MEMD Calibration Research – Appliance Recycling

Presentation to Energy Optimization Collaborative

June 16, 2015

DTE Energy

Consumers Energy
Count on Us

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ENERGY

CADMUS

EMI CONSULTING

Update to Appliance Recycling Savings Model

- Over time, the characteristics of appliances recycled changes

Calculation of Savings

- Current savings based on the Appliance Recycling metering study:
  - MEMD Technical Memo_Appliance Recycling_20120812
- Metering of 200 refrigerators and freezers found that, all things being equal:
  - Older units use more energy due to year-over-year efficiency degradation.
  - Units manufactured before the 1993 NAECA standard consume more energy.
  - Larger units consume more energy.
  - Single-door refrigerators consume less energy.
  - Side-by-side refrigerators have higher energy consumption.
  - Chest freezers use more energy than upright units.
  - Primary appliances have higher consumption.
  - Refrigerators consume slightly more energy at higher temperatures.

Savings Coefficients

Refrigerators		Freezers	
Independent Variables	Coefficient	Independent Variables	Coefficient
Intercept	-1.608	Intercept	-2.297
Age (years)	0.045	Age (years)	0.067
Dummy: Manufactured Pre-1993	1.399	Dummy: Manufactured Pre-1993	0.401
Size (cubic feet)	0.115	Size (cubic feet)	0.15
Dummy: Single Door	-1.803	Dummy: Chest	0.854
Dummy: Side-by-Side	1.571	CDDs	0.046
Dummy: Primary	0.83		
CDDs	0.007		

Source: The Cadmus Group,Inc.,Opinion Dynamics. Michigan Appliance Recycling Metering Study. August 2012.

2015 Calibration Approach

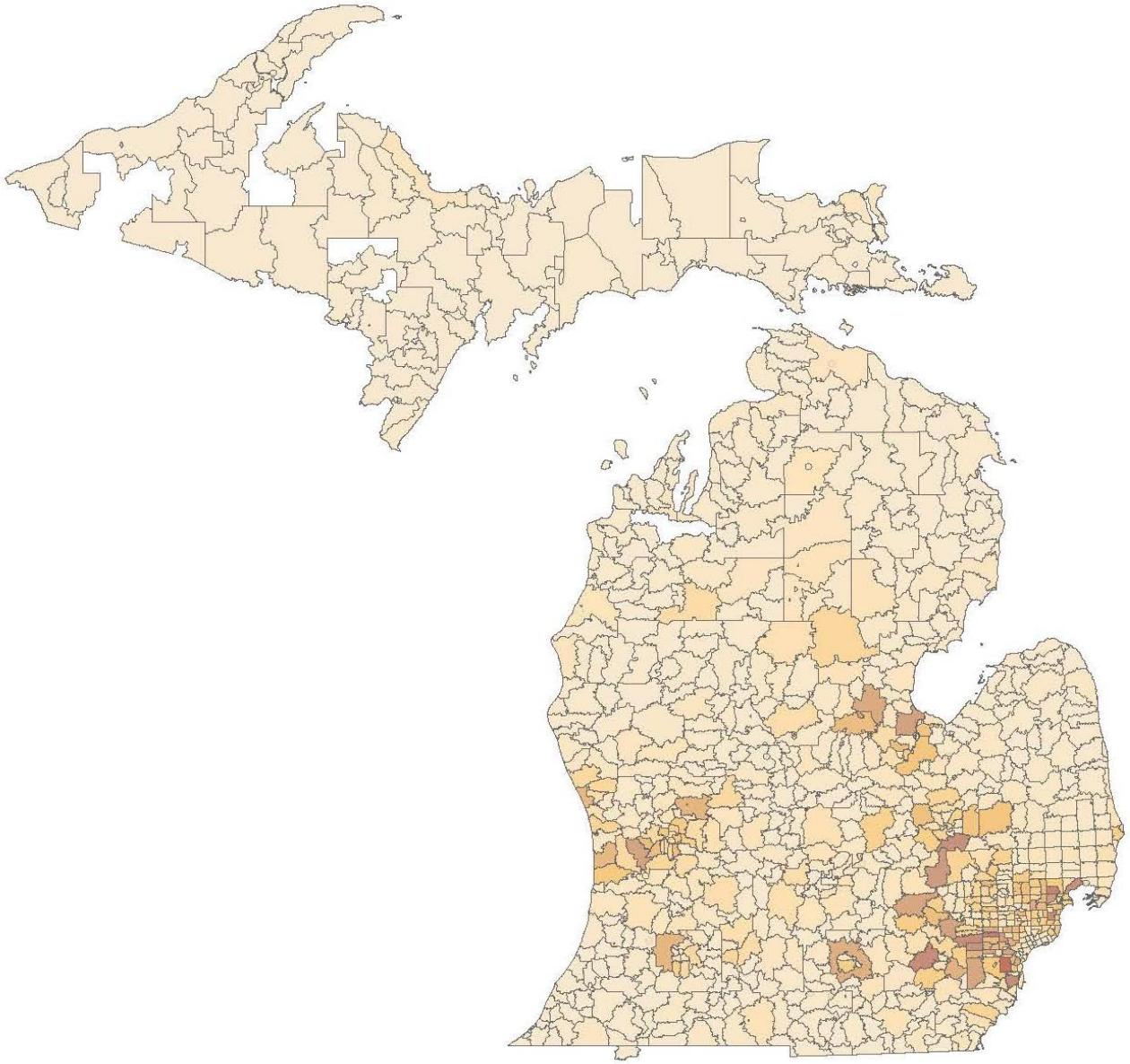
1. Assess changes in age, configuration, size and usage characteristics of appliances recycled statewide from 2013-2014
   - JACO collects unit model codes for the majority of units collected from which this information can be obtained
2. Update unit energy savings estimates using recent participant characteristics
3. Recommend updated values for 2016 MEMD

Appliance Recycling in Michigan 2013-2014

	Refrigerators	Freezers
Bay City Electric	463	73
Consumers Energy	44,734	10,497
Coldwater Board of Public Utilities	34	6
DTE Energy	58,373	9,251
Holland Board of Public Works	351	82
Lansing Board of Water & Light	49	15
MECA Energy Optimization	3,383	1,055
MPPA Energy Smart	623	138
MPSC Efficiency United	1,365	391
Wyandotte Municipal Services	209	34
Total	109,584	21,542

Source: JACO program data, statewide Michigan ARP.

109,584 refrigerators were recycled across the state in 2013 and 2014.



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Refrigerators recycled by zip code

Source: JACO program data, statewide Michigan ARP.

Refrigerator Characteristics

	2009-2012	2013-2014	Difference
Age (years)	26.42	21.61	-18%
Percent Manufactured Pre-1993	76%	55%	-27%
Size (cubic feet)	18.29	18.88	+3%
Configuration	7% Single Door; 23% Side by Side	5% Single Door; 27% Side by Side	-32% Single Door; +16% Side by Side
Primary Units	55%	55%	0%
CDD*	1.88	1.69	-10%

Source: JACO program data, statewide Michigan ARP, Cadmus Analysis.

* Cooling Degree Days are the weighted average daily CDDs from typical meteorological year (TMY3) data for weather stations mapped to participants ZIP codes.

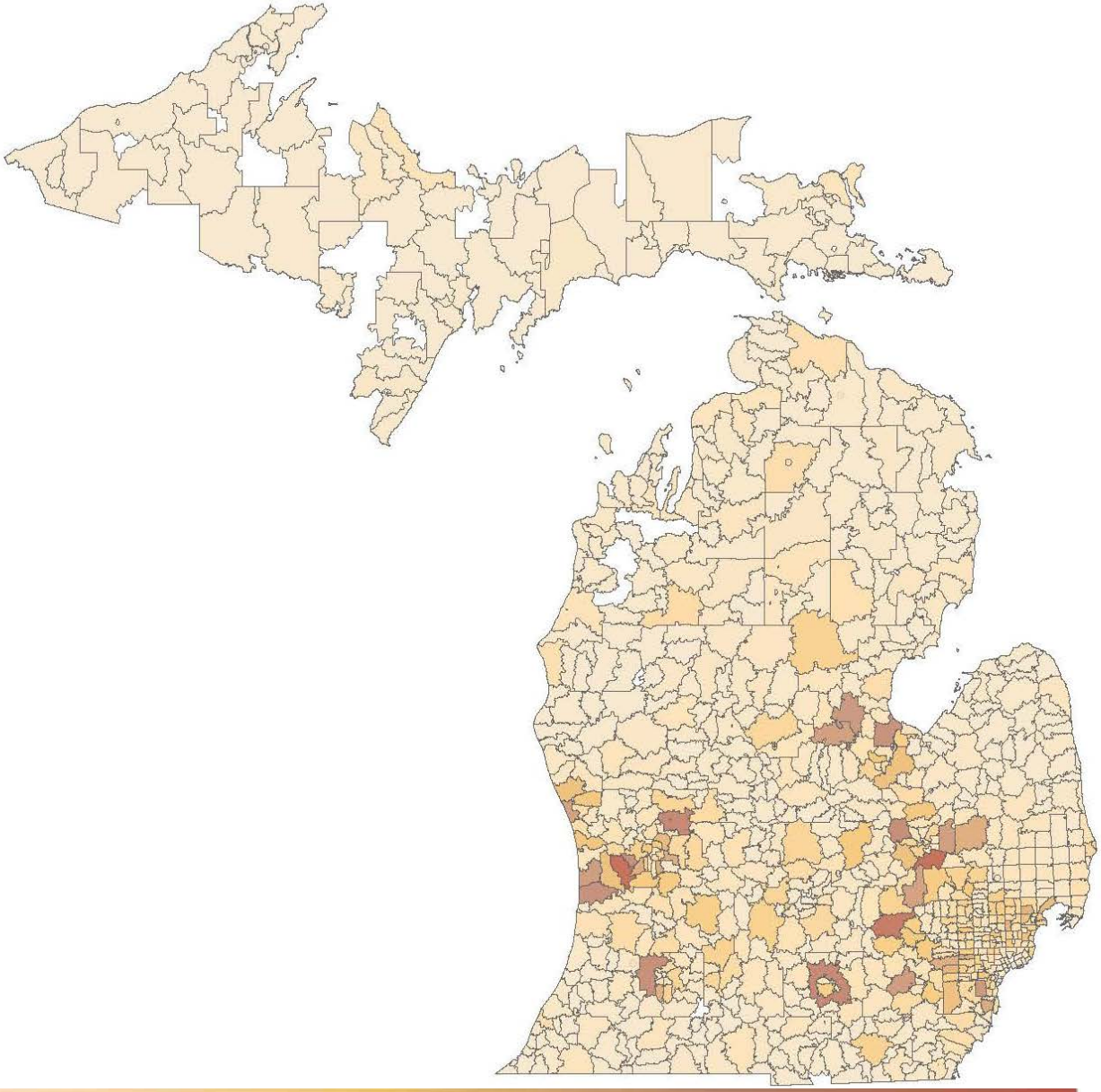
Refrigerator Savings Calculation

Savings from recycling equals average unit energy consumption (UEC) of recycled units.

Refrigerator UEC = 365.25 days

* (-1.608 + 0.045 * [21.61 years old] + 1.399
* [55% units manufactured pre-1993] + 0.115
* [18.88 ft^3] + -1.803 * [5% single door units]
+ 1.571 * [27% side-by-side units] + 0.830
* [55% primary units] + 0.007 * [1.69 CDD]
= 1,135 kWhs

21,542 freezers were recycled across the state in 2013 and 2014.



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Freezers recycled by zip code

Source: JACO program data, statewide Michigan ARP, Cadmus Analysis.

Freezer Characteristics

	2009-2012	2013-2014	Difference
Age (years)	31.98	26.50	-17%
Percent Manufactured Pre-1993	91%	78%	-14%
Size (cubic feet)	16.39	16.17	-1%
Configuration	34% Chest	34% Chest	<1%
CDD*	1.81	1.61	-11%

Source: JACO program data, statewide Michigan ARP, Cadmus Analysis.

* Cooling Degree Days are the weighted average daily CDDs from typical meteorological year (TMY3) data for weather stations mapped to participants ZIP codes.

Freezer Savings Calculation

Savings from recycling equals average unit energy consumption (UEC) of recycled units.

Freezer UEC = 365.25 days

* (-2.297 + 0.045 * [26.50 years old] + 0.401
* [78% units manufactured pre-1993] + 0.15
* [16.17 ft^3] + 0.854 * [34% chest unit]
+ 0.046 * [1.61 CDD]
= 944 kWhs

Demand Savings

$$\text{Coincident Factor} = \frac{\text{Summer kWh/day*}}{\text{Average kWh/day}} = \frac{\text{Summer kW}}{\text{Average kW}}$$

	kWh/unit	Average kW/unit	Coincidence Factor	Summer Coincident kW/unit
Refrigerator	1,135	0.130	1.010	0.131
Freezer	944	0.108	1.080	0.116

Source: Cadmus Analysis.

* Calculated using the regression model with weighted average CDD for the months of July and August consistent with the MISO summer peak definition (non-holiday weekdays in July and August between 1pm and 5pm).

Summary Results and Recommendation

Savings Type	2012 Recommendation/ 2013 MEMD Value	2015 Recommendation for 2016 MEMD	Difference
Refrigerator – Energy (kWh)	1,261	1,135	-10%
Refrigerator – Demand (kW)	0.146	0.131	-10%
Freezer – Energy (kWh)	1,111	944	-15%
Freezer – Demand (kW)	0.136	0.116	-15%

Source: Cadmus Analysis.

Recommendation: Energy Optimization collaborative should adopt the updated values for refrigerator and freezer savings for appliance recycling for the 2016 MEMD to better reflect the current participation characteristics.