MICHIGAN TIER 3 THERMOSTAT EXPLORATORY RESEARCH: DEMOGRAPHIC DISTRIBUTION EVALUABILITY ASSESSMENT AND RESEARCH FINDINGS

EWR COLLABORATIVE PRESENTATION

MARCH 19, 2019

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BACKGROUND AND CONTEXT

DTE Energy and Consumers Energy identified the following two study areas for the Tier 3 Thermostats Exploratory Research Study:

Demographic Distribution

- Using demographic data (1) assess statistical differences between participants and the matched control group, and (2) describe the characteristics of Tier 3 thermostat participants in MI
- Understand whether there are differences in Tier 3 thermostat participants in MI relative to manufacturer's general population
  - This research was discontinued as needed vendor data did not exist

➢ *Informs whether an alternate matching approach should be tested*

Savings Potential

- Estimate electric HVAC load using AMI data and develop a range of electric savings estimates based on possible electric saving values
- Estimate gas HVAC load using monthly billing data and develop a range of gas savings estimates using a similar approach
- Utilize vendor-provided data as a check on the reasonableness of estimated loads
  - With utilities, assess potential measure cost-effectiveness

➢ *Informs the potential for energy savings from Tier 3 thermostats*

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BACKGROUND AND CONTEXT

Navigant worked with DTE and CE during October and November to understand what data was available, modifying scope as needed.

Exploratory Analysis	Original Scope	Modified Scope	Reason
Demographic Distribution	Customer segmentation data and a range of demographic variables for both 2016 and 2017 participants	Age and income for 2016 participants that served as treatment and matched controls in Navigant's 2018 Tier 3 Thermostat Calibration study; Age and income for all 2017 Tier 3 thermostat participants	Lack of confidence in segmentation data; Agreement that age and income are good proxies for other demographics; Lack of confidence that other demographic variables would match well between the two utilities
Savings Potential	Electric AMI and gas billing data for 2016 and 2017 thermostat participants.	Electric AMI and gas billing data for 2017 Tier 3 thermostat participants	Limited availability of AMI data prior to 2016, and better confidence in the completeness of the 2017 participant list relative to prior years; 2017 being most reflective of a current participant

BACKGROUND AND CONTEXT

To accomplish the demographic research objectives, Navigant coordinated with DTE Energy and Consumers Energy according to the following work plan.

Evaluation Activity	Brief Description
Assessment of Evaluability	Work with DTE Energy and Consumers Energy to identify completeness and quality of demographic data for Tier 3 thermostat participants and matched control customers, and alignment on demographic characteristics and/or customer segments across utilities. Ensure sufficient sample sizes and representativeness of program population.
Data Management	• Collect, merge, clean and otherwise prepare demographic data for analysis.
Analysis	• Analyze the data to identify whether there are statistically significant differences in demographic characteristics across groups. • Analyze demographics of the typical MI thermostat adopter and whether these differ from those provided by manufacturers.

BACKGROUND AND CONTEXT

Navigant conducted demographic distribution evaluability assessment and analysis in December and January, and incorporated feedback.

- Navigant obtained both direct age and income data from the utilities, as well as age and income data derived from Mosaic segmentation data Navigant had in its possession for DTE.

- Mosaic-derived age and income data, and Oxxford age and income provided directly by DTE, were not well-aligned—hence Navigant proceeded with the Oxxford age and income data for comparison with CE-provided age and income variables.

- Vendors Nest and ecobee researched the data they had available and found that their firms do not collect applicable age and income data to use in this analysis, and so the third step of comparing results against vendor-provided data from MI and other jurisdictions was not undertaken.

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EVALUABILITY ASSESSMENT—TYPICAL MI TIER 3 THERMOSTAT PARTICIPANT

The data provided by both utilities for characterizing the typical 2017 Michigan thermostat participant was similarly complete.

Table 1. Data Completeness—DTE and CE 2017 Thermostat Participants

Utility	Percent Complete	Data Category	Number Missing	Number Customers
CE	93%	Age	808	11,329
CE	93%	Income	808	11,329
DTE	83%	Age	3,718	22,513
DTE	100%	Income	90	22,513

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EVALUABILITY ASSESSMENT—MI TIER 3 THERMOSTAT CALIBRATION STUDY COMPARISON GROUPS

Demographic data provided for the treatment and matched control customers (2016 participants) in Navigant's Calibration Study was sufficiently complete.

Table 2. Data Completeness—CE Calibration Study Treatment and Control Groups

Installer	Percent Complete	Utility	Service	Data Category	Number Missing	Number of Customers
Control	94%	CMS	Electric	Age	78	1,296
Treatment	93%	CMS	Electric	Age	98	1,315
Control	94%	CMS	Electric	Income	78	1,296
Treatment	93%	CMS	Electric	Income	98	1,315
Control	95%	CMS	Gas	Age	86	1,665
Treatment	93%	CMS	Gas	Age	113	1,712
Control	95%	CMS	Gas	Income	86	1,665
Treatment	93%	CMS	Gas	Income	113	1,712

Table 3. Data Completeness—DTE Calibration Study Treatment and Control Groups

Installer	Percent Complete	Utility	Service	Data Category	Number Missing	Number of Customers
Control	91%	DTE	Electric	Age	268	3,137
Treatment	90%	DTE	Electric	Age	304	3,151
Control	99%	DTE	Electric	Income	25	3,137
Treatment	100%	DTE	Electric	Income	9	3,151
Control	90%	DTE	Gas	Age	190	1,972
Treatment	89%	DTE	Gas	Age	218	1,985
Control	99%	DTE	Gas	Income	10	1,972
Treatment	100%	DTE	Gas	Income	4	1,985

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TYPICAL MI TIER 3 THERMOSTAT PARTICIPANT—DTE & CE

- Cross-tabulating age and income for CE participants reveals 30 to 45 year-olds with moderate incomes are the most common (12% of participants) followed by the same age group with high incomes (10%).
- Cross-tabulating age and income for DTE participants reveals 30 to 45 year-olds with high incomes are the most common (8% of participants) followed by the same age group with relatively low incomes (7%).

Figure 1. Combined Age and Income Distribution—DTE & CE Participants

Note: Sample sizes are as follows: CE n = 11,329; DTE n = 22,513.

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TREATMENT VS MATCHED CONTROL COMPARISON—OVERVIEW

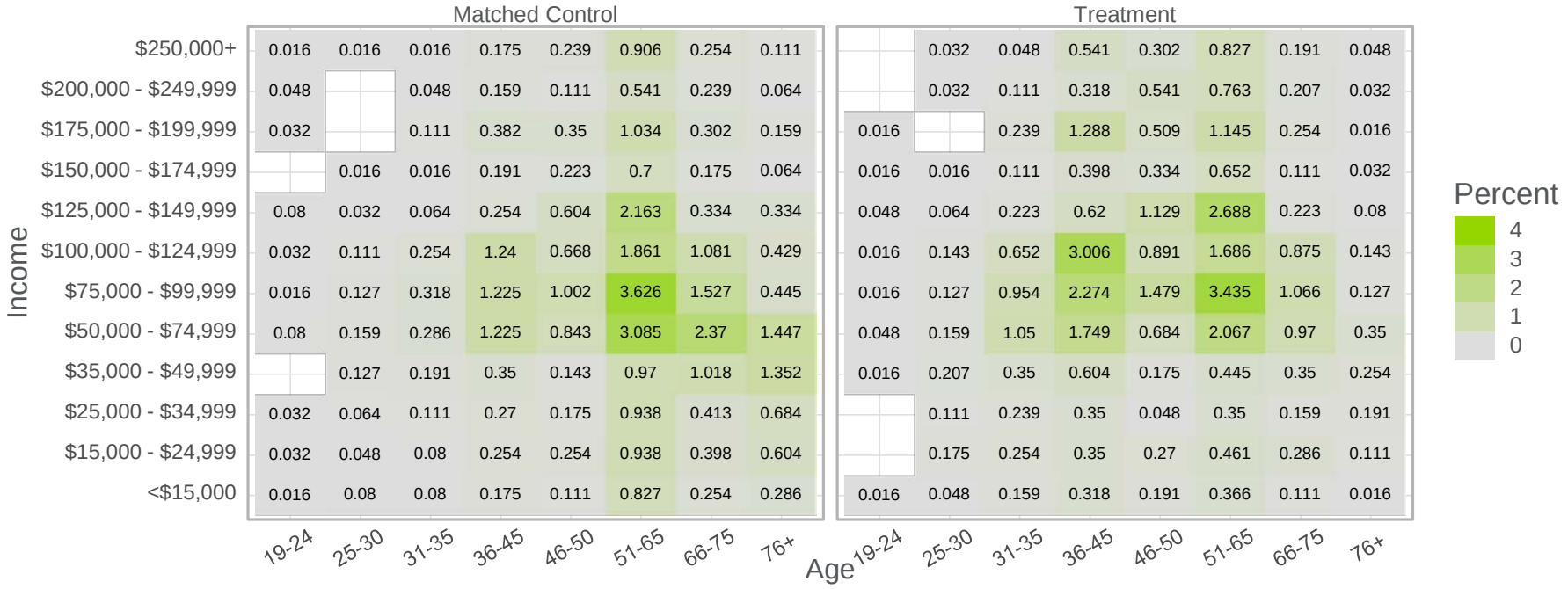
Matching based on past energy usage balanced age and income covariates fairly well, but statistically significant differences were evident in many cases.

- Treatment groups are generally younger and wealthier relative to controls.
- Overall distributions of age and income between treatment and control groups are typically *similar*, particularly for DTE. However, *in every case they are statistically significantly different* at the $p < 0.05$ level.
- For both DTE and CE's gas and electric regression treatment and control groups, many age and income bins are statistically significantly different at the $p < 0.05$ level.
- In several cases, particularly several age brackets for CE, there are *differences of notable magnitude.*
- Differences in demographic characteristics between treatment and control customers is not an issue directly. The regression model controls for these differences.

TREATMENT VS MATCHED CONTROL COMPARISON—DTE ELECTRIC CUSTOMERS, AGE AND INCOME

Cross-tabulating age and income for treatment and matched control groups within the DTE electric regression shows qualitatively similar groupings.

Figure 2. Treatment vs. Matched Control Comparison—DTE Electric



Note: Sample size = 6,288.

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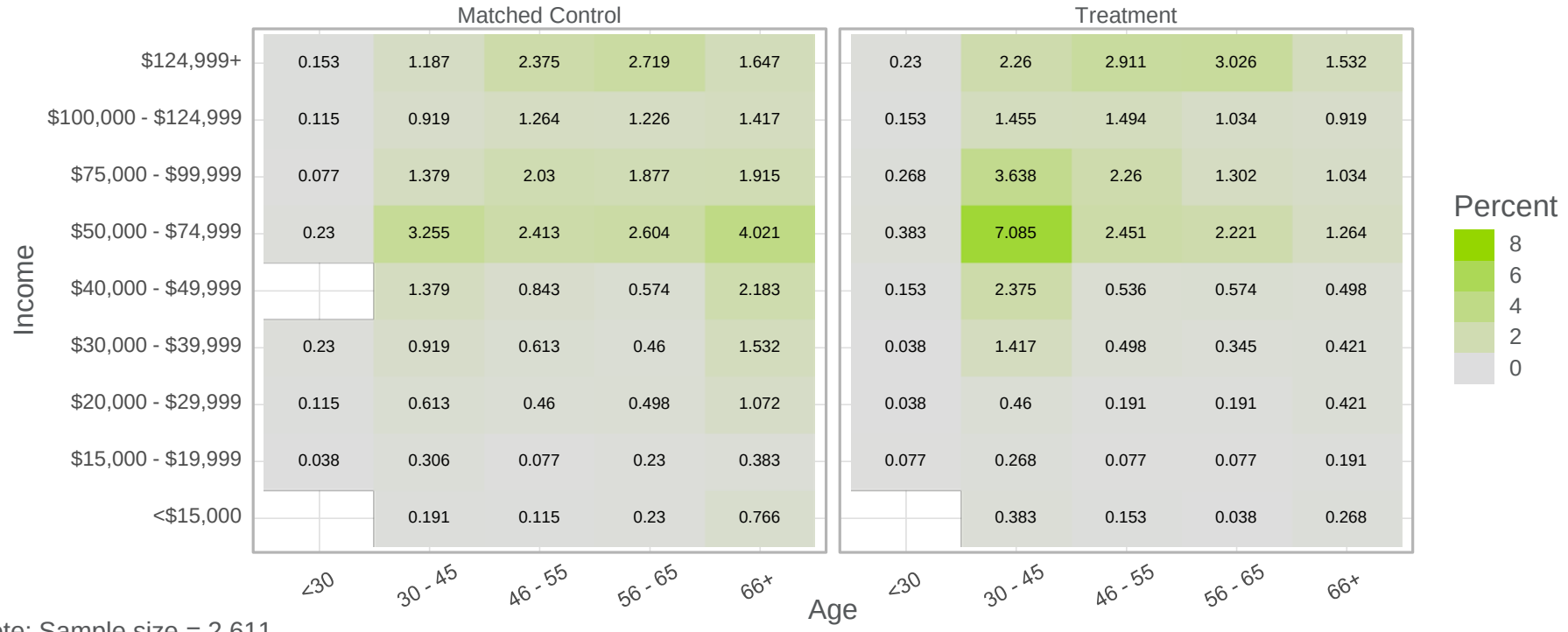
TREATMENT VS MATCHED CONTROL COMPARISON—CE ELECTRIC CUSTOMERS, AGE AND INCOME

Age and income are more tightly concentrated in a few age/income bins within the CE electric regression treatment group compared to the control group.

Figure 3. Treatment vs. Matched Control Comparison—CE Electric



Note: Sample size = 2,611.

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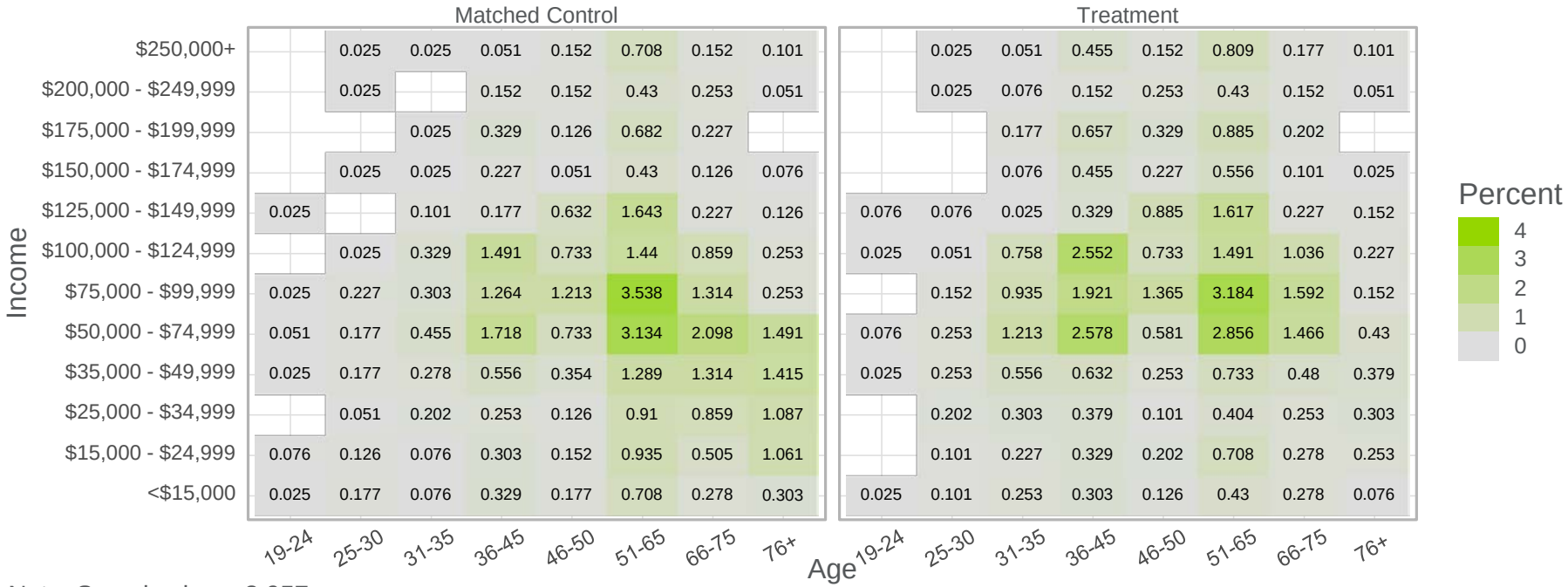
TREATMENT VS MATCHED CONTROL COMPARISON—DTE GAS CUSTOMERS, AGE AND INCOME

Cross-tabulating age and income for treatment and matched control groups within the DTE gas regression shows qualitatively similar groupings.

Figure 4. Treatment vs. Matched Control Comparison—DTE Gas



Note: Sample size = 3,957.

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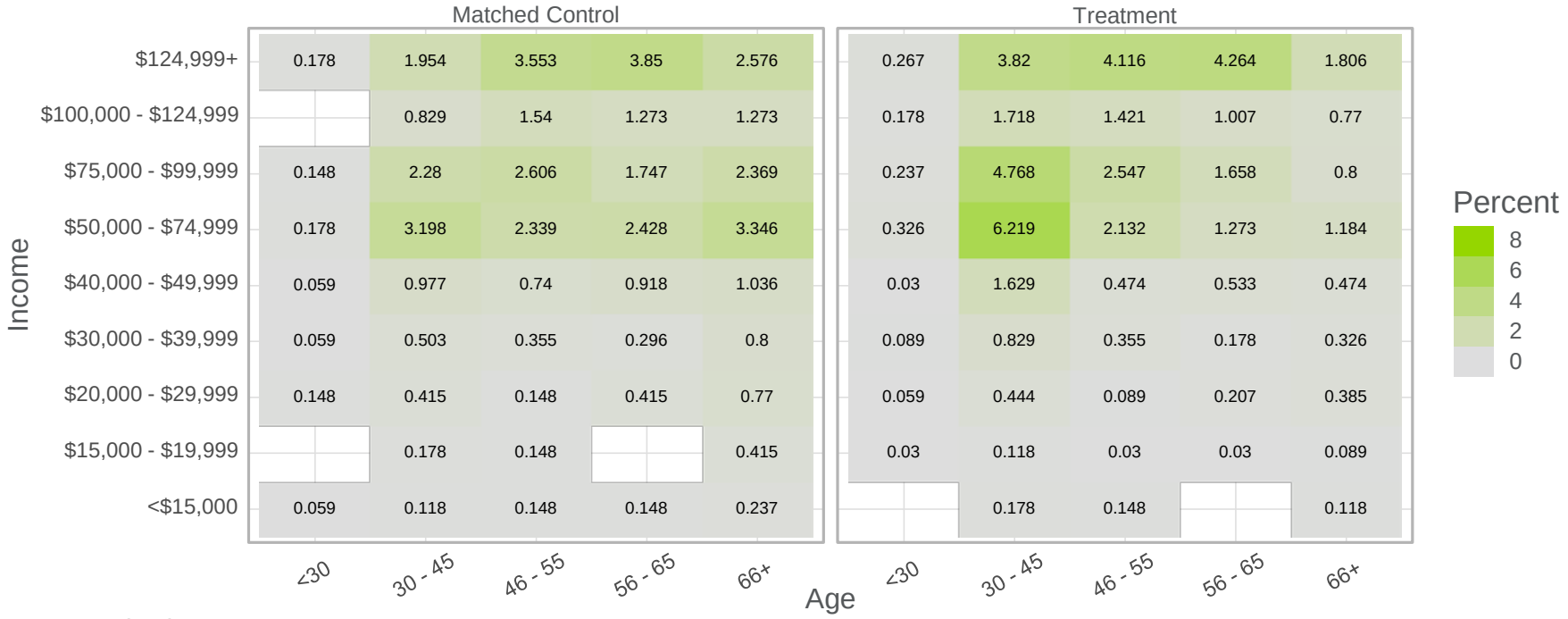
TREATMENT VS MATCHED CONTROL COMPARISON—CE GAS CUSTOMERS, AGE AND INCOME

Age and income are more tightly concentrated in a few age/income bins within the CE gas regression treatment group compared with the control group.

Figure 5. Treatment vs. Matched Control Comparison—CE Gas



Note: Sample size = 3,377.

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CONCLUSIONS

- 30 to 45 year-olds with moderate to high incomes are the largest group of typical Tier 3 thermostat adopters in 2017 for both DTE and CE.

- Euclidean distance matching on past energy usage balances treatment and control group age and income covariates well in many cases, though notable exceptions are evident, particularly in age. Calibration study treatment customers were likely to be younger and wealthier relative to controls.

- Differences between the treatment and control groups in demographic characteristics are largely controlled by the regression model. In other words, the regression analysis controls for differences in demographic characteristics between the two groups.

- Overall, results suggest further research is needed to understand the role of covariates such as income and age in predicting future energy use—including these covariates in future matching processes may yield informative results.

NEXT STEPS

Navigant's Tier 3 Exploratory Study comprises the following next steps:

- Navigant has completed the savings potential evaluability assessment and is currently incorporating feedback from the utilities.
- Navigant is currently conducting regression-analysis based load disaggregation to estimate cooling and heating loads based on DTE Energy and Consumers Energy electric AMI and monthly gas billing data.
- Nest has provided thermostat telemetry data to Navigant for use in checking the reasonableness of load estimation results.
- Navigant will share preliminary research findings with the utilities in April and present both evaluability assessment and research findings specific to savings potential with the EWR Collaborative in May.

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BACKGROUND AND CONTEXT

Tier 3 thermostats were added to the Michigan Energy Measures Database (MEMD) in 2016.

- As of 2016, program data did not yet exist to support primary research in impacts in MI.
- The heating and cooling savings estimates for the 2016 MEMD measures were based on 12 thermostat studies from across the United States.
- The measure was included in the MEMD with the expectation it would be calibrated once sufficient Michigan-specific data were available.
- In 2016 DTE Energy (DTE) installed 13,047 and Consumers Energy (CMS) installed 5,993 Tier 3 thermostats.
- Navigant performed a power analysis which demonstrated there would be sufficient data by the end of 2017 to conduct an impact analysis in 2018.

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BACKGROUND AND CONTEXT

Navigant completed and presented the results of its Tier 3 Calibration Study in 2018, submitting a white paper in May to calibrate 2019 MEMD measure savings.

- Navigant used a regression with pre-program matching technique whereby a matched control group was created based on energy usage in the pre-period.
- Matching was conducted within utility, within zip code cluster and accounting for HER participation.
- A linear fixed-effects model was used to estimate impacts for DTE and CE customers who installed a thermostat in 2016.
- The study found positive and statistically significant gas heating savings, statistically significant electric heating savings, and statistically significant electric cooling dis-savings (negative savings).
  - Negative electric cooling savings roughly equaled positive electric heating savings, leading to zero annual electric savings.

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BACKGROUND AND CONTEXT

Prolonged discussion of the Calibration results did not lead to agreement on an MEMD savings value and the Tier 3 thermostat measure was removed for 2019.

- Navigant and the utilities, DTE and CMS, worked to determine a path forward and helpful intermediate research goals to precede and inform a possible future calibration study.

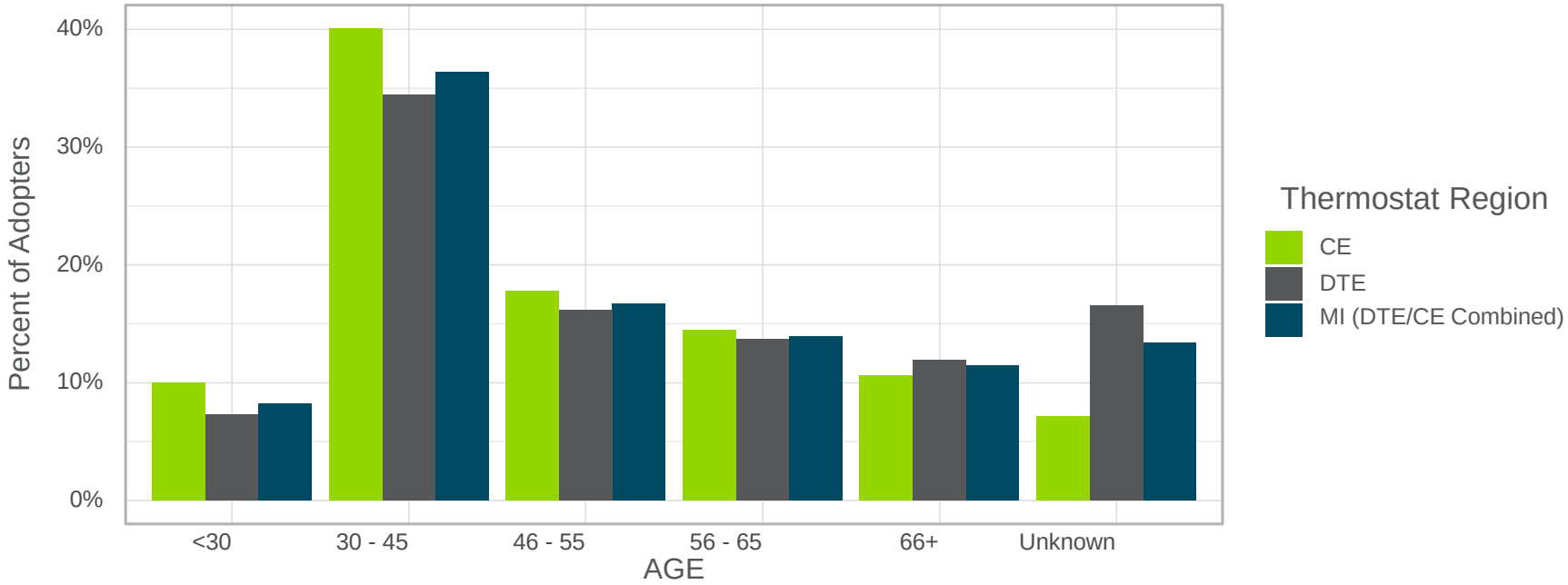
- After a collaborative scoping process, Navigant presented its plan for Tier 3 Thermostat Exploratory Research to the utilities and the EWR in an open meeting in August, and finalized the scope of work (SOW) authorizing the study in September, 2018.

- The Tier 3 Thermostats Exploratory Research Study is currently underway, and the plan for that study is summarize on the following slide.

TYPICAL MI TIER 3 THERMOSTAT PARTICIPANT--AGE

- 30 to 45 year-olds comprise the largest portion (over a third) of recent Michigan Tier 3 thermostat participants. Successively older cohorts comprise fewer participants, with the under-30 group accounting for the fewest.

Figure 6. Age Distribution of Typical Tier 3 Thermostat Participants



Note: Sample sizes are as follows: DTE n = 22,513; CE n = 11,329.

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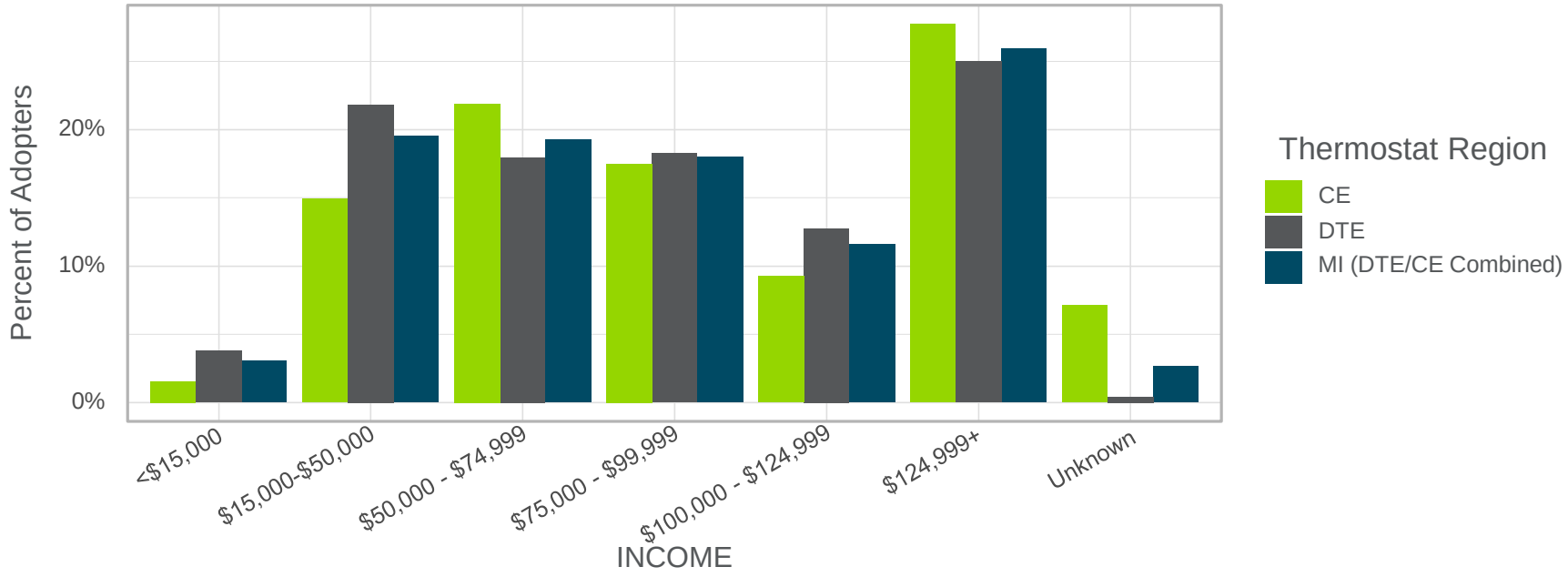
TYPICAL MI TIER 3 THERMOSTAT PARTICIPANT--INCOME

- Customers with incomes of $125K and over comprise the largest portion (over a quarter) of recent Michigan Tier 3 thermostat participants. Those with incomes between $15K and $100K also account for a large proportion.

Figure 7. Income Distribution Typical Tier 3 Thermostat Participant



Note: Sample sizes are as follows: DTE n = 22,513; CE n = 11,329.

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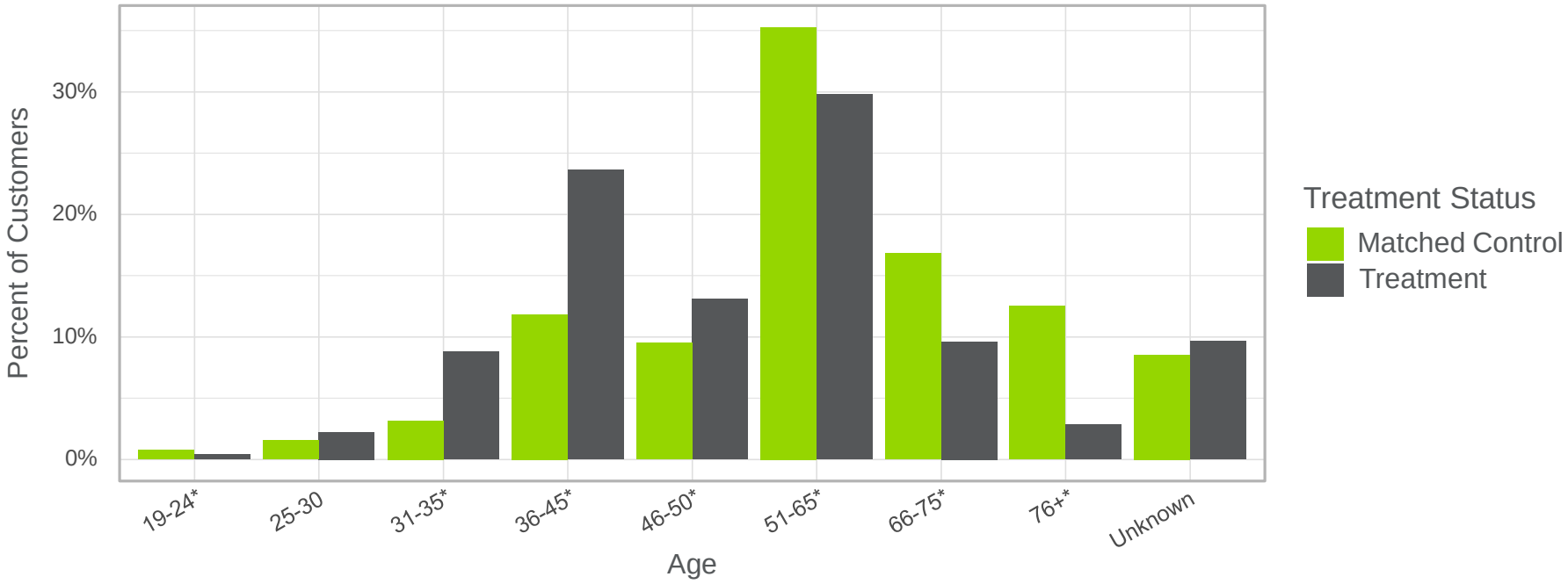
TREATMENT VS MATCHED CONTROL COMPARISON—DTE ELECTRIC CUSTOMERS, AGE

Age groups under 50 are over-represented in the treatment group, while those over 50 are over-represented within controls.

Figure 8. Treatment vs. Matched Control Comparison—Age, DTE Electric



Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 6,288.

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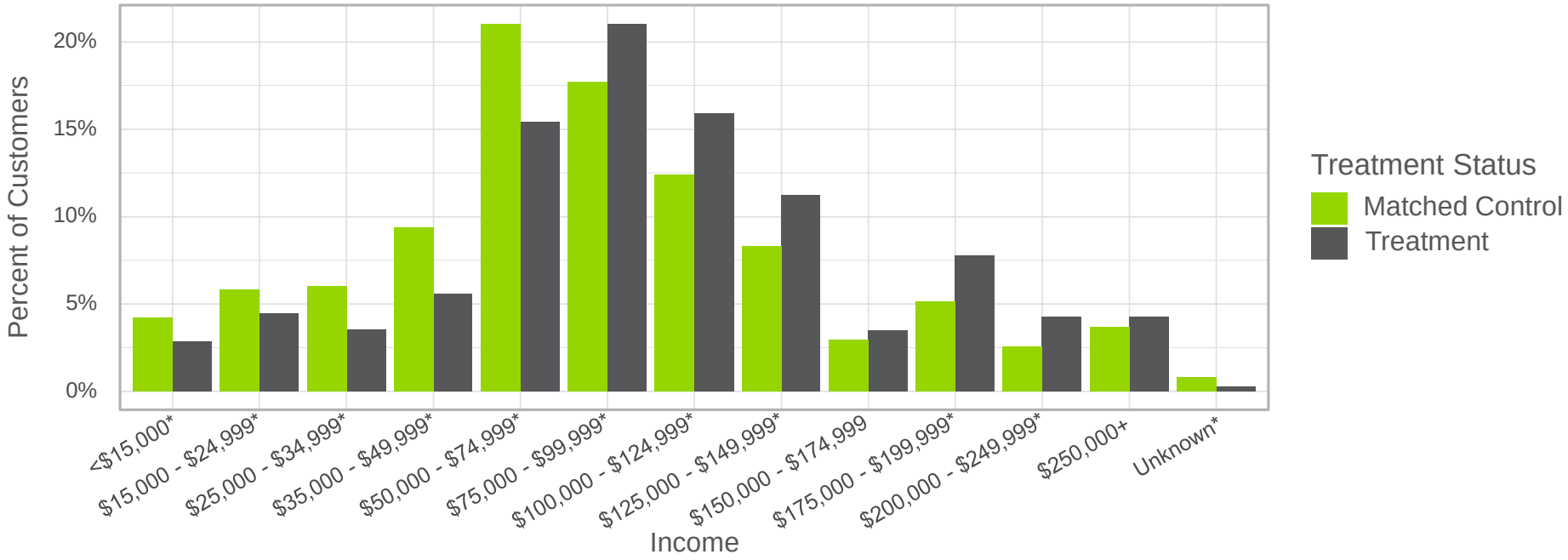
TREATMENT VS MATCHED CONTROL COMPARISON—DTE ELECTRIC CUSTOMERS, INCOME

Income brackets under $75K are over-represented in the control group, while those in brackets above $75K are over-represented within the treatment group.

Figure 9. Treatment vs. Matched Control Comparison—Income, DTE Electric



Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 6,288.

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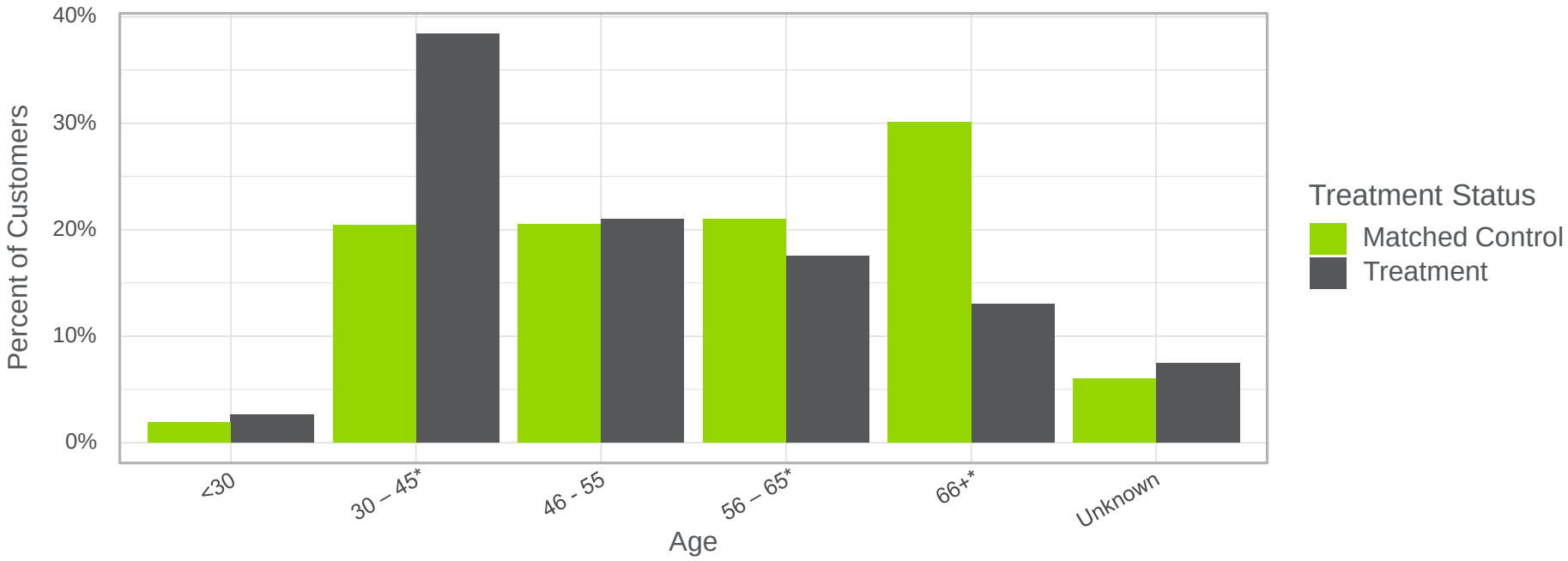
TREATMENT VS MATCHED CONTROL COMPARISON—CE ELECTRIC CUSTOMERS, AGE

While other age groups are well balanced, the 30-45 year-old and 66 year-old and over groups are notably unbalanced in opposite directions.

Figure 10. Treatment vs. Matched Control Comparison—Age, CE Electric



Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 2,611.

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TREATMENT VS MATCHED CONTROL COMPARISON—CE ELECTRIC CUSTOMERS, INCOME

Income brackets under $50K are over-represented in the control group, while those in brackets above $50K are over-represented within the treatment group.

Figure 11. Treatment vs. Matched Control Comparison—Income, CE Electric

Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 2,611.

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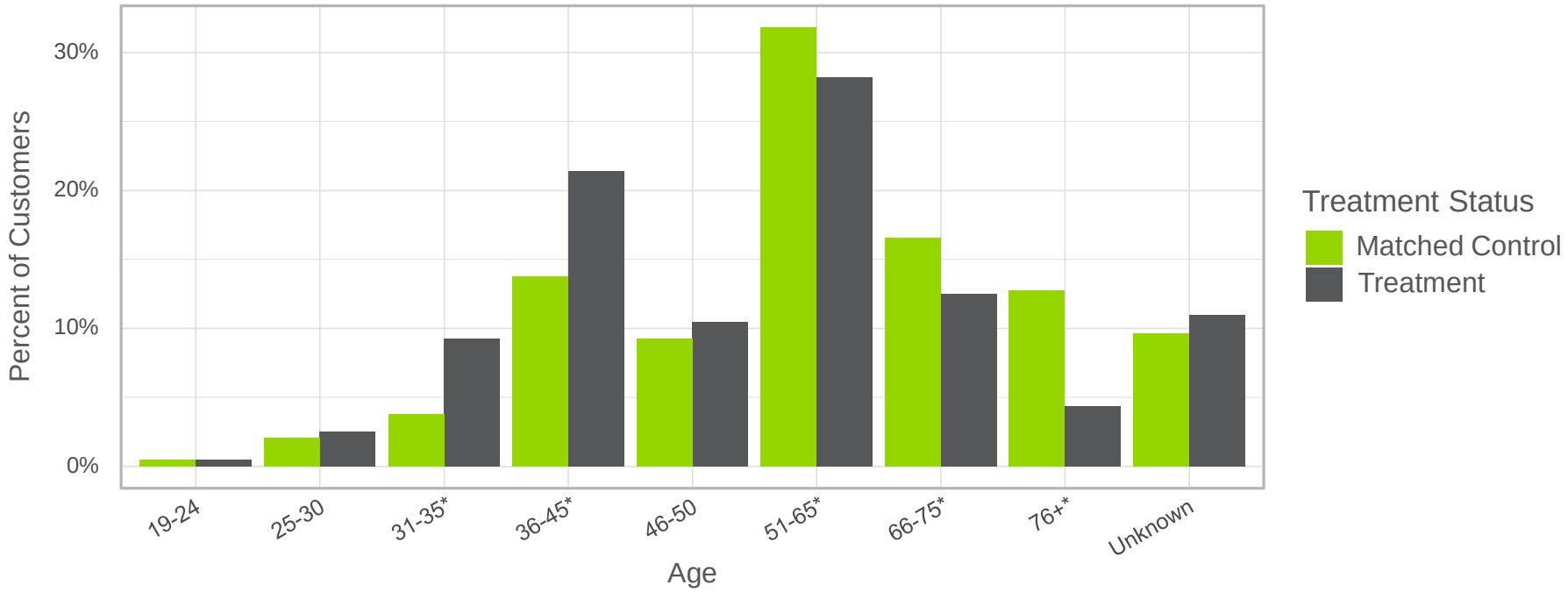
TREATMENT VS MATCHED CONTROL COMPARISON—DTE GAS CUSTOMERS, AGE

Age groups under 50 are over-represented in the treatment group, while those over 50 are over-represented within controls.

Figure 12. Treatment vs. Matched Control Comparison—Age, DTE Gas



Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 3,957.

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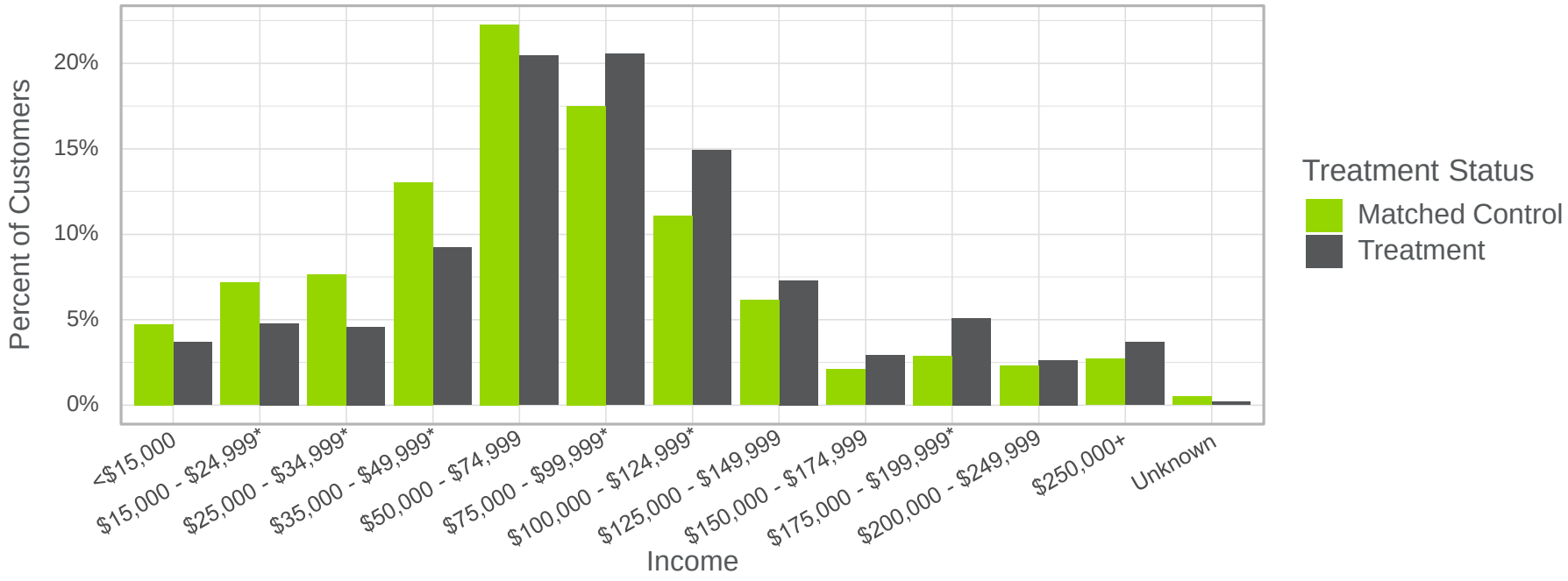
TREATMENT VS MATCHED CONTROL COMPARISON—DTE GAS CUSTOMERS, INCOME

Income brackets under $75K are over-represented in the control group, while those in brackets above $75K are over-represented within the treatment group.

Figure 13. Treatment vs. Matched Control Comparison—Income, DTE Gas



Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 3,957.

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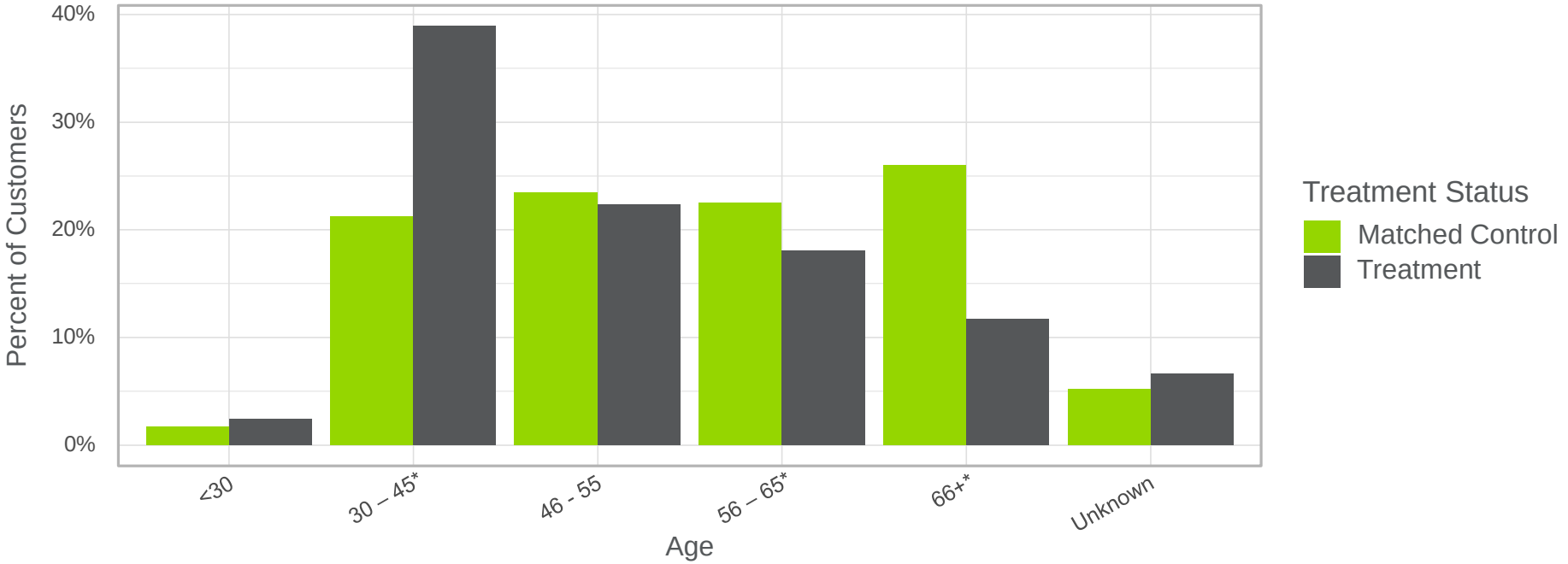
TREATMENT VS MATCHED CONTROL COMPARISON—CE GAS CUSTOMERS, AGE

While other age groups are well balanced, the 30-45 year-old and 66 year-old and over groups are unbalanced in opposite directions, as were the electric groups.

Figure 14. Treatment vs. Matched Control Comparison—Age, CE Gas



Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 3,377.

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TREATMENT VS MATCHED CONTROL COMPARISON—CE GAS CUSTOMERS, INCOME

Income brackets under $75K are over-represented in the control group, while those in brackets above $75K are over-represented within the treatment group.

Figure 15. Treatment vs. Matched Control Comparison—Income, CE Gas

Note: * Indicates matched control and treatment groups are statistically different from one another at the 0.05 level. Sample size = 3,377.

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