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Evaluating Lost Energy Savings – What Do We Know So Far?

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A Need to Evaluate Lost Energy Savings

- ▶ We know buildings do not comply with all code requirements
- ▶ How much energy savings are lost?
- ▶ Which requirements have largest impact?
- ▶ How can we reduce the lost energy savings?

- ▶ Forget the question; “does it comply?” Instead:



What Do We Know So Far?

A.K.A. Literature Review



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Principal Investigator	Year	State(s)
Baylon	1991	WA, OR
Baylon	1992	WA, OR
Baylon	1997	WA
MPUC	2004	NA
BMG	2005	IN
Quantec	2007	CA
Ecotope	2008	ID, MT, OR, WA
KEMA	2010	CA
Misuriello	2010	NA
PNNL	2010	NA
APEC	2011	IL

Principal Investigator	Year	State(s)
Navigant	2011	NA
Wirtshafter	2011	NY
Cadmus	2012	CA
KEMA	2012	MA
Meres	2012	NA
Navigant	2012	VT
Southface	2012	NA
VEIC	2012	NY
DOE	2013	GA, WI, UT, VY, NY
BMG	2014	NE
Elnecave	2014	IL



Goals of the Literature Review

Category	Research Questions
Compliance Definition	Was compliance defined? If yes, what was the definition?
Research Methodology	What was the research question? Was study hypothesis validated?
Sample Size	What was the sampling method? What was the sample size and was it considered to be representative?
Building Evaluation	How were buildings and documents accessed? Which requirements were checked? Were there site visits?
Cost	What was the cost of verification? What level of effort was required for verifying different requirements?

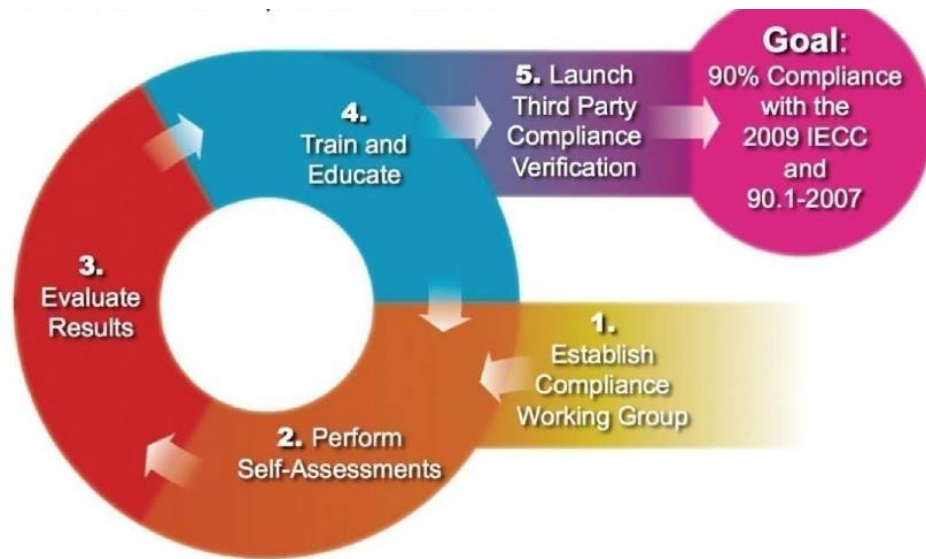


Compliance Definition

No.	Definition	Count
1	All requirements must be met (binary)	2
2	Compliance by system	3
3	Percentage of requirements met (BECP)	7
4	Not defined	8
5	Through Modeling	1



Research Methodology



BECP Methodology
2010

	Study	BECP	Northwest	Attribution
Pilot Studies	GA 2011	X		
	WI 2011	X		
	UT 2011	X		
Other evaluation studies	WA & OR 1991		X	
	WA & OR 1992		X	
	WA 1997		X	
	ID, MT, OR, WA 2008		X	
	CA 2010			X
	IL 2011	X		
	IL 2014			X
	NE 2014	X		
	MA 2012			X
	NY 2012	X		
VT 2011	X			



Sample Size

Parameter	Value
Data source	Dodge , state office
Sampling method	Convenience, simple random , stratified random, not reported
Stratification	
size	Yes , no
climate	Yes, no, partial, single zone state, not reported
geographic	Yes , no, partial, not reported
building type	Not reported
NC vs renovation	Yes, no, not reported
Sample size justification	Statistical, state sample generator (BECF), not reported
Confidence interval reported	Yes, no, not reported



Building Evaluation

- ▶ Plan review vs field inspection
- ▶ Compliance verification of all requirements vs focus on areas of particular concern
- ▶ Checking of compliance with controls requirements
- ▶ Spot checking
- ▶ Shortcuts
- ▶ Estimate of lost energy savings
 - VEIC 2012: Lost energy savings of \$8.8 million annually in the state of NY

The ~~million~~ billion dollar question:

How much does it cost to evaluate compliance in a commercial building?

- ▶ Cost reported in only four studies
 - Three DOE ARRA-related studies: GA, WI, northwest lighting study
 - Illinois: APEC 2011

- ▶ 127 buildings evaluated between the four studies at a cost of \$511,000
- ▶ Average cost per building: \$4,000
 - Sample size, building size can impact cost
 - Residential vs. commercial
 - Average cost may not be representative



Summary – What Did We Learn?

The Good

Many states showed compliance rates above 80%

Single site visit occurring post-occupancy

Average cost \$4,000 (though this may not be representative)

The Bad

Sample bias. Compliance not well-defined

Single site visit occurring post-occupancy

Focus on new construction

The Ugly

Sample size not sufficient

Requirements impacting energy use were ignored

Difficulty in accessing code compliance documentation and buildings



Future Work

Start Simple

1 building
1 climate zone
1 code



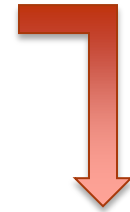
Rank requirements

by potential lost
energy savings



Field study

Evaluate effort
required to verify
compliance for each
requirement



Re-rank requirements

Based on lost energy savings
and level of effort for
verification



Understand what can
and can't be done

- ▶ Is a commercial compliance study feasible?
- ▶ If yes, then create methodology with a focus on quantifying lost energy savings

Thank you!



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Questions?

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