

The shortest distance between two points is under construction.

—Leo Aikman

	<u>Contents</u>	<u>Page</u>
Background		1
Measure Results		2
Additional Results		7

Residential Energy Code Field Study Results

Background

In 2018 a field study of Montana residential energy code compliance was carried out with funding from the U.S. Department of Energy and the Northwest Energy Efficiency Alliance. The research identified opportunities to reduce homeowner utility bills in residential single-family new construction by increasing compliance with the state energy code. The study was initiated in May 2018; data collection began in June 2018 and continued through September 2018. During this period, the project team visited 125 homes at various stages of construction, resulting in a data set based on observations made directly in the field. Public and private entities within the state can use this information to justify and catalyze future investments in energy code training and related energy efficiency programs.

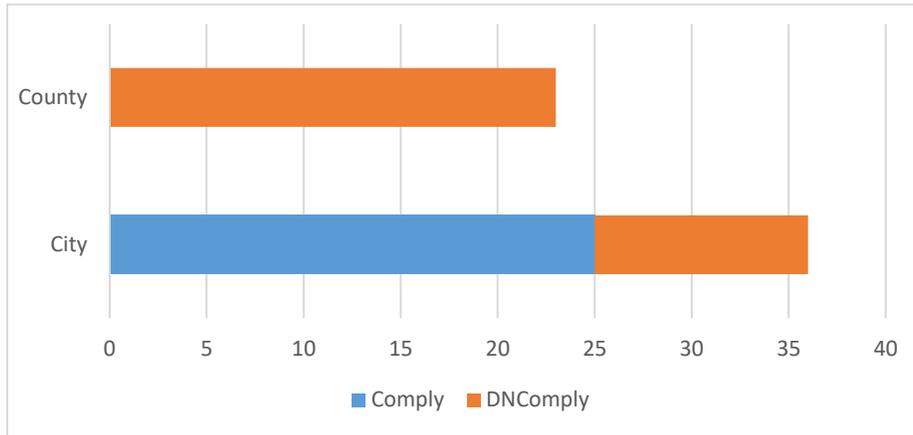
Methodology

The project team was led by an independent energy code consultant, with support from Cadmus and the Northwest Energy Efficiency Alliance. The team applied a methodology prescribed by the U.S. Department of Energy (DOE), which was based on collecting information for the energy code-required building components with the largest direct impact on energy consumption. The project team implemented a customized sampling plan representative of new construction single family homes within the state; the sampling plan was developed by Pacific Northwest National Laboratory (PNNL) and reviewed by the Montana Energy Code Collaborative.

The study was based on a single site visit to reduce burden and minimize bias. The study was designed to produce statistically significant results for state as a whole. Information differentiating results between city and county areas is not statistically valid but is illustrative of compliance patterns. Data confidentiality was built into the study—no occupied homes were visited, no personal data is shared, and results by jurisdiction are not available. The study plan was based on a proportional random sample. In other words, home locations were selected to represent building activity in the state.

About 25 percent of new homes are less efficient than a home that fully complies with the energy code. On the other hand, many homes use less energy than a home that is precisely as efficient as the energy code. Following are some of the more significant results from the study.

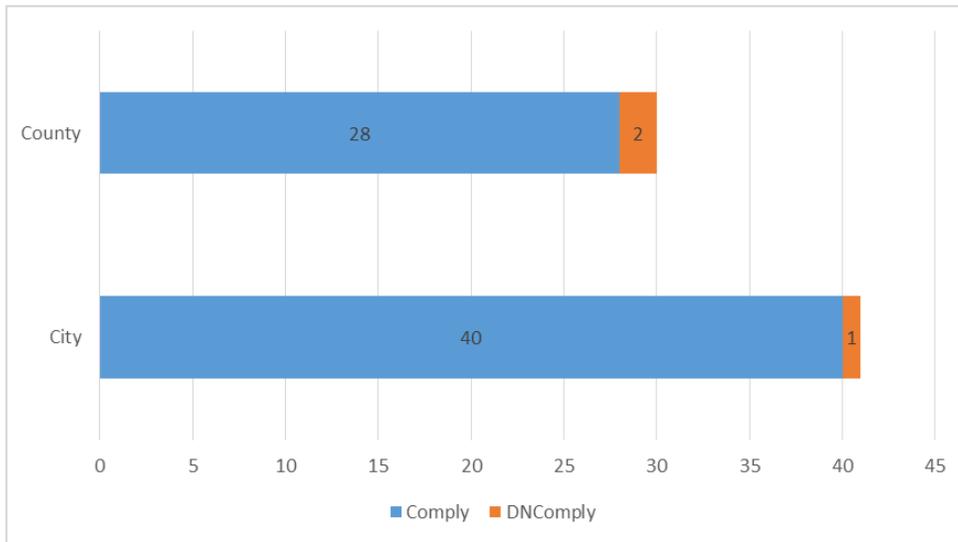
Energy Certificate Posted?



	Comply	DNComply	Total	% Comply
City	25	11	36	69%
County	0	23	23	0%
Total	25	34	59	42%

Observation: No homes located outside of city jurisdictions complied with the required energy label.

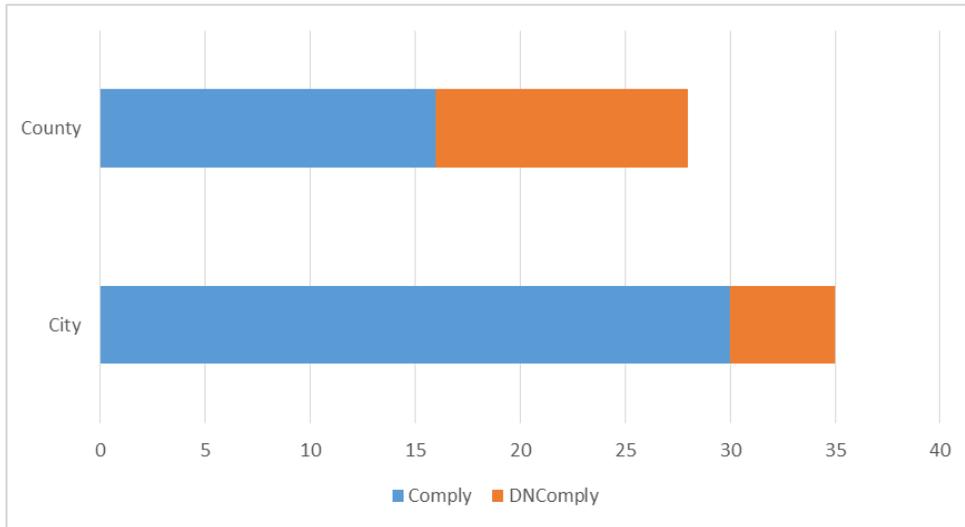
Window U-factor



	Comply	DNComply	Total	% Comply	Average Value
City	40	1	41	98%	0.29 U-Factor
County	28	2	30	93%	0.29 U-Factor
Total	68	3	71	96%	0.29 U-Factor

Observation: Window compliance was excellent. Average U-factor of 0.29 was considerably better than the maximum code requirement of U-0.32.

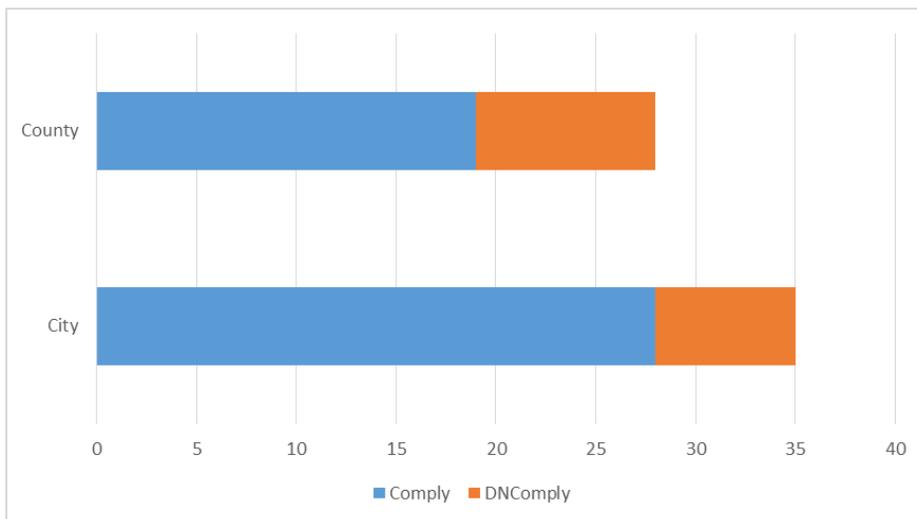
Building Tightness Testing (ACH50)



	Comply	DNComply	Total	% Comply	Average Value
City	30	5	35	86%	3.28 ACH50
County	16	12	28	57%	3.87 ACH50
Total	46	17	63	73%	3.54 ACH50

Observation: Houses located in cities were tighter than those located outside cities. All houses were tested at completion. All registers were installed, all weather-stripping was installed, and all access doors were installed.

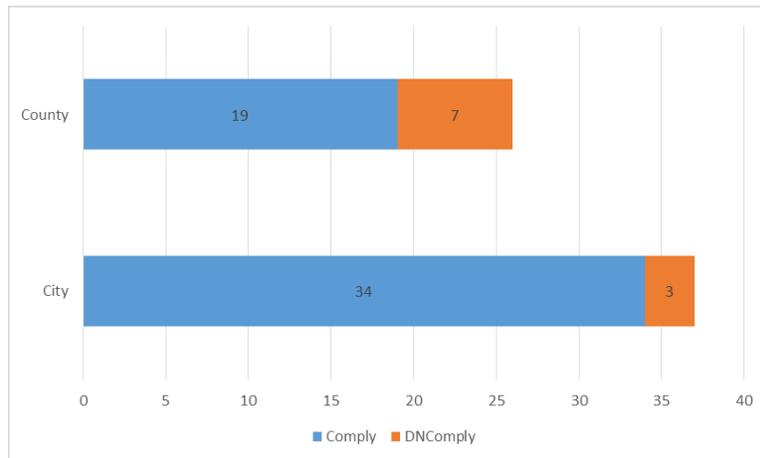
Thermal Envelope Sealed



	Comply	DNComply	Total	% Comply
City	28	7	35	80%
County	19	9	28	68%
Total	47	16	63	75%

Observation: Compliance with envelope air sealing is better in cities than outside of cities.

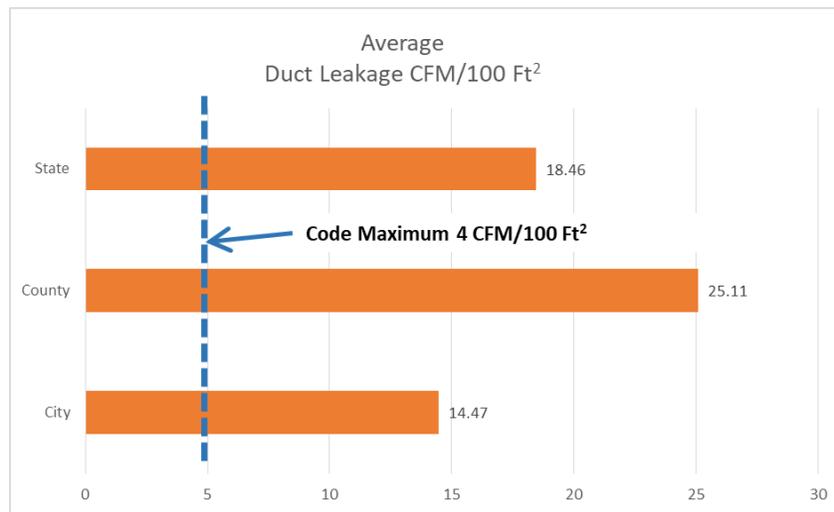
Crawl Space Vapor Retarder



	Comply	DNComply	Total	% Comply
City	34	3	37	92%
County	19	7	26	73%
Total	53	10	63	84%

Observation: Compliance with crawlspace floor Class I vapor retarders is better in cities than in counties.

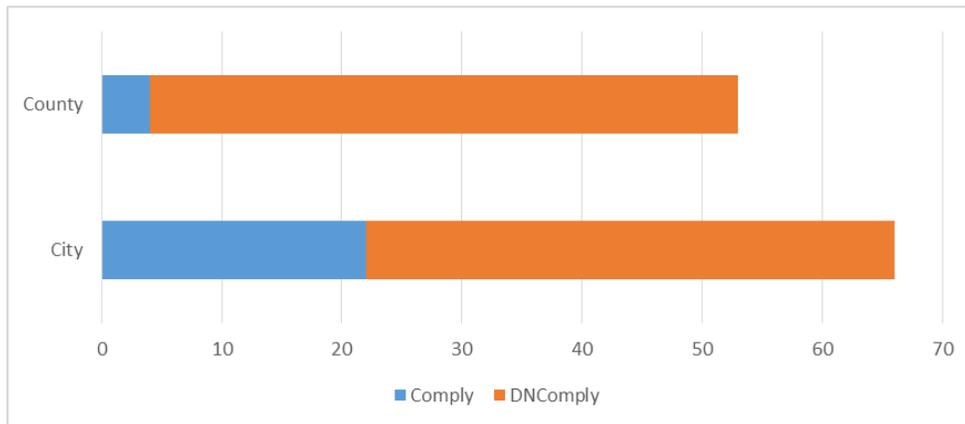
Total Leakage Duct Tightness Test Results



	Comply	DNComply	Total	% Comply	Average Value
City	0	35	35	0%	14.47 CFM/100 Ft ²
County*	0	29	29	0%	25.11 CFM/100 Ft ²
Total	0	64	64	0%	18.46 CFM/100 Ft ²

Observation: All of the houses tested exceeded the code limit. However testing is not required by code if all ducts and the air handler are located within the thermal boundary. In the study only a Total Leakage Test was performed. Montana allows a Leakage to the Outside Test which could allow a system to comply despite failing the Total Leakage Test. The leaky ducts are likely due, at least in part, to the fact that Montana allows building cavities to be used as return ducts. Return ducts are notoriously difficult to seal and can contribute to backdrafting of atmospherically vented combustion appliances.

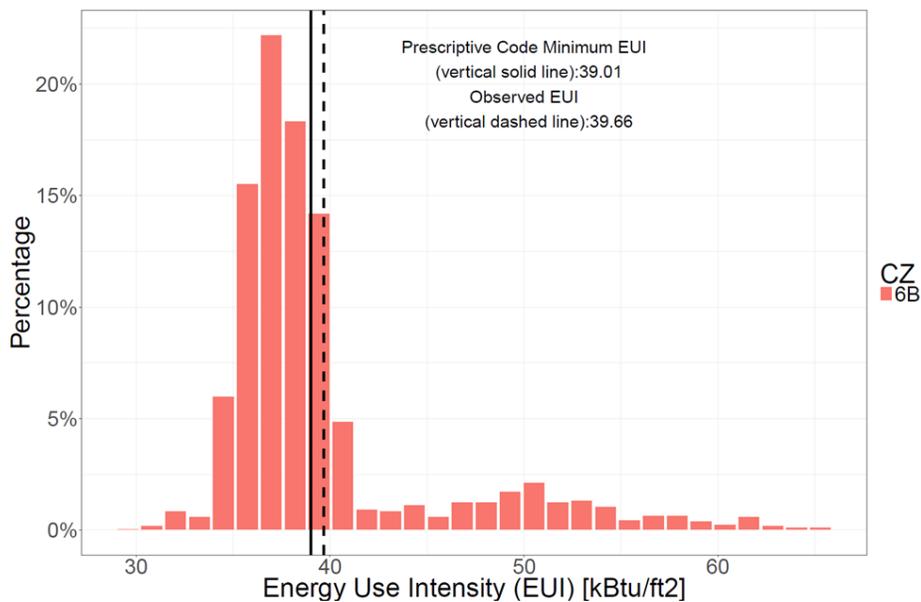
Air Ducts Sealed?



	Comply	DNComply	Total	% Comply
City	22	44	66	33%
County	4	49	53	8%
Total	26	93	119	22%

Observation: While duct sealing compliance is a problem for the state as a whole, compliance is poorer outside the cities. A majority of the homes tested used joist returns that were not sealed properly.

Energy Use Intensity



Observation: The homes in the percentage bars to the left of the dark vertical line are more efficient than a code built home. The homes to the right of the dark heavy vertical line are less efficient than a code built home. As a whole all new homes use slightly more energy than if all homes were built exactly at the energy code level of efficiency. In other words, the efficiency of the above code homes almost offset the inefficiency of the noncompliance homes. The owners of the homes to the right of the dark vertical solid line in the graph will in some cases see significantly poorer energy performance than home built to code.

Additional Results

Thermal Envelope

Average Home Size: 2,652 ft² and 1.33 stories

Foundation Types: Unvented crawlspaces (55%), heated basements (32%), and slab on grade (13%)

Attic access openings sealed (10%)

Knee walls sealed (3%)

Envelope areas behind bathroom tubs & showers sealed (7%)

Dropped ceilings sealed (4%)

Duct Systems

80% of duct systems located supply ducts entirely within conditioned space

82% of duct systems located return ducts entirely within conditioned space

81% of duct systems had the entire system within conditioned space

HVAC Equipment

Heating: Mostly gas furnaces (96%) with an average efficiency of 92 AFUE

Cooling: Mostly central AC (97%) with an average efficiency of 13 SEER

Water Heating: Mix of gas (64%) and electric (36%) storage (95%) with an average capacity of 51 gallons and average efficiency rating of EF 0.73

Lighting

Compliance with high efficacy fixtures/lamps (91%)



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Energize Montana Energy Code Website:
<http://deq.mt.gov/Energy/EnergizeMT/EnergyCode>