MICHIGAN RESIDENTIAL ENERGY CODE FIELD STUDY

SUMMARY OF FINDINGS

JULY 19, 2016

NAVIGANT

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Content of Report

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Results of Michigan Residential Energy Code Field Study indicate potential of 5 GWh, 29 MMCF, and $1 million in annual statewide savings. The study revealed exterior wall insulation and high efficacy lighting as elements of Michigan's existing 2009 code where performance improvements would have the greatest impact. As Michigan transitions to an updated energy code in February 2016, additional opportunity for savings are available.

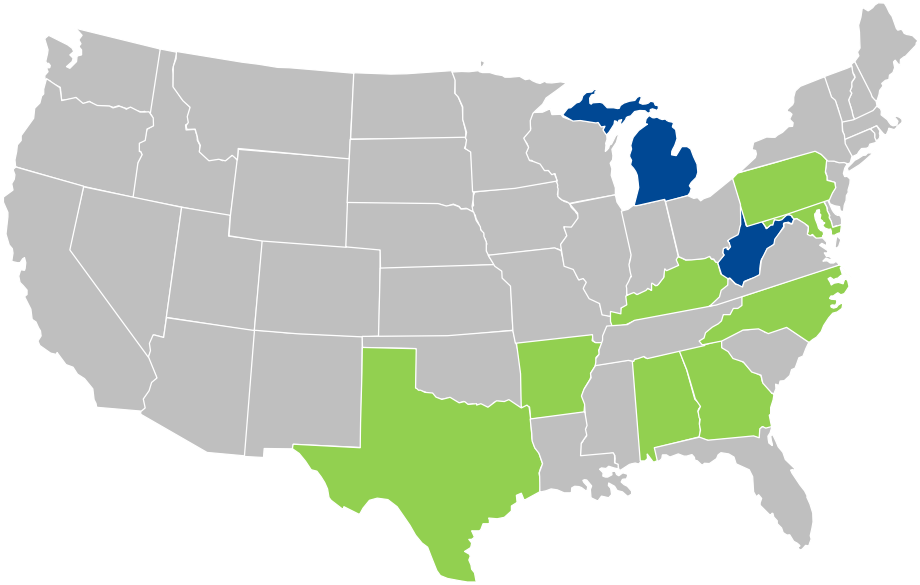
Key Michigan Residential Energy Code Field Study – Findings and Recommendations

- **Key question:** is there sufficient energy savings opportunity for DTE Energy and Consumers Energy to run a codes support program?
- Enhanced energy code performance has potential to achieve **5 GWh, 29 MMCF, and $1 million** worth of energy savings statewide ($165 - $275 annually per under-performing newly-constructed home). Roughly $750,000 in statewide savings result from offset electricity usage, and $250,000 result from offset gas usage.
- DTE Energy and Consumers Energy can reasonably expect to claim **10% - 25% of statewide savings**, depending on fuel type and attribution estimate.
- **Exterior Wall** and **High Efficacy Lighting represent over 90% of available savings** and the greatest opportunity to enhance performance.
- Statewide savings potential relative to Michigan's incoming energy code is **9 GWh, 84 MMCF, and $2.12 million**. When Michigan transitions to new energy code, Air Sealing will present additional savings opportunity; these three measures will account for over 90% of savings. Roughly $1,350,000 in statewide savings result from offset electricity usage, and $750,000 result from offset gas usage. Savings are based on observed practices relative to incoming code requirements

In Fall 2014, DTE Energy and Consumers Energy joined efforts in 9 other states to assess residential new construction energy codes. DTE/CE retained Navigant, along with Michigan State University (MSU), Britt/Makela Group, and Midwest Energy Efficiency Alliance (MEEA), to compare current construction practices to minimum Michigan residential energy code requirements.

- Eight states initially selected (in green) as part of Department of Energy (DOE) funding opportunity announcement (FOA)
- Michigan and West Virginia joined the study later (in blue)
- All states using DOE and Pacific Northwest National Laboratory (PNNL) sampling and analysis methodology

Figure 1.1: States participating DOE-led Code Compliance Studies



Participating FOA States		Non-FOA States	
Alabama	Maryland	Michigan	West Virginia
Arkansas	North Carolina		
Georgia	Pennsylvania		
Kentucky	Texas		

Field data collection began November 2014 and concluded September 2015. In total, 124 construction sites observed across 33 counties. Despite initial recruitment challenges, all county observation targets were achieved.

- 124 under-construction homes visited
- **Compliance of any given home was not measured**. Instead, individual measure observations were taken
- 8 key code items, with target number of observations set at either **63** or **40**
- Targets set based on expected code item **variability** and **impact on residential energy use**
- Sample distributed across 3 Michigan climate zones based on proportion of construction activity
- While 2 item-specific climate zone targets were not achieved, **all overall targets were achieved**

Table 1.1: Key Item Target vs. Achieved Observations per Climate Zone

Item	Climate Zone			Achieved Observations
	5	6	7	
Target:	**50**	**9**	**4**	**63**
ACH50	***49***	*9*	*5*	***63***
Ceiling R	*60*	*10*	*9*	***79***
Foundation (Floor/Basement/Slab R)	*69*	*16*	*6*	***91***
Target	**32**	**6**	**2**	**40**
Duct Leakage	*36*	*6*	*2*	***44***
Window SHGC	*57*	*12*	*5*	***74***
Window U-Factor	*62*	*12*	***1***	***75***
Wall R	*41*	*7*	*5*	***53***
High Efficiency Lighting	*66*	*12*	*3*	***81***

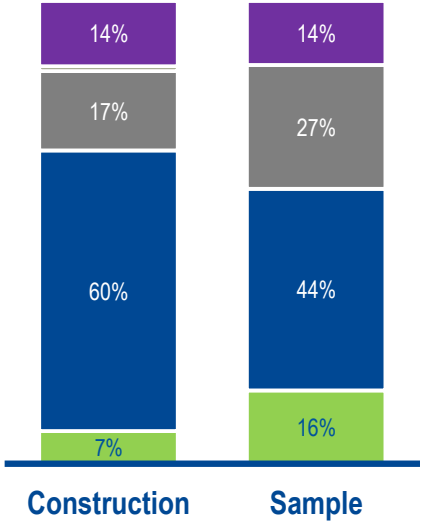
Navigant reviewed data collection activities at various points and when field data collection had ended, and determined any bias was negligible. Final sample distribution closely mirrors statewide new construction activity by jurisdiction type and code enforcement authority, as seen in Tables 1.2 and 1.3.

Sample design focused on representing existing construction activity across:

- All Michigan **climate zones**
- Different **code enforcement authorities**
- Different **jurisdiction types**

Table 1.2: Activity by Jurisdiction Type

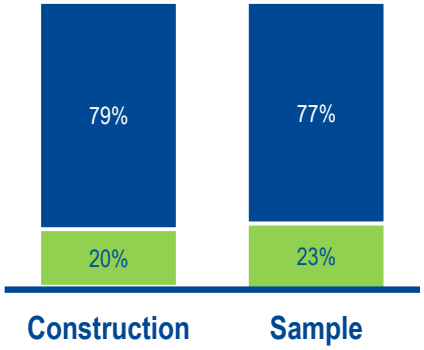
Jurisdiction	Construction Activity	Construction %	Sampling Activity	Sampling %
County	911	7%	20	16%
Township	7,755	60%	54	44%
City	2,164	17%	33	27%
Village	191	1%	0	0%
Unincorporated	1,838	14%	17	14%
State	56	0%	0	0%
Total:	**12,915**	**100%**	**124**	**100%**



Sampling activity focused on collecting data in **DTE Energy** and **Consumers Energy** service territory

Table 1.3: Activity by Code Enforcement Authority

Jurisdiction	Construction Activity	Construction %	Sampling Activity	Sampling %
State	115	1%	0	0%
County	2,440	20%	29	23%
Local	9,905	79%	95	77%
Total:	**12,460**	**100%**	**124**	**100%**



Minimum performance rates for specific code elements were found to vary, however all but two items had performance rates above 60%. The biggest identified areas for improvement relative to existing construction practices and energy code were 1) frame wall insulation and 2) high-efficacy lighting, both with performance rates below 50%.

Table 1.4: Observed Performance for Key Items

Item	Observations	Performance Rate	Non-Performance Rate
ACH50	**63**	**97%**	**3%**
Ceiling R-value	**79**	**89%**	**11%**
Foundation (Floor/Basement/Slab R-value)	**63**	**68%**	**32%**
Duct Tightness	45	62%	38%
Window SHGC & U-factor	75	99%	1%
Wall R-value	55	42%	58%
High Efficiency Lighting	84	35%	65%

There were 84 observations taken for high efficacy lighting; 35% meet or exceed the required 50% socket saturation.
Many homes observed had construction bulbs installed. It is unclear whether lamps would be replaced before time of sale.

Figure 1.2: % High Efficacy Lighting
Climate Zone 5A, 6A, 7

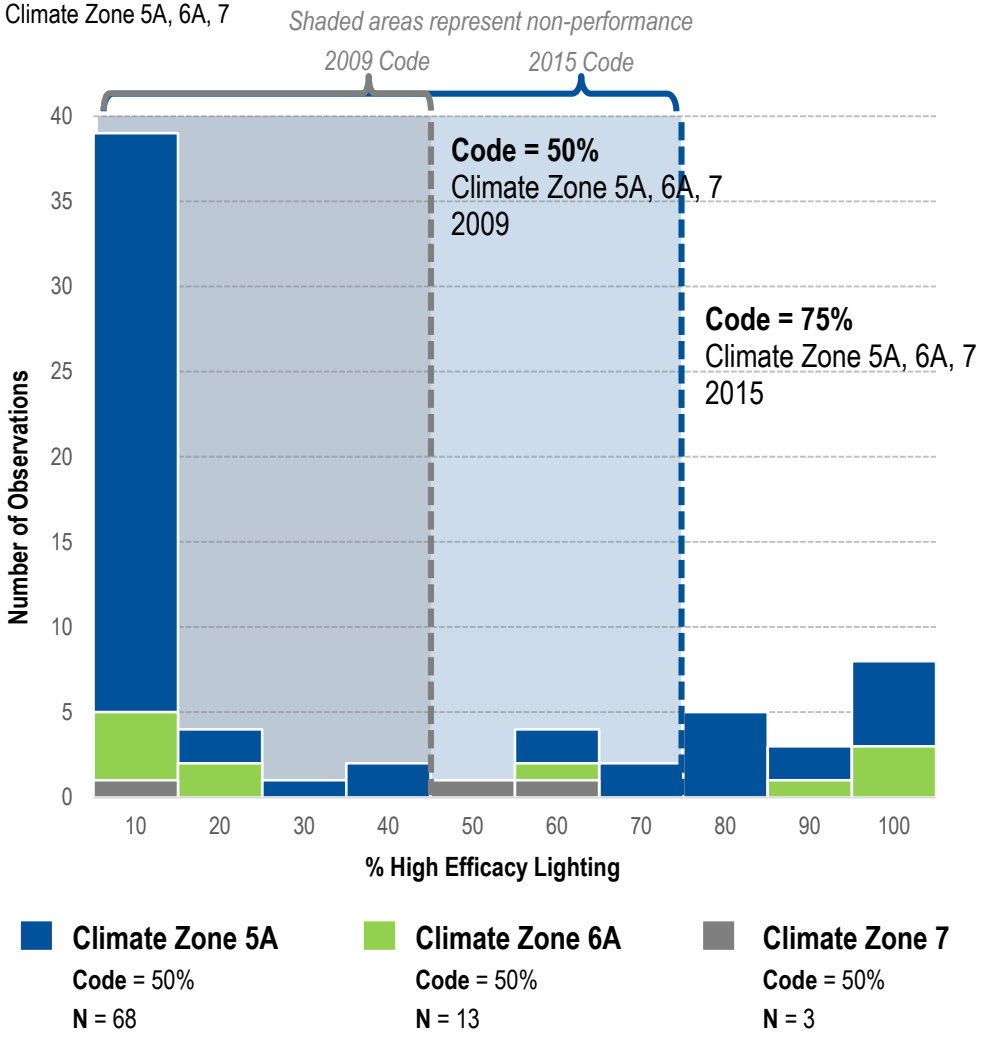


Figure 1.3: % High Efficacy Lighting
Climate Zone 5A

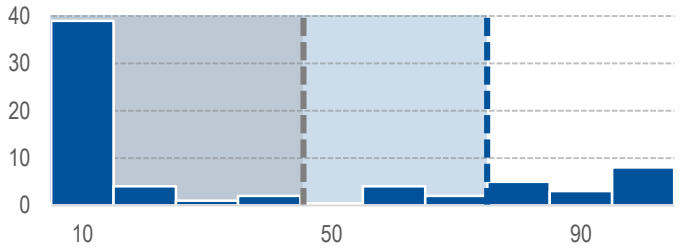


Figure 1.4: % High Efficacy Lighting
Climate Zone 6A

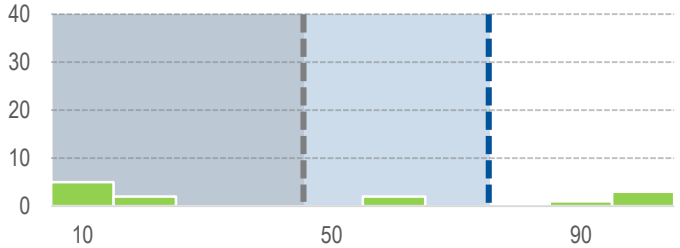
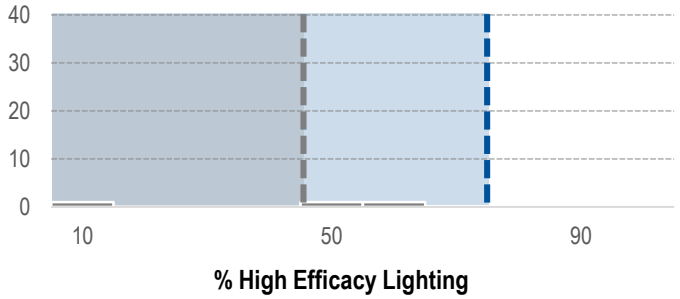


Figure 1.5: % High Efficacy Lighting
Climate Zone 7



There were 55 observations for wall insulation were taken, 42% of which met or exceeded code requirements. With exception of Climate Zone 7, requirements are not set to change with energy code update.

Figure 1.6: Frame Wall R-Values
Climate Zone 5A, 6A, 7

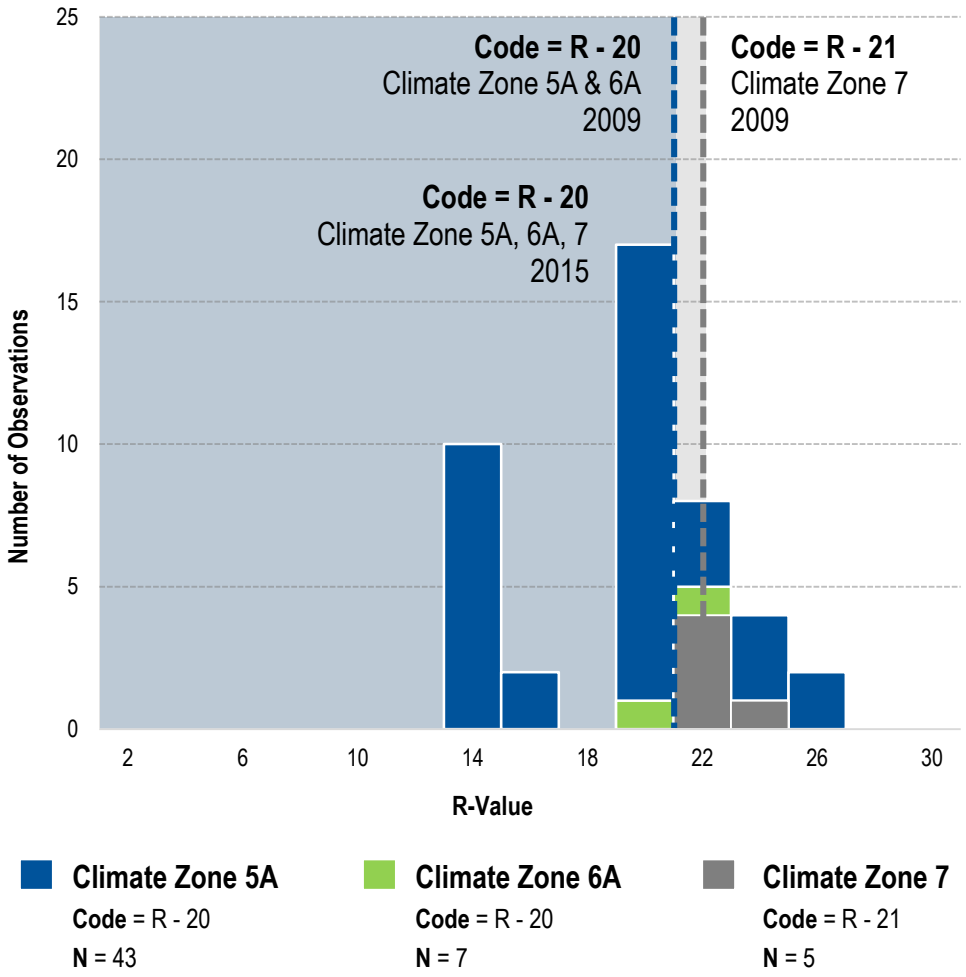


Figure 1.7: Frame Wall R-Values
Climate Zone 5A

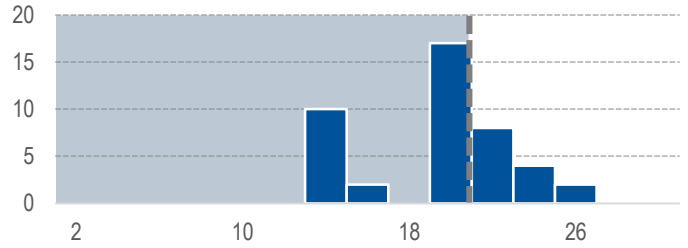


Figure 1.8: Frame Wall R-Values
Climate Zone 6A

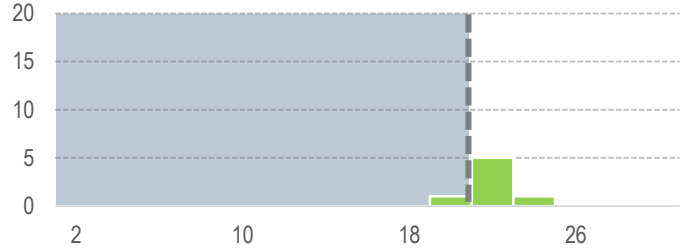
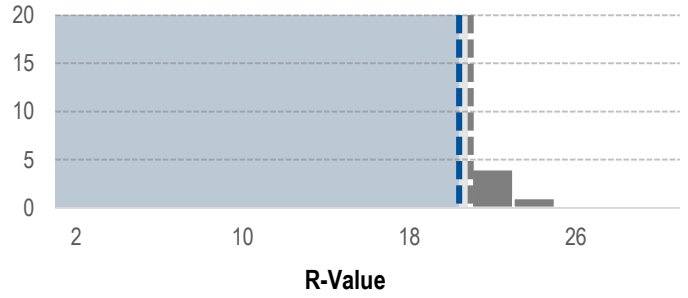


Figure 1.9: Frame Wall R-Values
Climate Zone 7



Of the 63 air sealing measurements taken, 2 were found to be below the minimum requirement, resulting in a characteristic-specific performance achievement rate of 97%. The two non-performance measurements were not significantly above the code requirement, both being between 7.75 and 8.00 ACH50.

Figure 1.10: ACH50 Values
Climate Zone 5A, 6A, 7

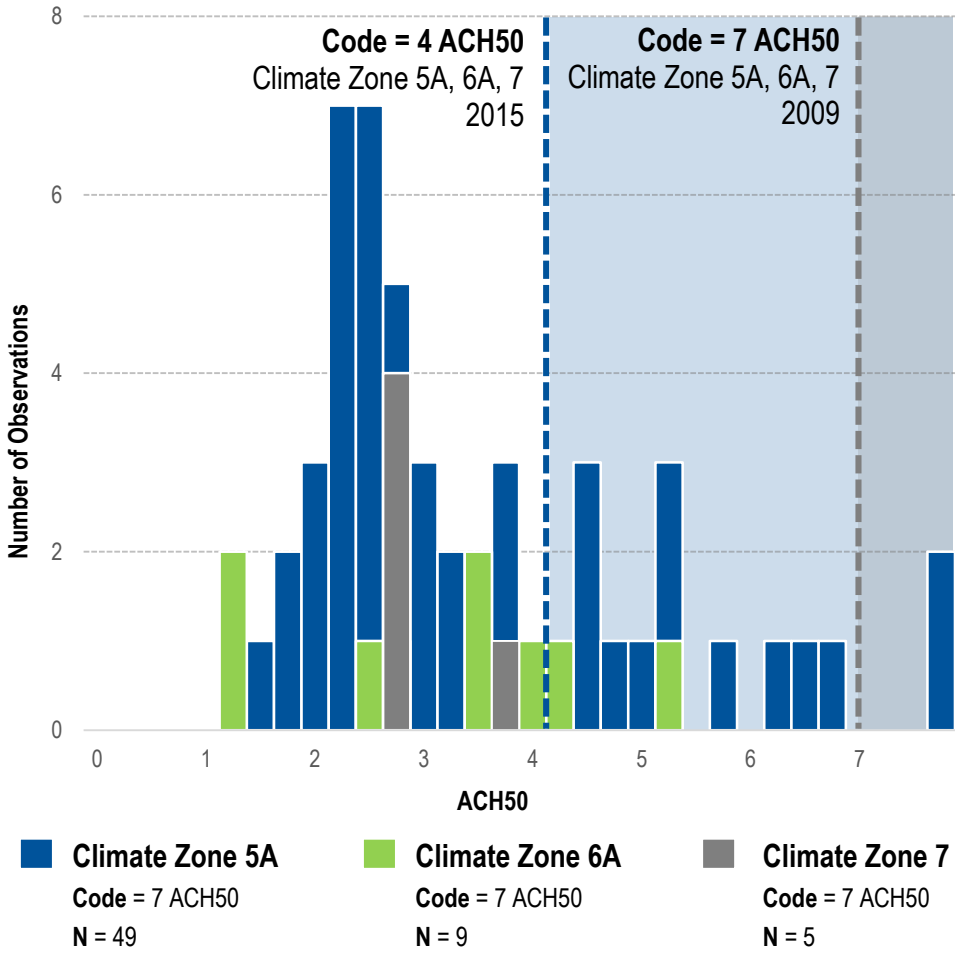


Figure 1.11: ACH50 Values
Climate Zone 5A

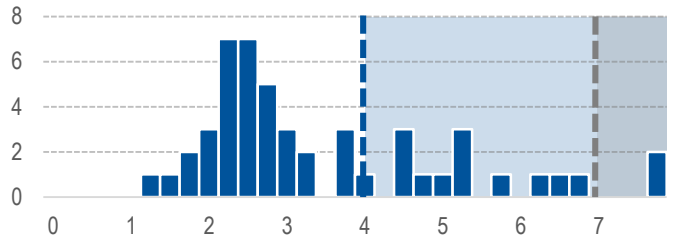


Figure 1.12: ACH50 Values
Climate Zone 6A

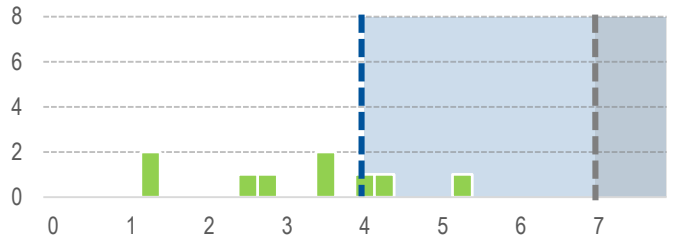
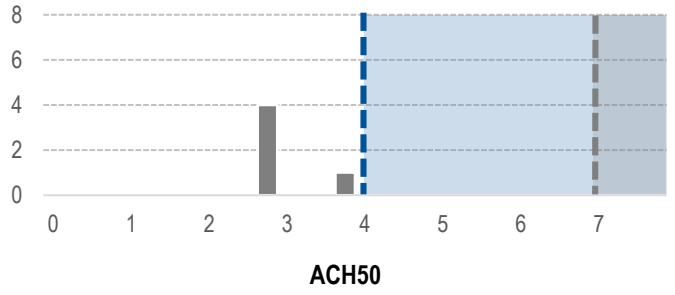


Figure 1.13: ACH50 Values
Climate Zone 7



To determine how best to conduct savings analysis, observed code criteria were broken down into two categories: 1) mandatory and 2) tradeable. Code requirements for mandatory items must be achieved in all newly-constructed homes, whereas efficiency of certain envelope items can be "traded" up or down to meet overall energy performance metric. To account for differences how these measures can be used to meet energy code, Navigant, along with PNNL and MEEA, conducted two separate analyses to identify potential savings.

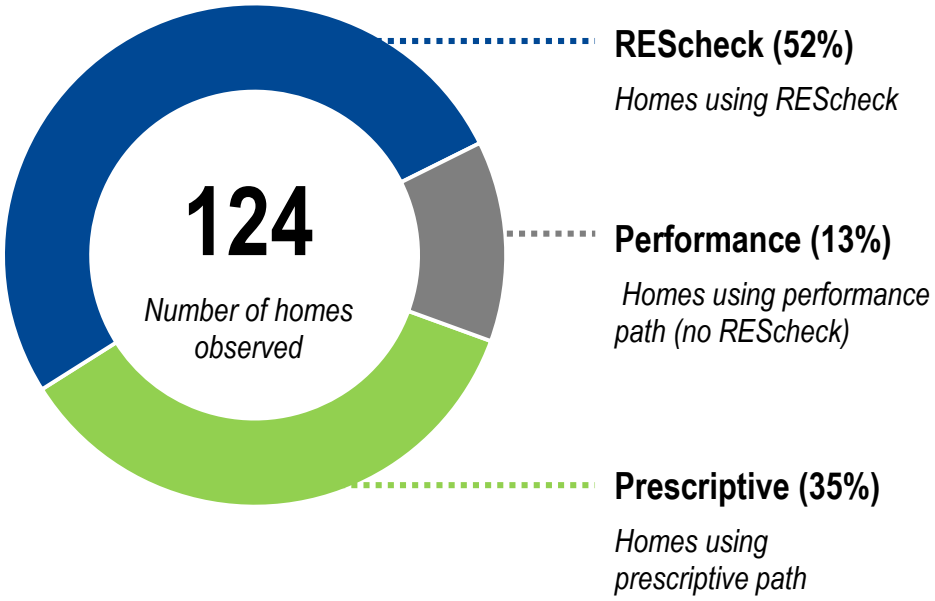
Table 1.5: Mandatory Measures

Measure	Performance
ACH50	97%
Duct Tightness	62%
Lighting	35%

Table 1.6: Tradeoff Measures

Measure	Performance
Ceiling R-value	89%
Foundation R-Value	68%
Window SHGC & U-factor	99%
Wall R-value	42%

Figure 1.14: Energy Code Path Breakdown for Observed Homes



Homes using REScheck analyzed across tradeable measures to determine whether or not trading employed. Results revealed tradeoffs were not employed for measures observed. **Note**: black line in figures indicate observed trend; red line indicate trend expected with tradeoffs.

- All REScheck items compared against each other.
- **In general, homes do not appear to be "trading"** performance of measures
- High-performance homes tended to perform well across all measures, and vice versa
- Homes using REScheck should be analyzed as though they were using **prescriptive path**

Figure 1.15: Wall R vs. Ceiling R[1]

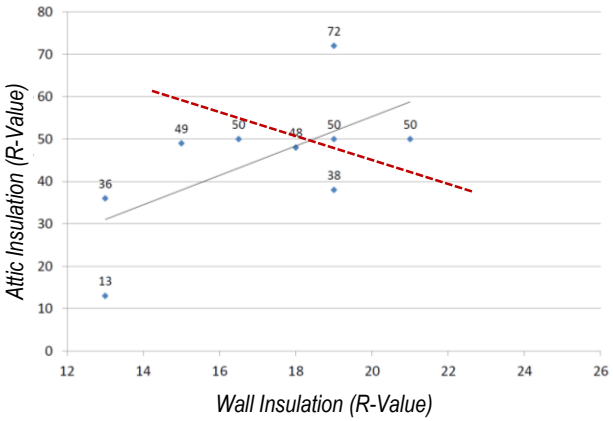


Figure 1.16: Ceiling R vs. Basement R[1]

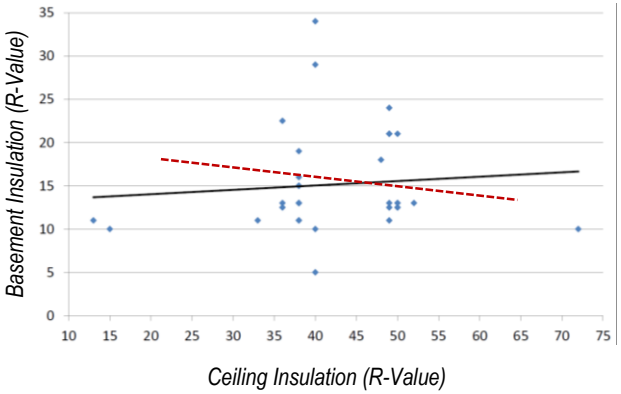


Figure 1.17: Wall R vs. Window U[1]

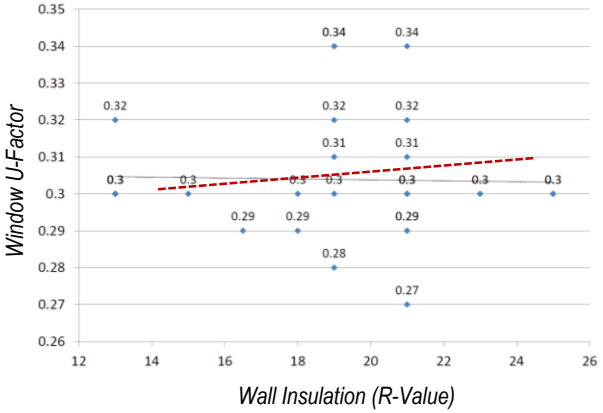
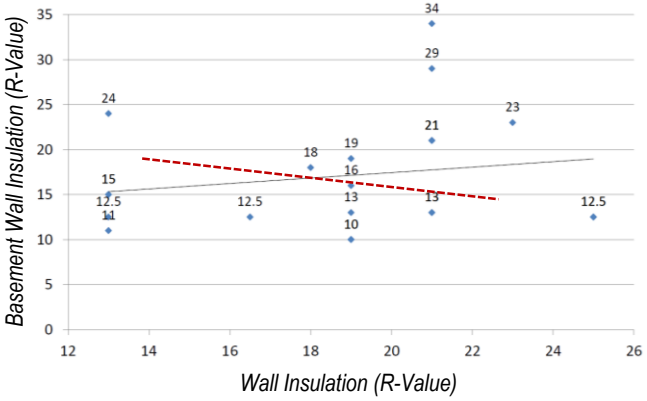


Figure 1.18: Wall R vs. Basement R[1]



1. Source: MEEA Analysis

Using results from two different analyses, Navigant determined annual statewide savings of 5 GWh, 29 MMCF, and $1 million. Savings calculated using US Census data for residential new construction starts (12,381 homes), equivalent to $150 – $275 annually per non-compliant newly-constructed home in Michigan.

- Lower savings bound assumes all homes are using the performance path for tradeoff measures, and results in **annual statewide savings** of **4.4 GWh, 1.25 MMCF, and $600,000**.
- Upper bound assumes all homes use prescriptive path for all observed code items, resulting in **annual statewide savings** of **5.3 GWh, 34 MMCF, and $1 million**.
- Weighted savings based on proportion of homes electing each compliance path closer to **5.1 GWh, 29 MMCF, and $1 million** in **annual statewide savings.** Roughly $750,000 in statewide savings results from offset electricity usage, and the remaining $250,000 in savings results from offset gas usage.

Table 1.7: Statewide Savings Potential for Codes Enhancement

Annual Savings Estimate	MWh	MCF	Dollars
Lower Bound (Energy Use Intensity Analysis)	4,377	1,251	$606,800
Upper Bound (Measure-Level Analysis)	5,260	34,317	$1,083,200
Weighted (Upper and lower bounds weighted based on homes electing performance vs. prescriptive path)	5,140	29,100	$1,000,000

Expected Savings Range: $600,000 - $1,000,000

Navigant used two different allocation analysis methods, the results of which differ (in absolute terms) by ≤ 5%. Both estimates present a range of fuel-specific savings each utility could expect to claim from codes support activity. The "Average Estimate" presents a conservative estimate Navigant will use for allocation throughout remainder of this presentation.

Figure 1.19: Potential Electric Savings, by Methodology

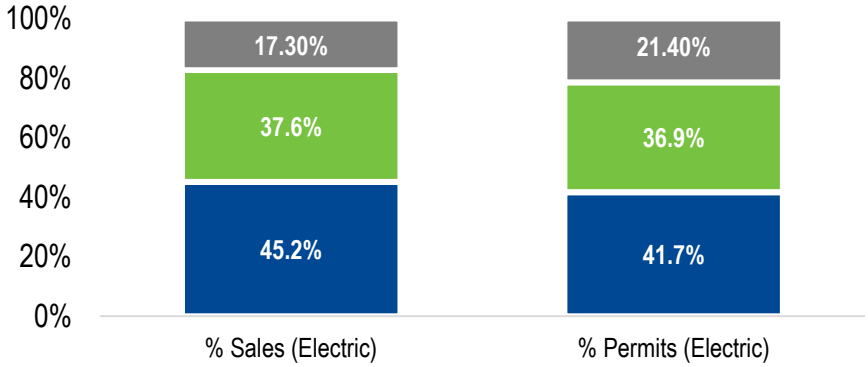


Figure 1.20: Potential Gas Savings, by Methodology

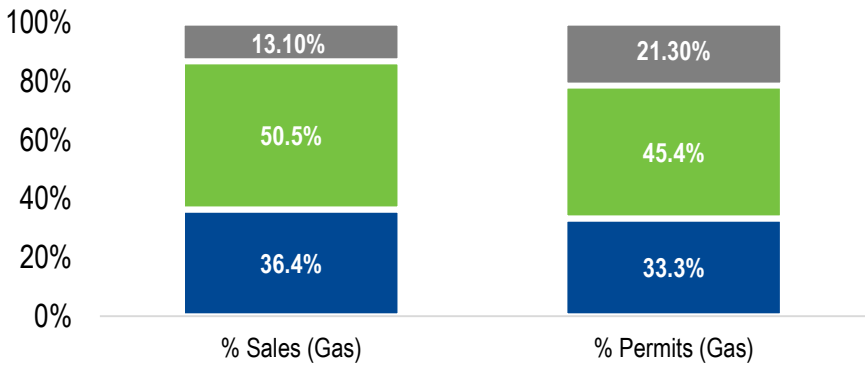
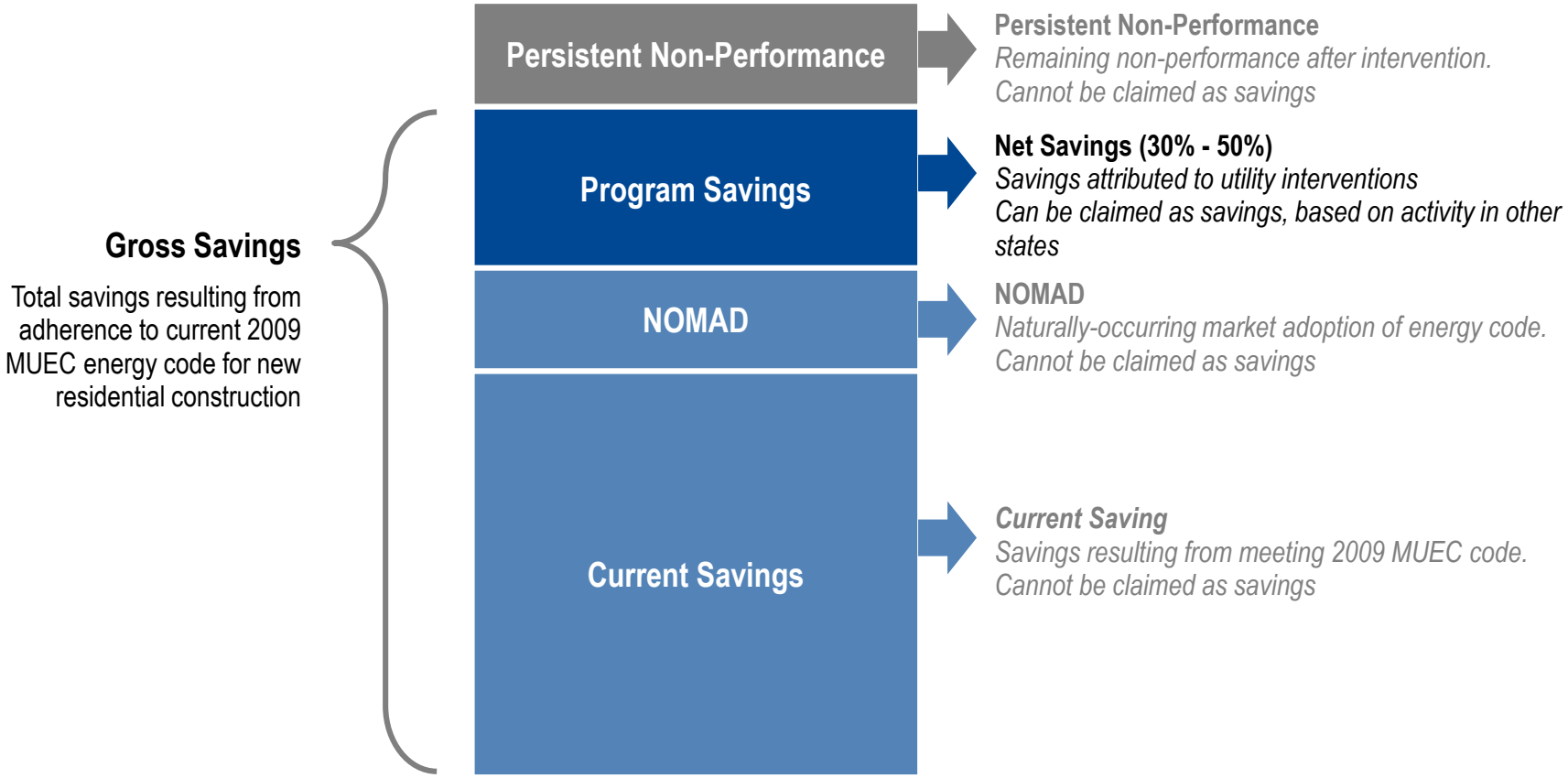


Table 1.8: Potential Savings Available to Utilities for Energy Codes Enhancement Program Activity

Utility	% of Electric Savings			% of Gas Savings		
	% Res. Sales Estimate	% Permit Estimate	Average Estimate	% Res. Sales Estimate	% Permit Estimate	Average Estimate
DTE Energy	*45.2%*	*41.7%*	*42.5%*	*36.4%*	*33.3%*	*35%*
Consumers Energy	*37.6%*	*36.9%*	*37.5%*	*50.5%*	*45.4%*	*47.5%*
Other Utilities	*17.3%*	*21.4%*	*20.0%*	*13.1%*	*21.3%*	*17.5%*

Of total savings available from an energy code, a portion could be attributed to utility support activities. Figure 1.21 illustrates different categories of energy savings available through utility efforts. Of four categories presented, "Program Savings" represents the amount of energy savings attributable to a utility energy codes enhancement program.

Figure 1.21: Energy Savings from Energy Codes Enhancement Activities[1]



1. *Figure adapted from "Attributing Building Energy Code Savings to Energy Efficiency Programs", February 2013.*

Should DTE Energy and Consumers Energy choose to make a savings claim based on code support activity, each utility could reasonably claim between 10% - 25% of existing statewide potential savings relative to 2009 MUEC. Figures 1.22 and 1.23 show relative portions of total statewide savings each utility could expect to claim, assuming average estimated allocation and 40% attribution.

Figure 1.22: Potential Statewide Electric Savings[1]

(Annual MWh)

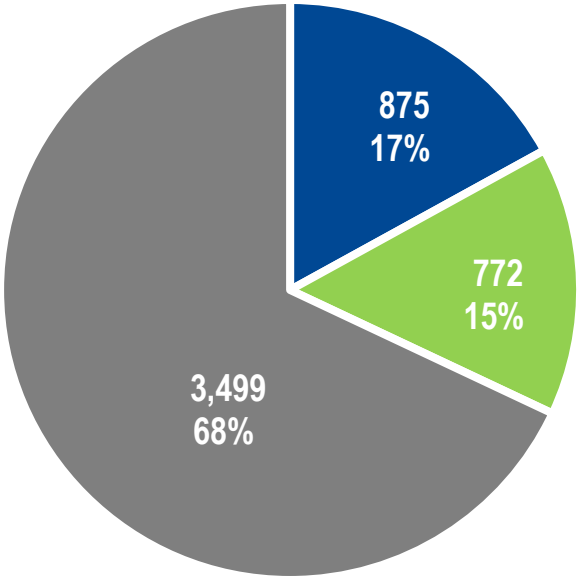
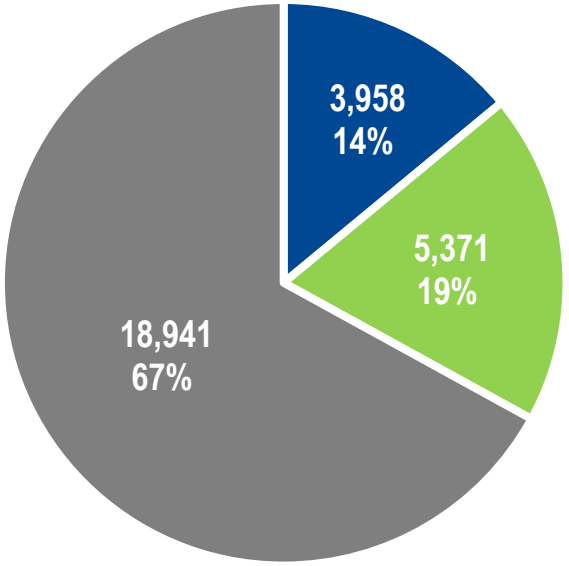


Figure 1.23: Potential Statewide Gas Savings[1]

(Annual MCF)



DTE Energy Potential Savings

Consumers Energy Potential Savings

Unavailable Savings (extra-jurisdictional or not attributed to program activity)

1. *Source: Navigant Analysis*

Should DTE Energy and Consumers Energy choose to make a savings claim based on code support activity, each utility could reasonably claim between 10% - 25% of the existing statewide potential savings relative to the 2009 MUEC. Tables 1.9 through 1.12 lay out the various amount of energy savings this could mean for each utility across identified allocation and attribution ranges. For the purposes of this analysis, **weighted electric (5.14 GWh)** and **weighted gas (29.1 MMCF)** savings results are used.

Table 1.9: DTE Energy - Potential Electric Savings

(annual MWh)

Allocation \ Attribution	30%	40%	50%
40%	610	820	1,020
45%	690	920	1,150

Table 1.11: Consumers Energy – Potential Electric Savings

(annual MWh)

Allocation \ Attribution	30%	40%	50%
30%	460	610	770
35%	540	720	900

Table 1.10: DTE Energy - Potential Gas Savings

(annual MCF)

Allocation \ Attribution	30%	40%	50%
35%	3,060	4,090	5,110
40%	3,500	4,670	5,840

Table 1.12: Consumers Energy – Potential Gas Savings

(annual MCF)

Allocation \ Attribution	30%	40%	50%
45%	3,940	5,260	6,570
50%	4,380	5,840	7,300

When compared to savings potential relative to Michigan's incoming energy code, utility- and fuel-specific savings potential increases significantly. Tables 1.13 through 1.16 indicate potential savings available as Michigan transitions to updated energy code in February 2016. Numbers used represent weighted statewide savings potential of **9 GWh, 84 MMCF, and $2.12 million,** and assume that **observed construction practice trends** continue immediately following new code adoption. This analysis is ongoing, and currently represents Navigant's best estimate at potential savings.

Table 1.13: DTE Energy - Potential Electric Savings

(annual MWh)

Allocation \ Attribution	30%	40%	50%
40%	1,100	1,470	1,840
45%	1,240	1,660	2,070

Table 1.14: DTE Energy - Potential Gas Savings

(annual MCF)

Allocation \ Attribution	30%	40%	50%
35%	8,790	11,720	14,650
40%	10,040	13,390	16,740

Table 1.15: Consumers Energy – Potential Electric Savings

(annual MWh)

Allocation \ Attribution	30%	40%	50%
30%	830	1,100	1,380
35%	960	1,290	1,610

Table 1.16: Consumers Energy – Potential Gas Savings

(annual MCF)

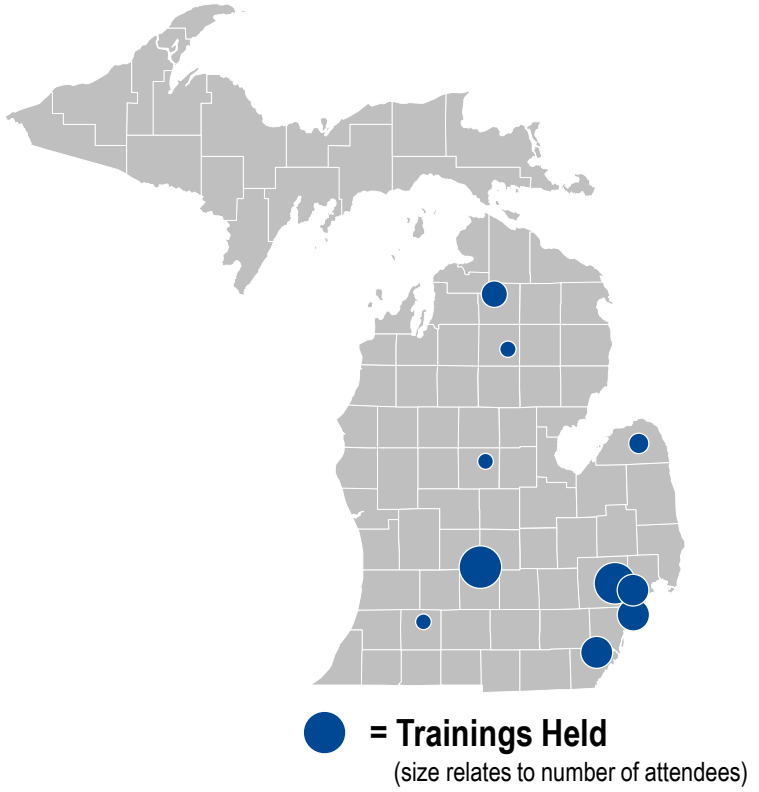
Allocation \ Attribution	30%	40%	50%
45%	11,300	15,070	18,840
50%	12,560	16,740	20,930

DTE Energy is currently building upon these findings by offering trainings to code officials and home builders on Michigan's updated energy code, with special attention paid to code elements with low observed performance. This effort, which began in February 2016, has already reached nearly 1,000 home builders or code officials across the state of Michigan. Despite modest potential savings, DTE was interested in continuing to engage with the home building community.

Table 1.17: Trainings Held

#	Event Name	Attendees	Location
1	Code Officials Conference of Michigan	185	Lansing
2	Sterling Heights City Hall	105	Sterling Hts
3	City of Detroit Building and Safety	100	Detroit
4	Battle Creek Building Department	58	Battle Creek
5	Monroe County	103	Monroe
6	HBANCL	14	Roscommon
7	SEMBOIA/DETROIT AIA	220	Troy
8	Home Builders of the Thumb	50	Bad Axe
9	Shiawassee HBA D'Mar Banquet	10	Owosso
10	Mt. Pleasant HBA	15	Mt. Pleasant
11	Northern Michigan Code Officials	75	Gaylord
TOTAL		**935**	

Figure 1.24: DTE Training Locations



Results of Michigan Residential Energy Code Field Study indicate potential of 5 GWh, 29 MMCF, and $1 million in annual statewide savings. The study revealed exterior wall insulation and high efficacy lighting as elements of Michigan's existing 2009 code where performance improvements would have the greatest impact. As Michigan transitions to an updated energy code in February 2016, additional opportunity for savings are available.

Key Michigan Residential Energy Code Field Study – Findings and Recommendations

- **Key question:** is there sufficient energy savings opportunity for DTE Energy and Consumers Energy to run a codes support program?
- Enhanced energy code performance has potential to achieve **5 GWh, 29 MMCF, and $1 million** worth of energy savings statewide ($165 - $275 annually per under-performing newly-constructed home). Roughly $750,000 in statewide savings result from offset electricity usage, and $250,000 result from offset gas usage.
- DTE Energy and Consumers Energy can reasonably expect to claim **10% - 25% of statewide savings**, depending on fuel type and attribution estimate.
- **Exterior Wall** and **High Efficacy Lighting represent over 90% of available savings** and the greatest opportunity to enhance performance.
- Statewide savings potential relative to Michigan's incoming energy code is **9 GWh, 84 MMCF, and $2.12 million**. When Michigan transitions to new energy code, Air Sealing will present additional savings opportunity; these three measures will account for over 90% of savings. Roughly $1,350,000 in statewide savings result from offset electricity usage, and $750,000 result from offset gas usage. Savings are based on observed practices relative to incoming code requirements