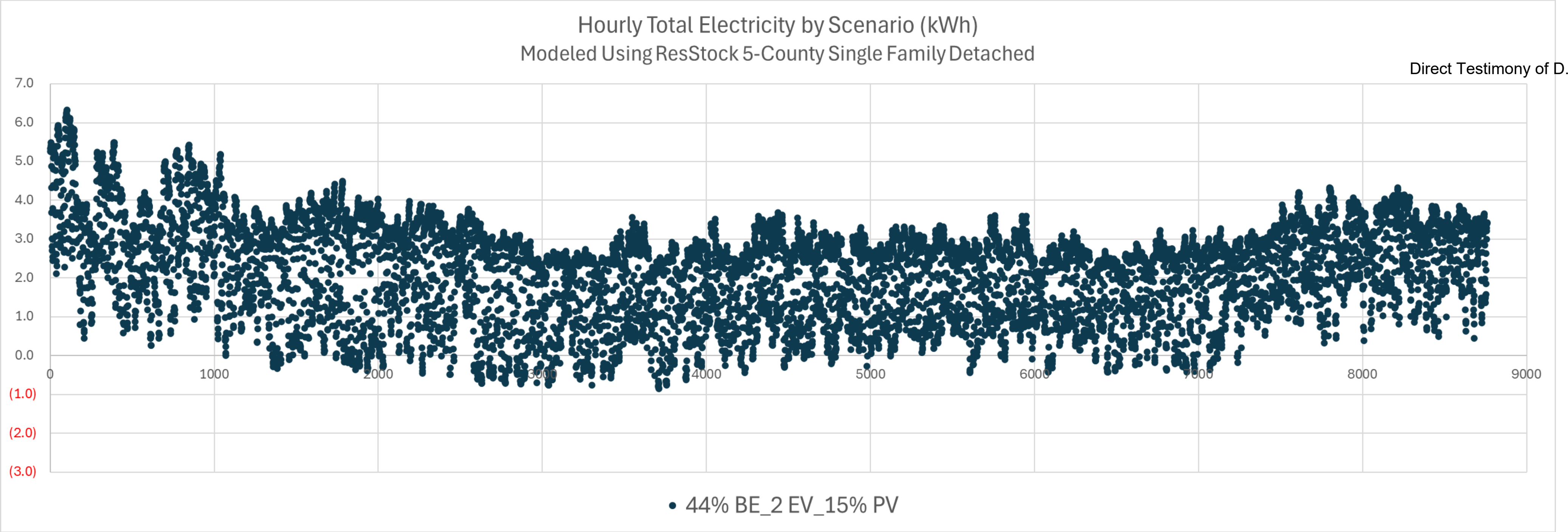

Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached

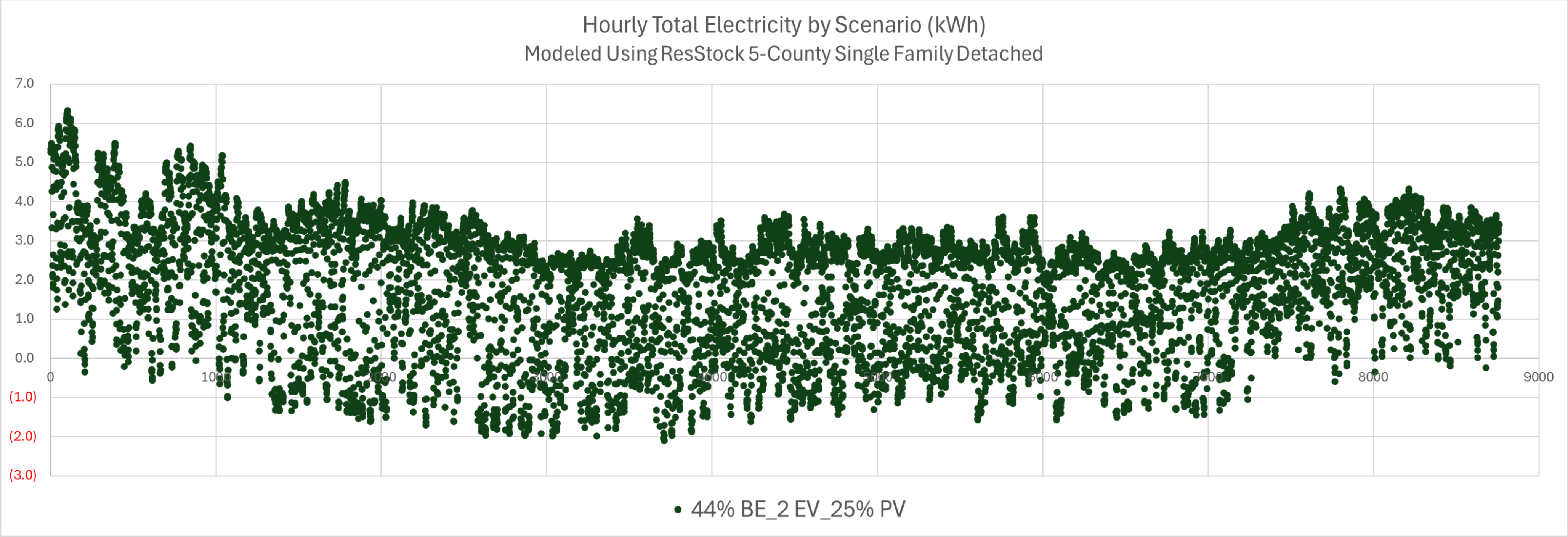


Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached

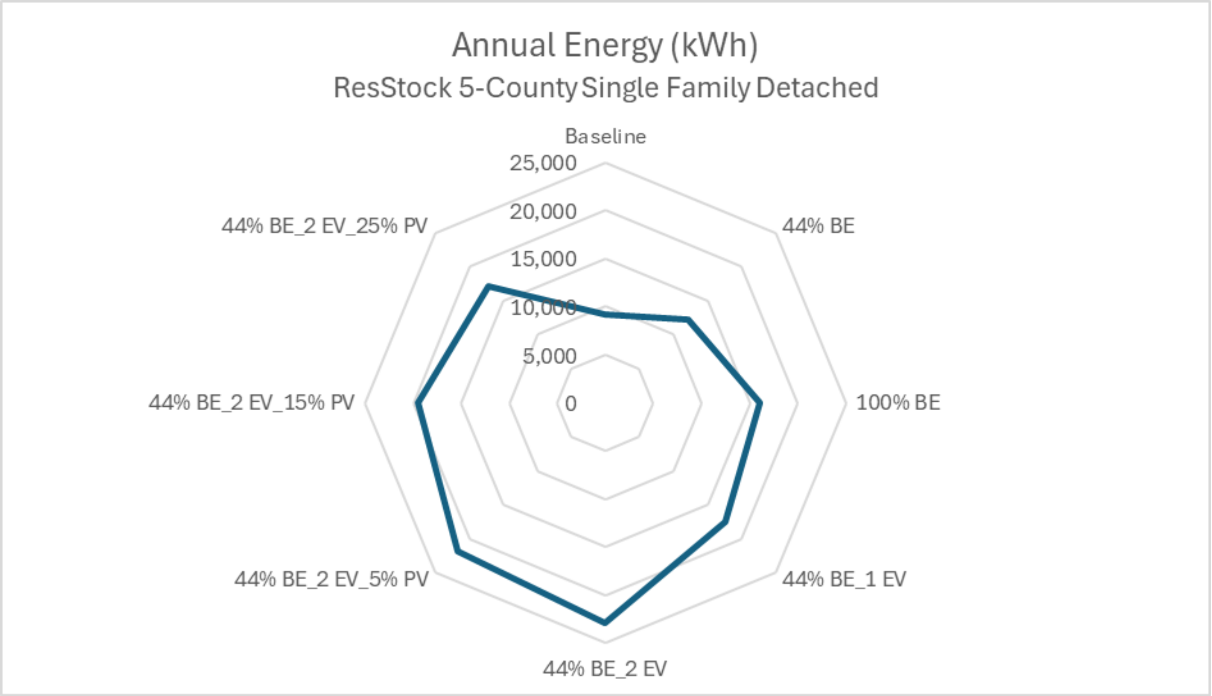


Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached


Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
(1.0)
(2.0)
(3.0)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
● 44% BE_2 EV_15% PV


Hourly Total Electricity by Scenario (kWh)
Modeled Using ResStock 5-County Single Family Detached
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
(1.0)
(2.0)
(3.0)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
● 44% BE_2 EV_25% PV

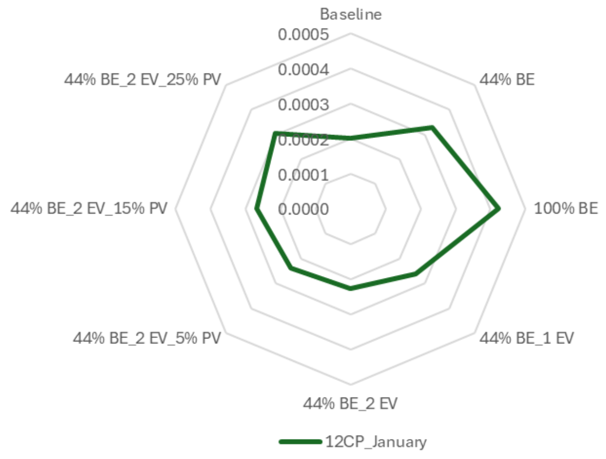
Scenario	Annual Energy (kWh)
Baseline	9,140
44% BE	12,196
100% BE	16,040
44% BE_1 EV	17,581
44% BE_2 EV	22,965
44% BE_2 EV_5% PV	21,817
44% BE_2 EV_15% PV	19,521
44% BE_2 EV_25% PV	17,224



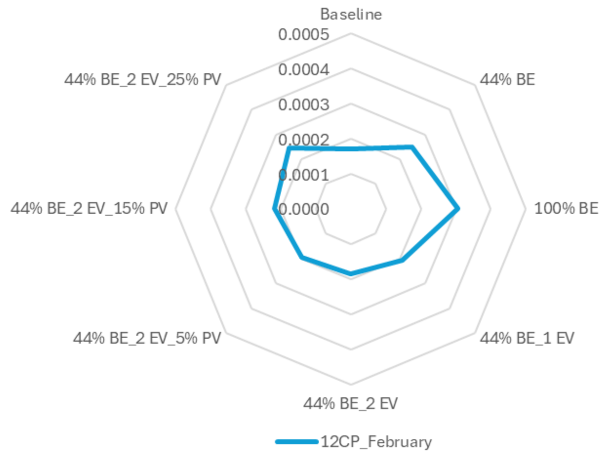
COS Parameter	COS Parameter / Annual Energy							
	Baseline	**44% BE**	**100% BE**	**44% BE_1 EV**	**44% BE_2 EV**	**44% BE_2 EV_5% PV**	**44% BE_2 EV_15% PV**	**44% BE_2 EV_25% PV**
1CP	0.00029	0.00021	0.00016	0.00016	0.00014	0.00013	0.00010	0.00008
4CP	0.00029	0.00021	0.00016	0.00016	0.00014	0.00013	0.00010	0.00007
12CP_January	0.00020	0.00033	0.00042	0.00026	0.00023	0.00024	0.00027	0.00030
12CP_February	0.00017	0.00025	0.00030	0.00021	0.00019	0.00020	0.00022	0.00025
12CP_March	0.00015	0.00016	0.00018	0.00016	0.00015	0.00016	0.00018	0.00020
12CP_April	0.00011	0.00012	0.00012	0.00009	0.00008	0.00008	0.00007	0.00006
12CP_May	0.00026	0.00019	0.00014	0.00015	0.00013	0.00011	0.00007	0.00001
12CP_June	0.00029	0.00021	0.00016	0.00016	0.00014	0.00013	0.00010	0.00008
12CP_July	0.00030	0.00022	0.00017	0.00017	0.00014	0.00013	0.00010	0.00007
12CP_August	0.00028	0.00020	0.00015	0.00016	0.00014	0.00013	0.00011	0.00007
12CP_September	0.00029	0.00021	0.00016	0.00016	0.00014	0.00013	0.00010	0.00006
12CP_October	0.00023	0.00017	0.00013	0.00014	0.00012	0.00011	0.00008	0.00005
12CP_November	0.00015	0.00018	0.00021	0.00015	0.00014	0.00014	0.00016	0.00018
12CP_December	0.00015	0.00018	0.00019	0.00015	0.00013	0.00014	0.00016	0.00018

COS Parameter	COS Parameter / Annual Energy							
	Baseline	**44% BE**	**100% BE**	**44% BE_1 EV**	**44% BE_2 EV**	**44% BE_2 EV_5% PV**	**44% BE_2 EV_15% PV**	**44% BE_2 EV_25% PV**
1NCP	0.00030	0.00022	0.00017	0.00017	0.00015	0.00015	0.00014	0.00013
4NCP	0.00029	0.00021	0.00016	0.00017	0.00015	0.00014	0.00012	0.00010
12NCP_January	0.00019	0.00029	0.00037	0.00024	0.00021	0.00022	0.00025	0.00028
12NCP_February	0.00017	0.00024	0.00029	0.00019	0.00017	0.00018	0.00020	0.00023
12NCP_March	0.00015	0.00016	0.00017	0.00015	0.00015	0.00016	0.00018	0.00020
12NCP_April	0.00014	0.00015	0.00016	0.00014	0.00014	0.00015	0.00016	0.00018
12NCP_May	0.00027	0.00020	0.00015	0.00017	0.00015	0.00015	0.00014	0.00013
12NCP_June	0.00029	0.00022	0.00016	0.00017	0.00015	0.00014	0.00012	0.00010
12NCP_July	0.00030	0.00022	0.00017	0.00017	0.00015	0.00015	0.00014	0.00013
12NCP_August	0.00028	0.00021	0.00016	0.00016	0.00014	0.00013	0.00011	0.00008
12NCP_September	0.00028	0.00021	0.00016	0.00017	0.00014	0.00013	0.00011	0.00008
12NCP_October	0.00020	0.00015	0.00012	0.00014	0.00014	0.00014	0.00016	0.00018
12NCP_November	0.00013	0.00018	0.00021	0.00013	0.00011	0.00011	0.00012	0.00013
12NCP_December	0.00016	0.00017	0.00018	0.00015	0.00014	0.00015	0.00017	0.00019

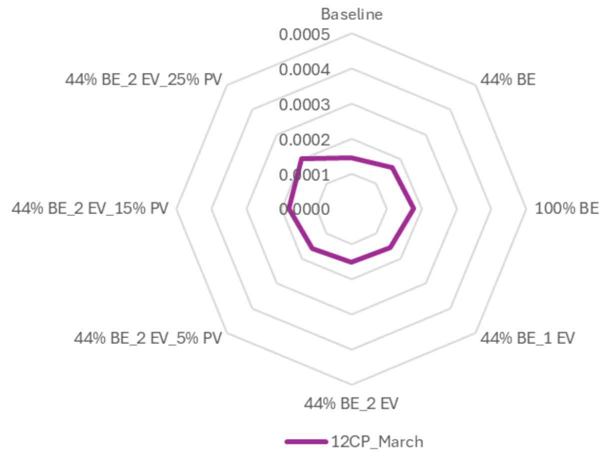
DTE CP Metrics / Annual Energy (by Scenario)



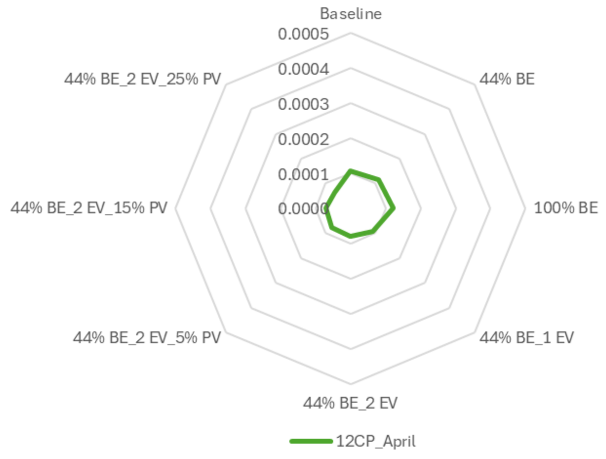
DTE CP Metrics / Annual Energy (by Scenario)



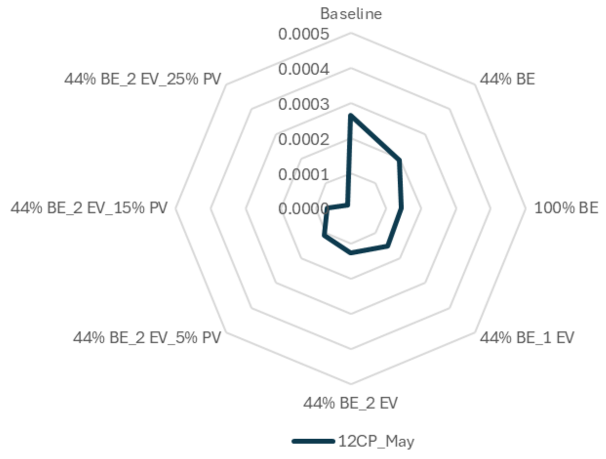
DTE CP Metrics / Annual Energy (by Scenario)



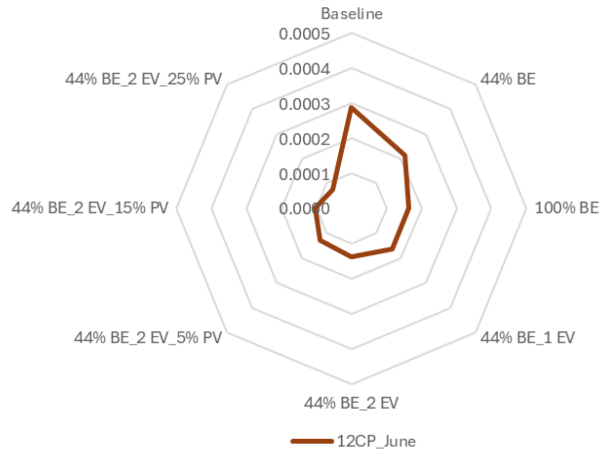
DTE CP Metrics / Annual Energy (by Scenario)

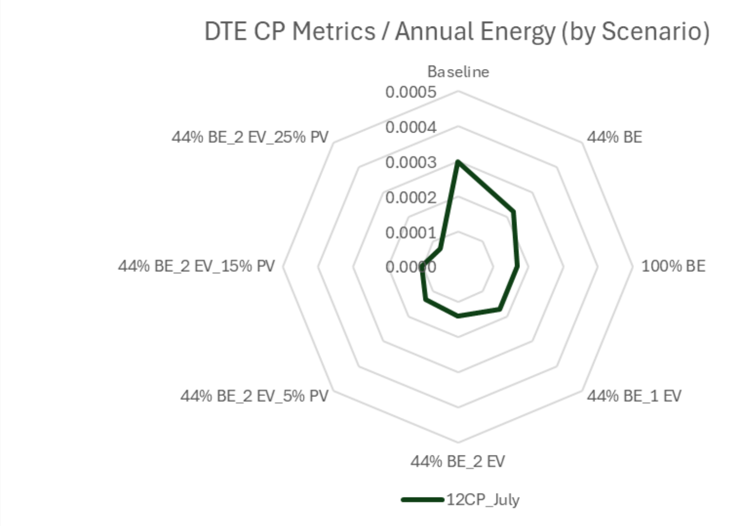


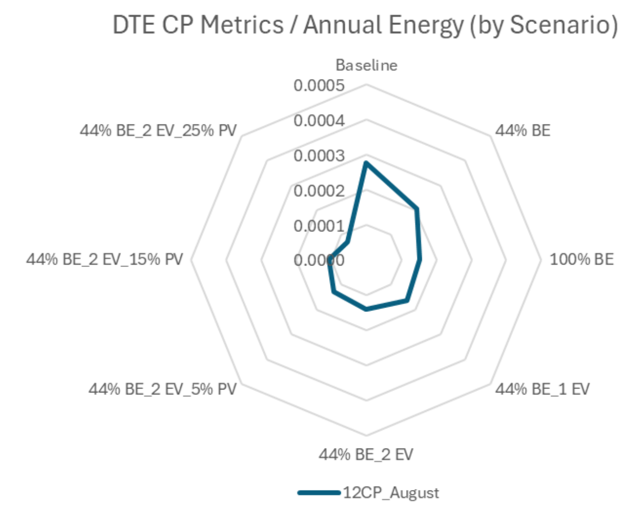
DTE CP Metrics / Annual Energy (by Scenario)

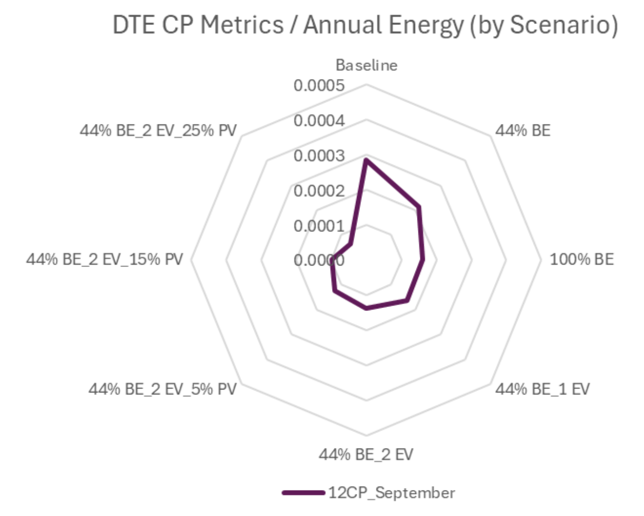


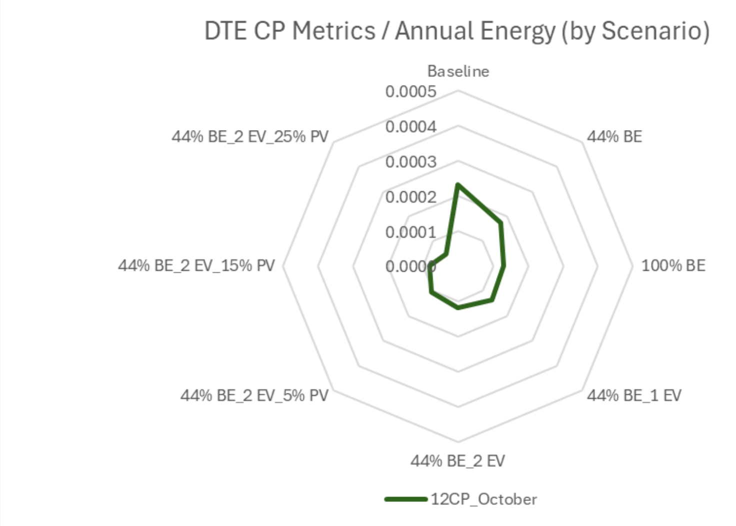
DTE CP Metrics / Annual Energy (by Scenario)




DTE CP Metrics / Annual Energy (by Scenario)


DTE CP Metrics / Annual Energy (by Scenario)


DTE CP Metrics / Annual Energy (by Scenario)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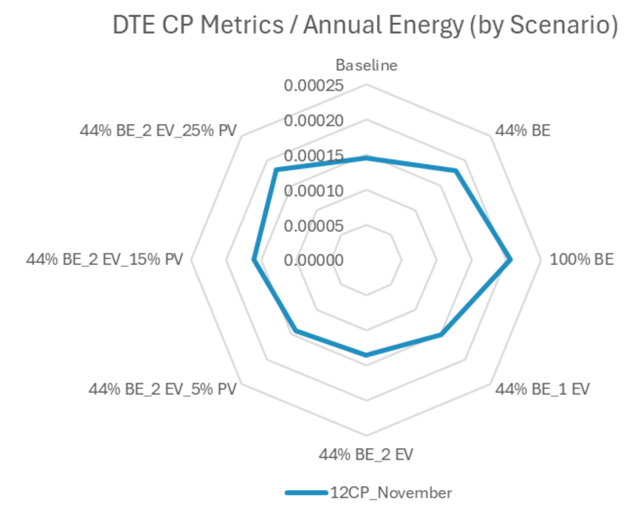
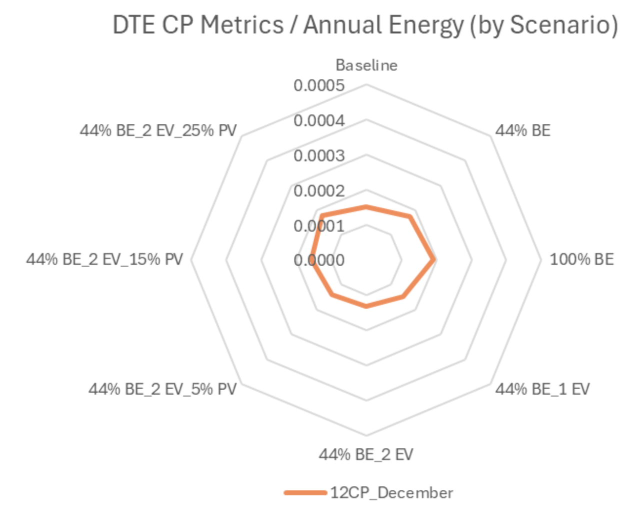
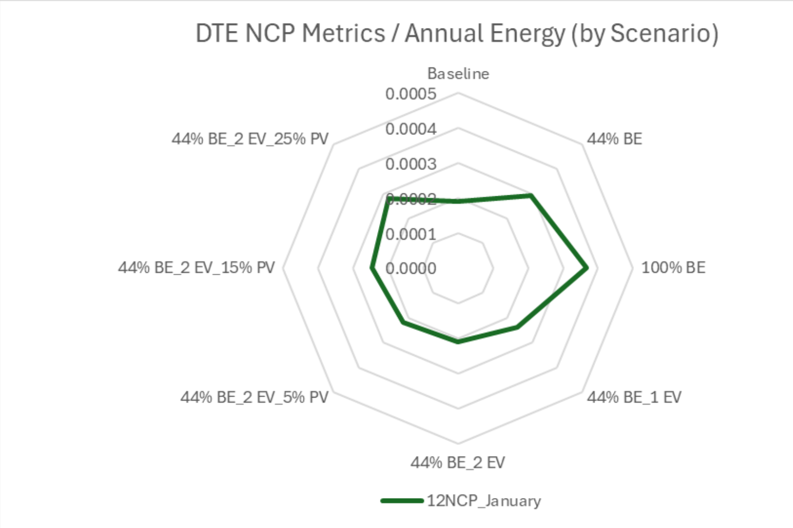
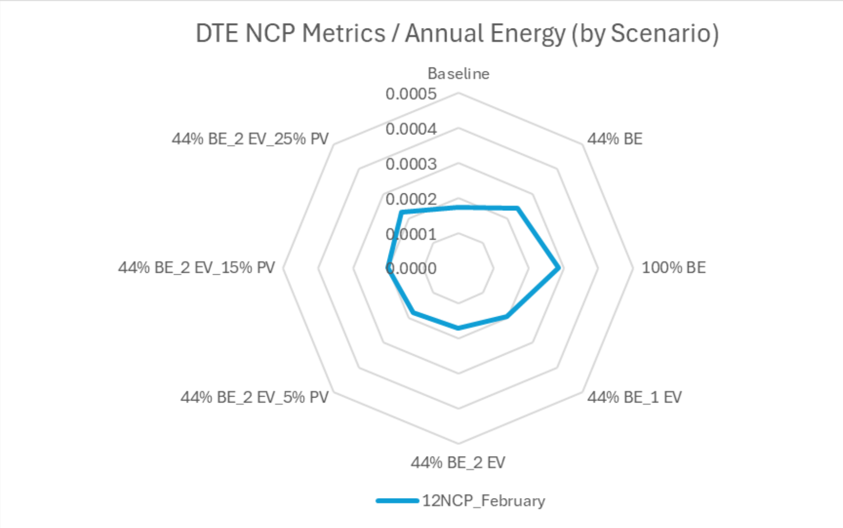
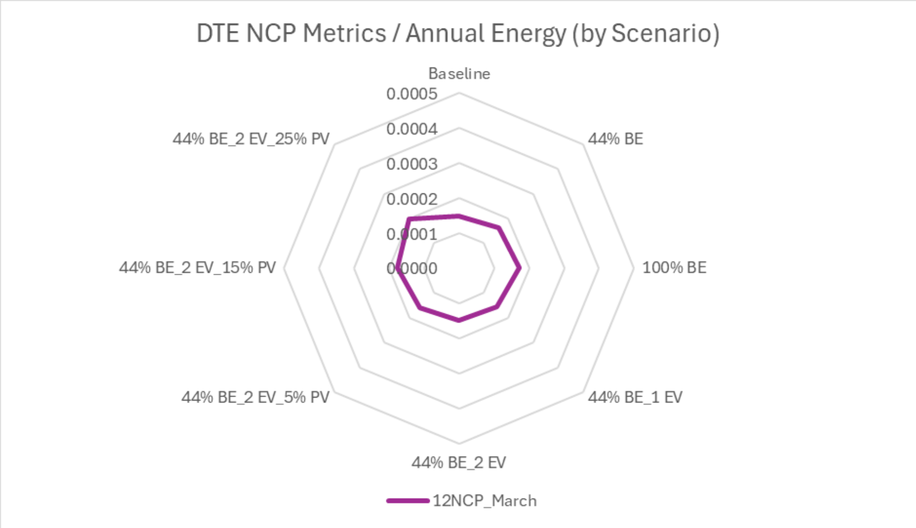

DTE CP Metrics / Annual Energy (by Scenario)

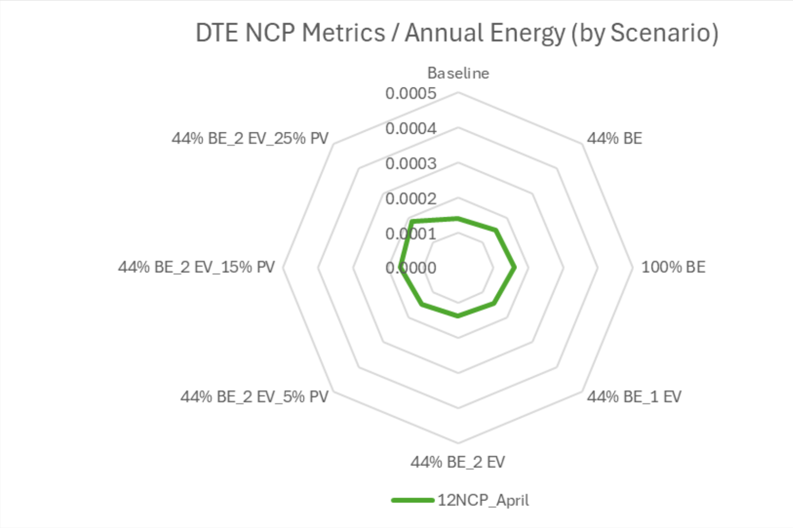

DTE CP Metrics / Annual Energy (by Scenario)

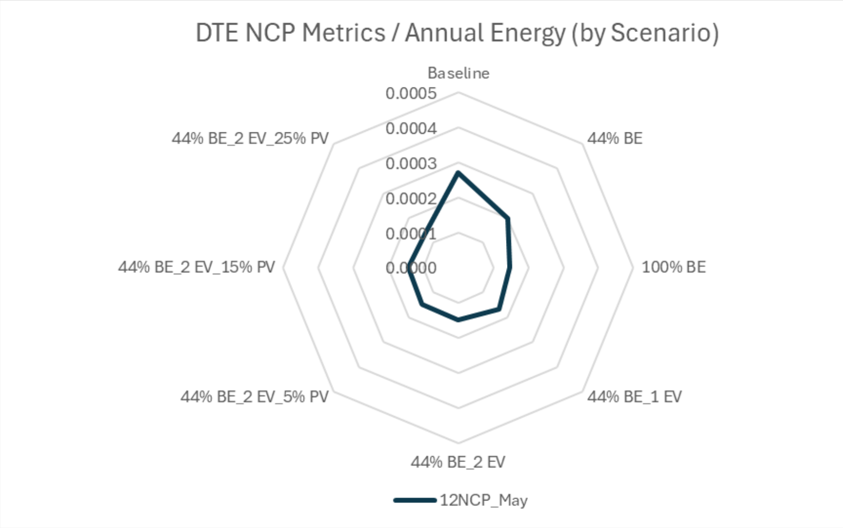
U-21534 | July 26, 2024
Direct Testimony of D. Gard obo CUB, MEC & NRDC
Ex CUB-29 | Source: D. Gard
Page 1 of 2

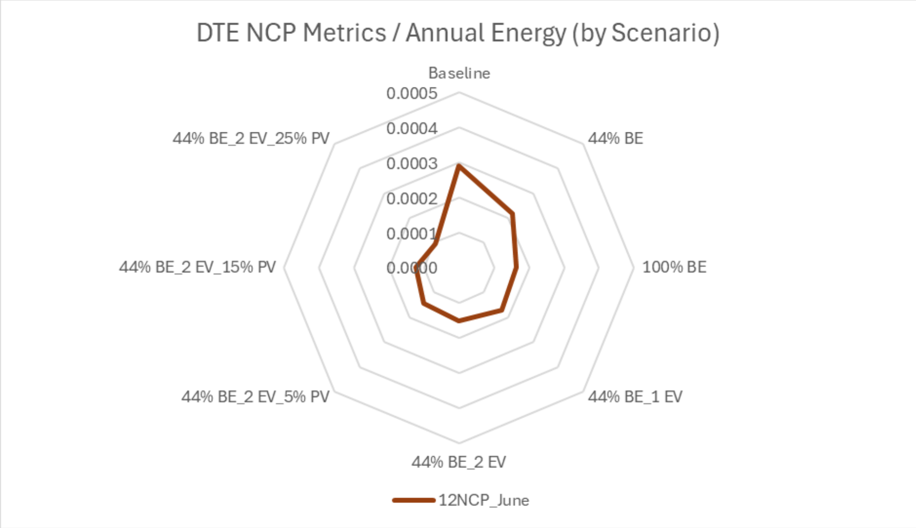


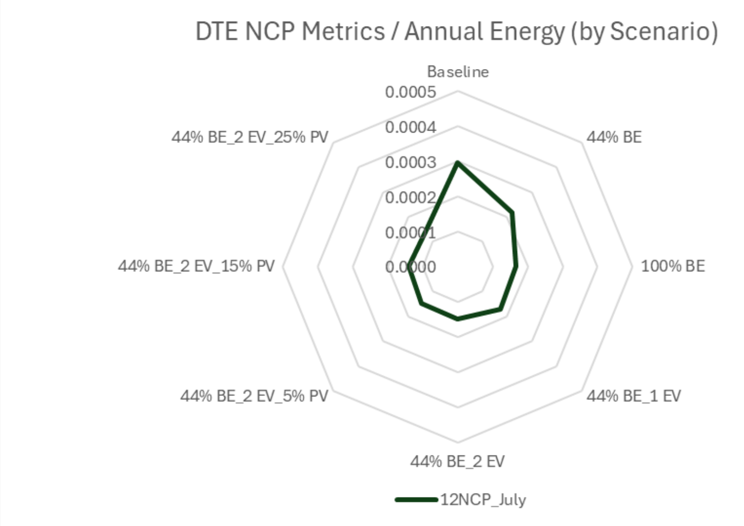


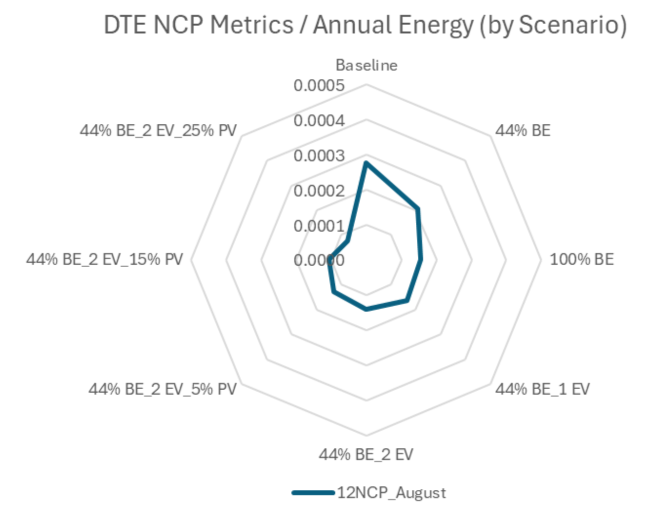


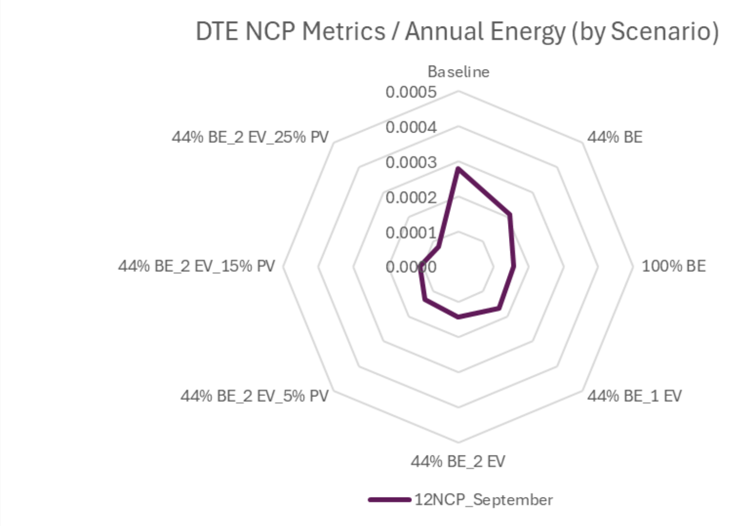


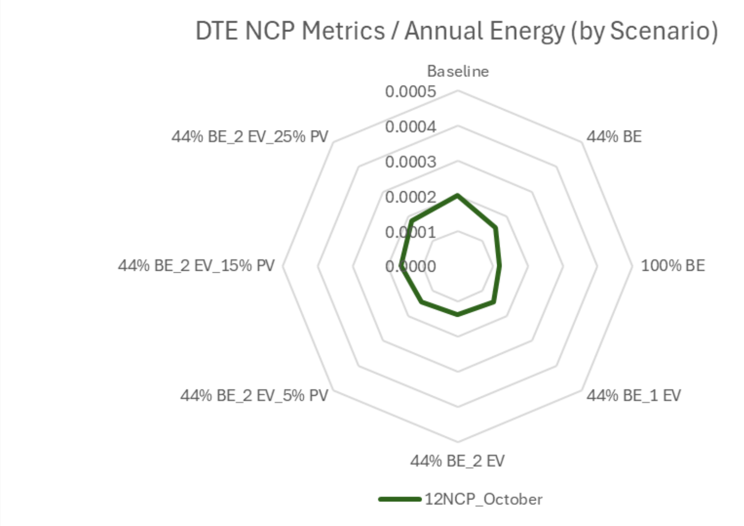


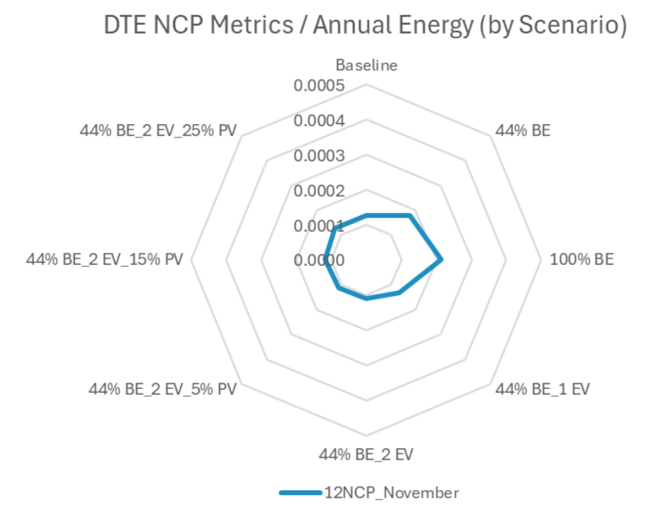


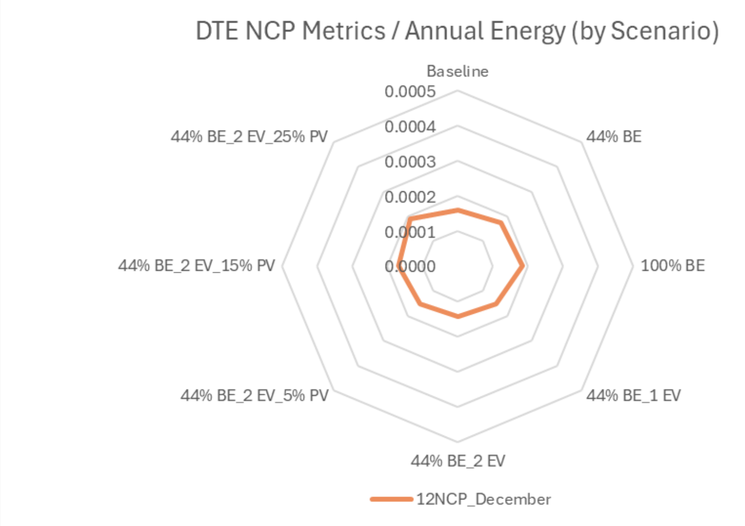

DTE NCP Metrics / Annual Energy (by Scenario)
Baseline
44% BE
100% BE
44% BE_1 EV
44% BE_2 EV
44% BE_2 EV_5% PV
44% BE_2 EV_15% PV
44% BE_2 EV_25% PV
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
12NCP_July


DTE NCP Metrics / Annual Energy (by Scenario)
Baseline
44% BE
100% BE
44% BE_1 EV
44% BE_2 EV
44% BE_2 EV_5% PV
44% BE_2 EV_15% PV
44% BE_2 EV_25% PV
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
12NCP_August


DTE NCP Metrics / Annual Energy (by Scenario)
Baseline
44% BE
100% BE
44% BE_1 EV
44% BE_2 EV
44% BE_2 EV_5% PV
44% BE_2 EV_15% PV
44% BE_2 EV_25% PV
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
12NCP_September


DTE NCP Metrics / Annual Energy (by Scenario)
Baseline
44% BE
100% BE
44% BE_1 EV
44% BE_2 EV
44% BE_2 EV_5% PV
44% BE_2 EV_15% PV
44% BE_2 EV_25% PV
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
12NCP_October


DTE NCP Metrics / Annual Energy (by Scenario)
Baseline
44% BE
100% BE
44% BE_1 EV
44% BE_2 EV
44% BE_2 EV_5% PV
44% BE_2 EV_15% PV
44% BE_2 EV_25% PV
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
12NCP_November


DTE NCP Metrics / Annual Energy (by Scenario)
Baseline
44% BE
100% BE
44% BE_1 EV
44% BE_2 EV
44% BE_2 EV_5% PV
44% BE_2 EV_15% PV
44% BE_2 EV_25% PV
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
12NCP_December

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

Proof of Service

On the date below, an electronic copy of **Direct Testimony and Exhibits of David L. Gard on behalf of Citizens Utility Board of Michigan, Michigan Environmental Council, and Natural Resources Defense Council (Exhibits CUB-20 through CUB-29)** was served on the following:

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{signature on following page}

The statements above are true to the best of my knowledge, information and belief.

Troposphere Legal, PLC
Counsel for MEC, NRDC, SC & CUB

Digitally signed by Breanna Thomas
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Date: July 25, 2024 By: ______________________

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