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Columbia Gas of Pennsylvania
A NiSource Company

Health and Safety Investments to Increase Energy-Saving Opportunities

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Presentation Overview

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- Columbia Gas LIURP Background
- LIURP Health & Safety Approach
- Assessing the Problem
- Current Health and Safety Investments
- LIURP Savings Results
- Potential Savings for Homes with Health and Safety Problems
- Decision Framework for Additional Health and Safety Investments

Columbia Gas of Pennsylvania

- Serve 26 counties
- Roughly 380,000 residential customers
- Census Data – 100,000 low income
- Mandated Universal Service Programs

Columbia LIURP

- Low Income Usage Reduction Program
- Mandated in 1988
- Spending & Production Increases
- Primary metrics – Production Goals & Savings

LIURP Production

- Current Budget $4,750,000
- 500 – 550 homes completed
- Company administered
- Contractor installed measures

Production Issue

- Ratio of Referral to Completion decreasing
- >2000 pre screens to reach production goals
- Review of Reasons & Analysis

Bottom Line = Housing Conditions preventing Weatherization and limited (no) funding resources

Health & Safety Deep Dive

- High Deferral rate
- Been walking away for 20 years
- High cost of Deferred jobs
- No Wx = Continued High CAP bill subsidy

Current H&S Approach

- Fixed CAP on H&S costs per job
- Soft CAP on total spend per job
- Contractor determines deferral decisions
- Average deferral rate – greater than 50%

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ASSESSING THE PROBLEM

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Nonprofit Research Institute

- Established in 2002
- Princeton, NJ

Mission

- Analyze data and information to assess and improve public programs

Research Areas

- Energy Efficiency
- Energy Affordability

Clients

- Federal Government (DOE, HHS)
- State Governments
- Utility Companies
- Nonprofits

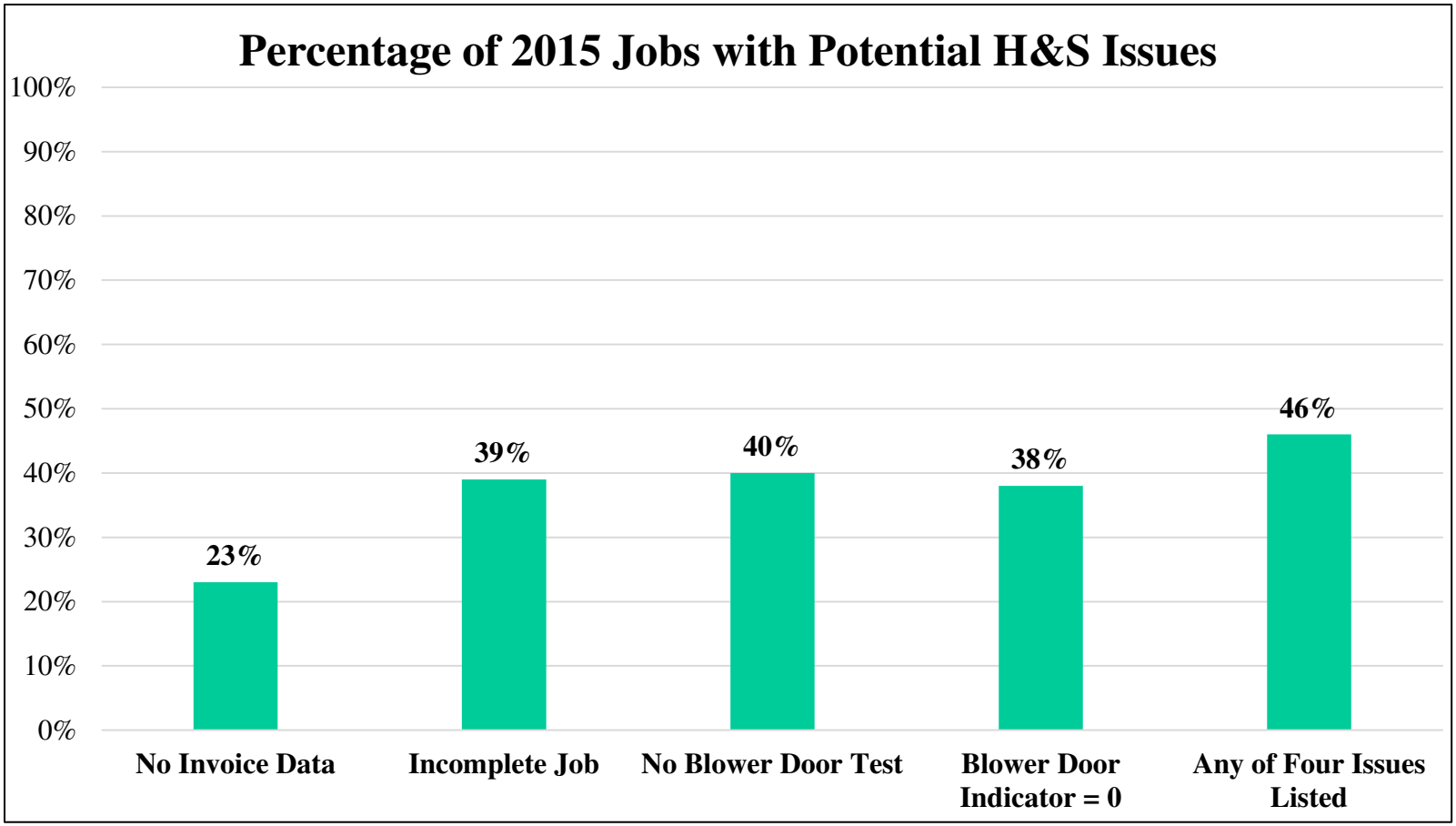
Low-Income EE Challenge

- Low-Income Energy Efficiency
  - Increased challenges serving households
  - Significant health and safety issues
  - Prevent installation of major measures
  - Lost potential for high-usage customers
- Where/when can additional cost-effective health and safety investments be made?

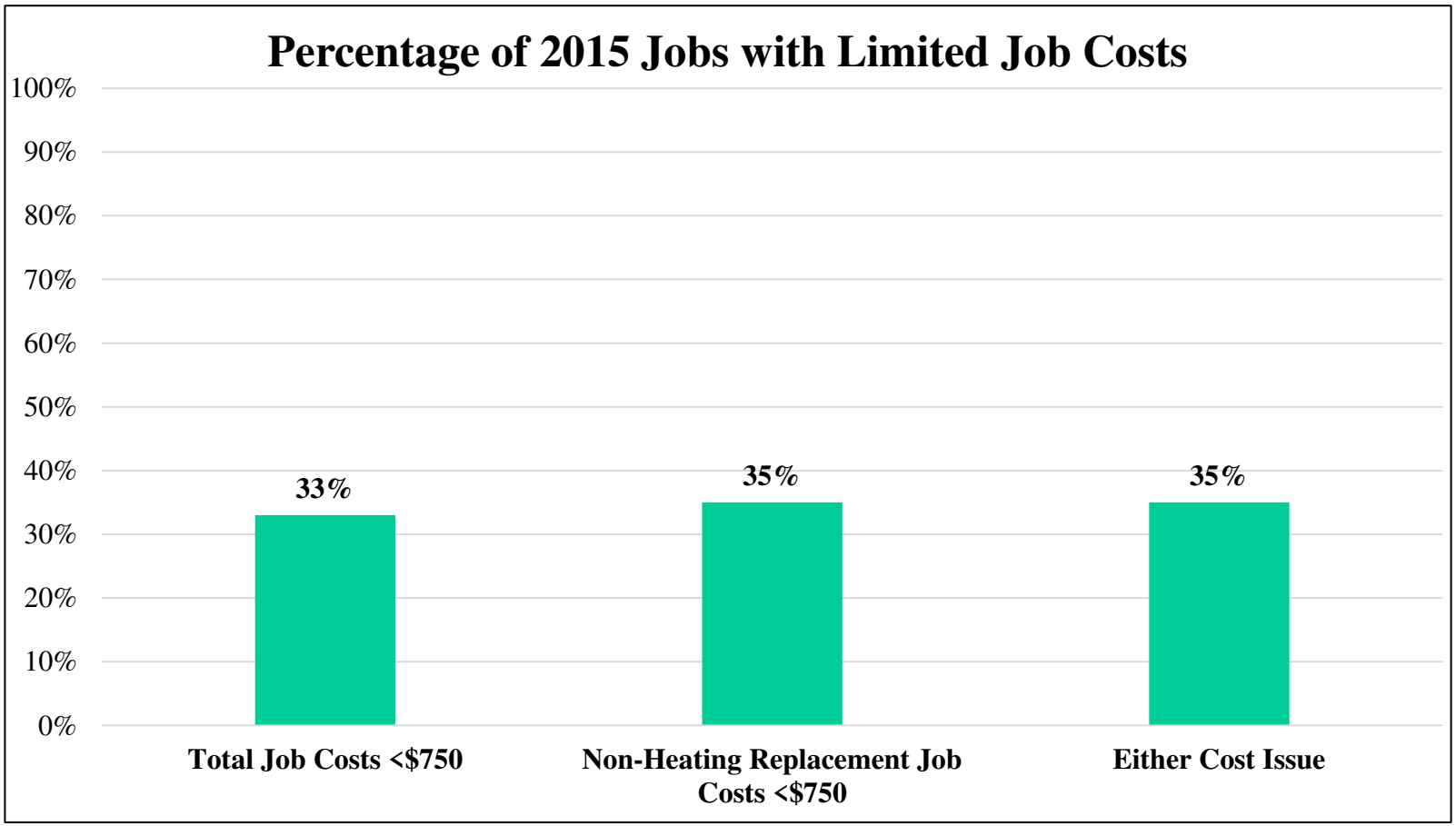
Assessing the Problem Methodology

1. Analyze 2015 LIURP Database
2. Review cancelled job spreadsheet
3. Review job paperwork
4. Initial indicators of health and safety issues that prevented work
   - No measure or invoice data
   - Job marked as incomplete
   - No blower door test data
   - Blower door indicator marked as not conducted

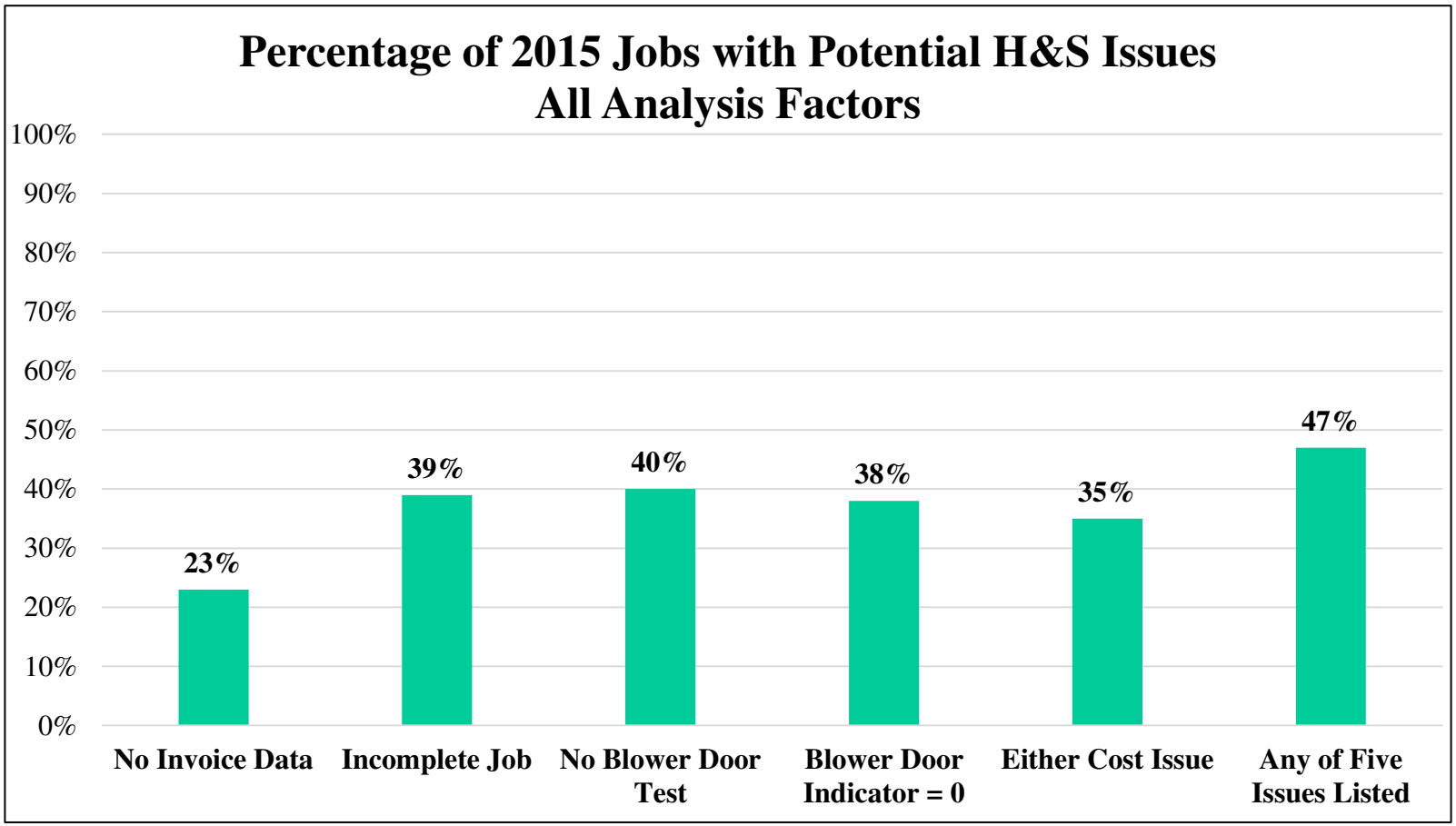
Jobs with Potential H&S Issues



Jobs with Potential H&S Issues



Jobs with Potential H&S Issues



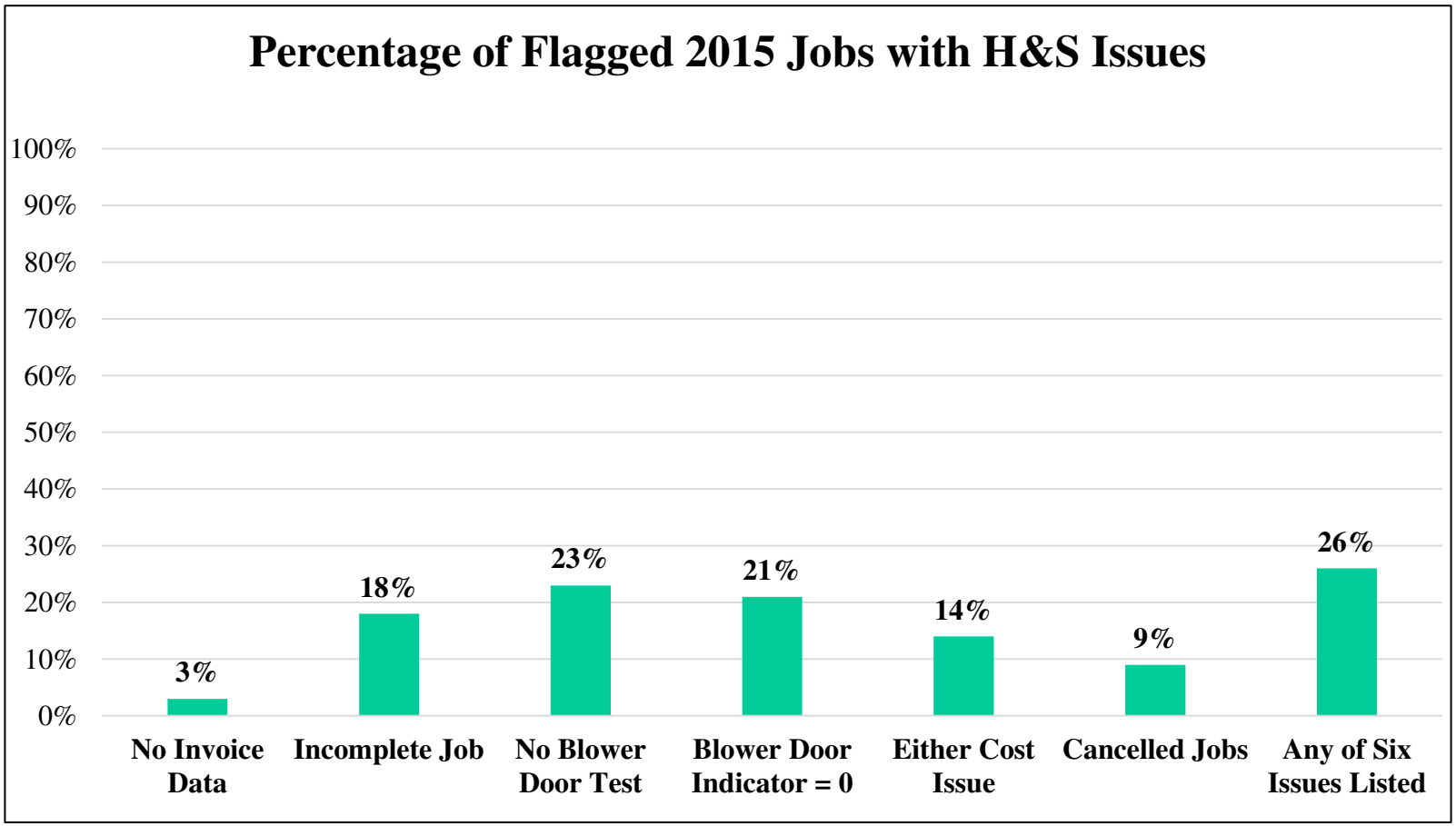
Assessing the Problem Methodology

- Merge jobs with potential H&S issues with the cancelled/deferred jobs spreadsheet
  - 467 2015 jobs with potential issues
  - 329 in cancelled/deferred spreadsheet
  - 91 due to health and safety issues
  - Others due to refusal, ineligibility, etc.

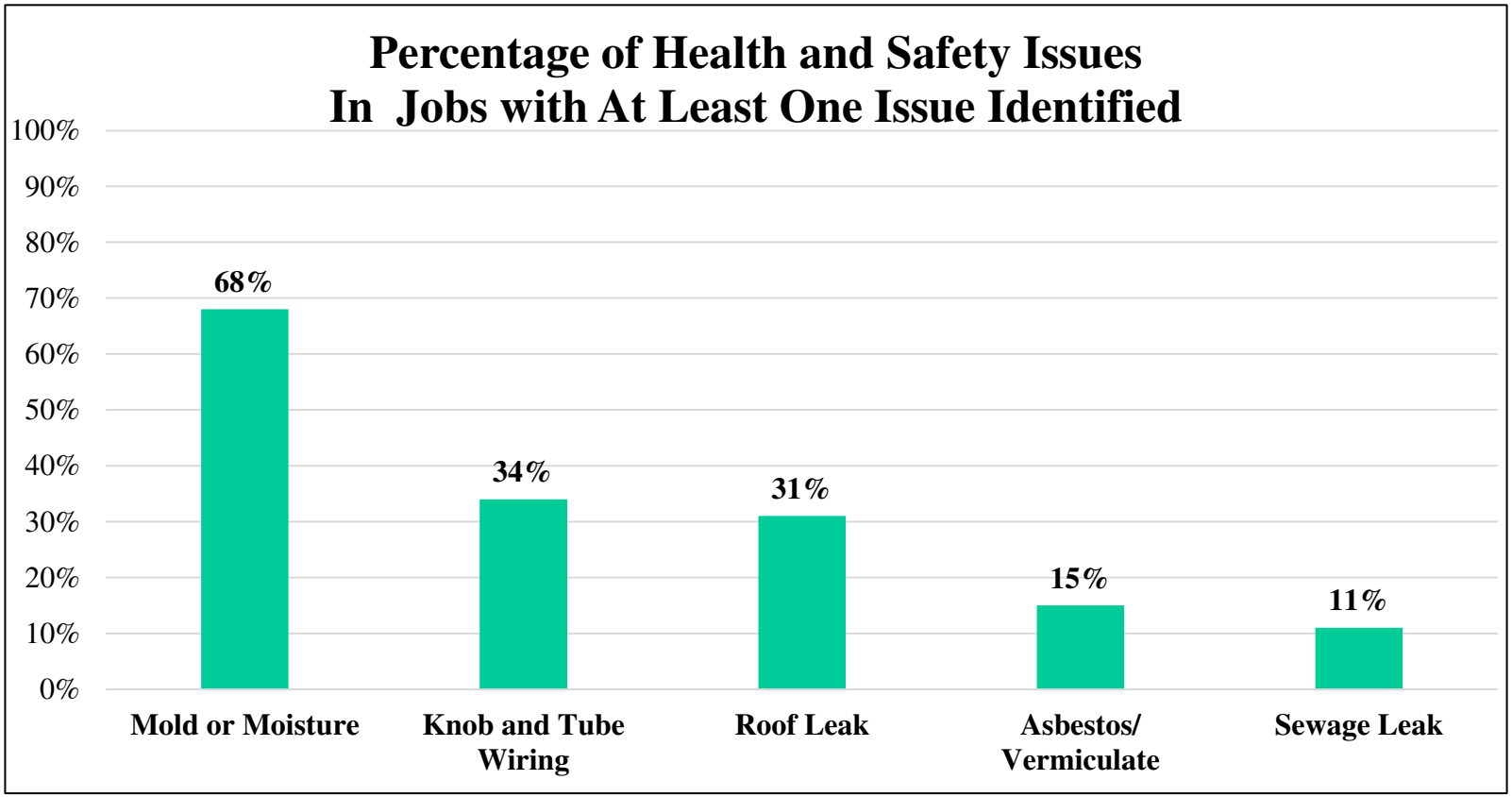
Assessing the Problem Methodology

- Request 229 job files
  - 91 cancelled/deferred due to health and safety issues
  - 138 identified as having a potential health and safety issue, but not in cancelled/deferred spreadsheet
- Review job files – audit form, work scope, measure invoice(s)
- Assess whether H&S issue prevented work
- 122 jobs had at least one H&S issue (12% of all 2015 jobs)

Frequency of H&S Issues



Frequency of Specific Health and Safety Issues



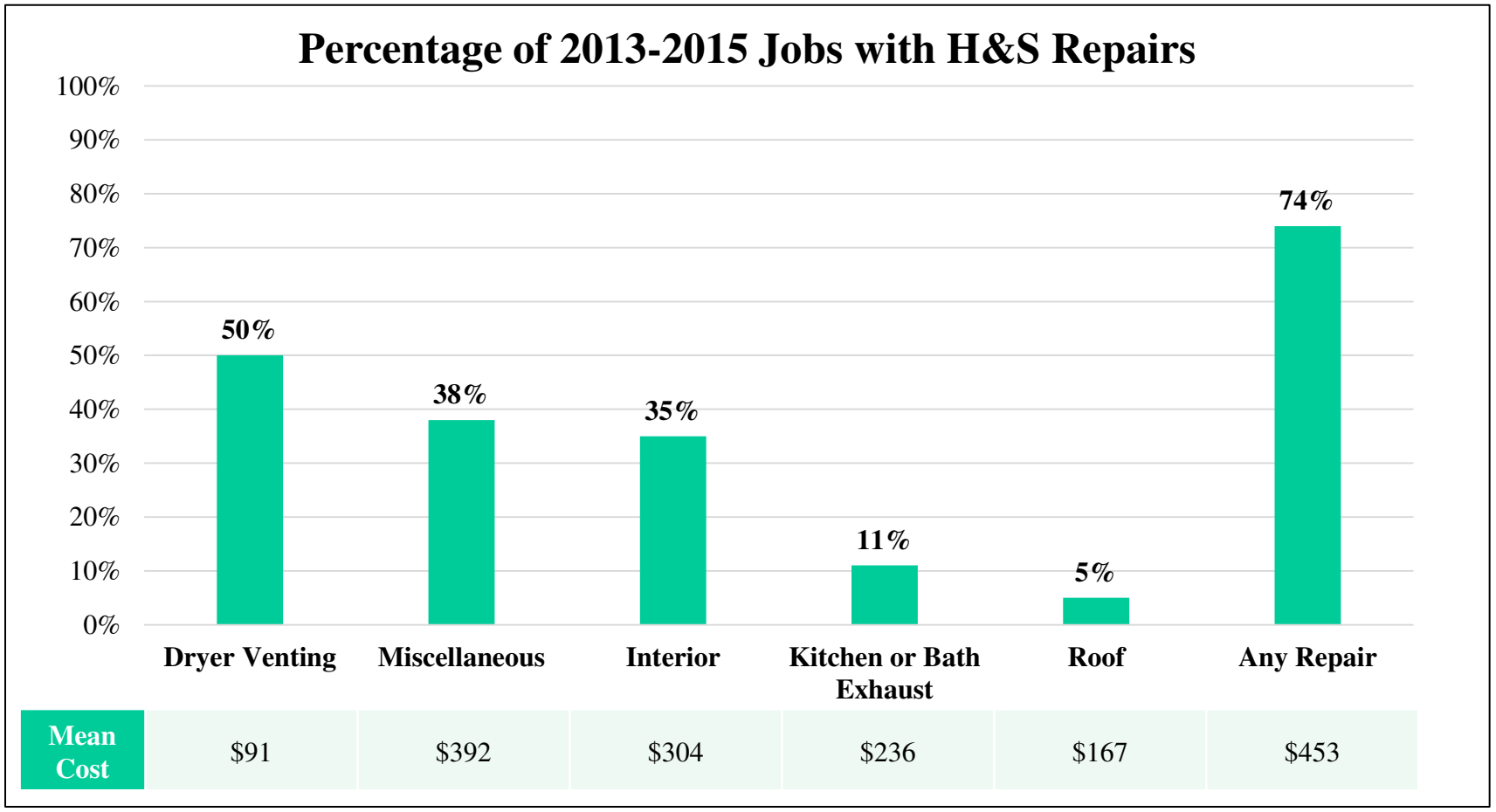
Other Issues:		
	• Infestation	• Structural Issues
	• Holes in Attic Floor	• Clutter

CURRENT HEALTH AND SAFETY APPROACH

Health and Safety Remediation Approach

- Spend up to $650 for owner or renter
- Renter – spending usually related to HVAC
- Owner – could be roof patch, small amount of mold, etc.
- Contractors request additional H&S spending
  - Approved based on potential savings

Health and Safety Repairs



Health and Safety Spending Distribution

Repair Issue	Repair Cost (For 2013-2015 Jobs with Repair)							
	Mean	Percentile						
		Min	10	25	50	75	90	Max
Dryer Venting	$91	$10	$57	$75	$90	$91	$119	$635
Miscellaneous	$392	$0	$31	$48	$102	$239	$1,388	$6,464
Interior	$304	$8	$75	$112	$153	$345	$684	$2,654
Kitchen or Bath Exhaust	$236	$28	$82	$125	$202	$350	$420	$1,016
Roof	$167	$20	$70	$85	$85	$170	$370	$850
Total – Any Repair	**$453**	**$0**	**$80**	**$105**	**$230**	**$440**	**$1,025**	**$6,625**

LIURP SAVINGS RESULTS

Weather-Normalized Energy Savings

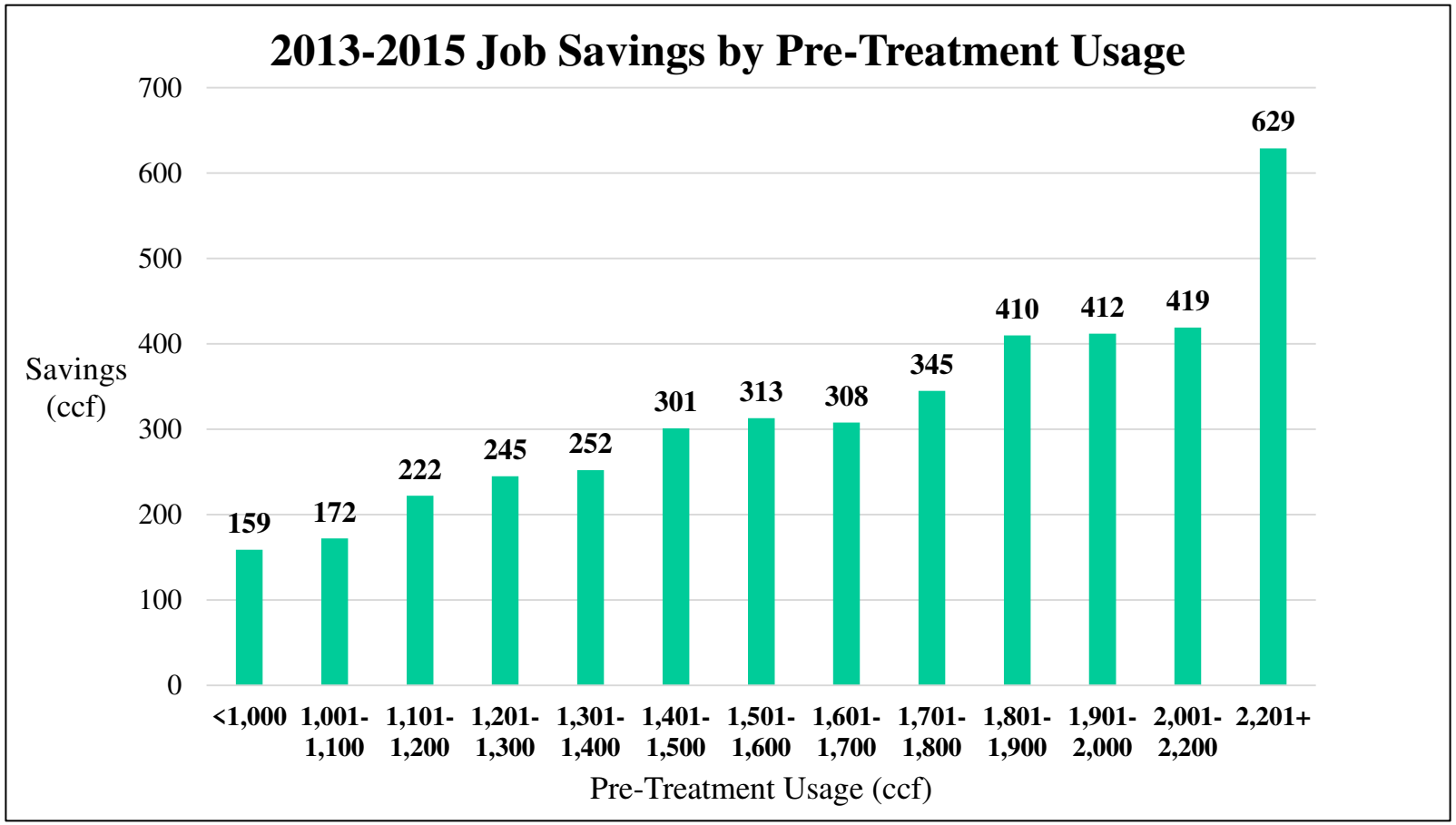
- 2013, 2014, and 2015 jobs
- Energy savings based on billing data
- 3-year analysis to allow for disaggregation
  - Pre-treatment usage
  - Contractor
  - Measures
  - Job costs

Weather-Normalized Gas Savings Analysis

Analysis Group	Observations	Usage (ccf)		Savings	
		Pre	Post	ccf	%
2015	533	1,449	1,191	258**	17.8%
2013-2015	1,398	1,515	1,211	304**	20.1%

**Denotes significance at the 99 percent level.

Savings by Pre-Treatment Usage



Savings by Pre-Treatment Usage

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Pre-Treatment Usage (ccf)	2013-2015 Participants					
	Obs.	Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
<1,000	104	$5,514	927	767	159**	17.2%
1,001-1,100	122	$4,935	1,049	877	172**	16.4%
1,101-1,200	118	$5,672	1,151	929	222**	19.3%
1,201-1,300	136	$5,307	1,249	1,004	245**	19.6%
1,301-1,400	159	$5,288	1,349	1,097	252**	18.7%
1,401-1,500	125	$5,574	1,448	1,147	301**	20.8%
1,501-1,600	151	$5,135	1,547	1,234	313**	20.2%
1,601-1,700	112	$5,217	1,648	1,340	308**	18.7%
1,701-1,800	89	$5,130	1,746	1,402	345**	19.8%
1,801-1,900	67	$5,648	1,847	1,436	410**	22.2%
1,901-2,000	54	$6,169	1,947	1,535	412**	21.2%
2,001-2,200	60	$6,408	2,082	1,663	419**	20.1%
2,201+	101	$7,601	2,627	1,999	629**	23.9%

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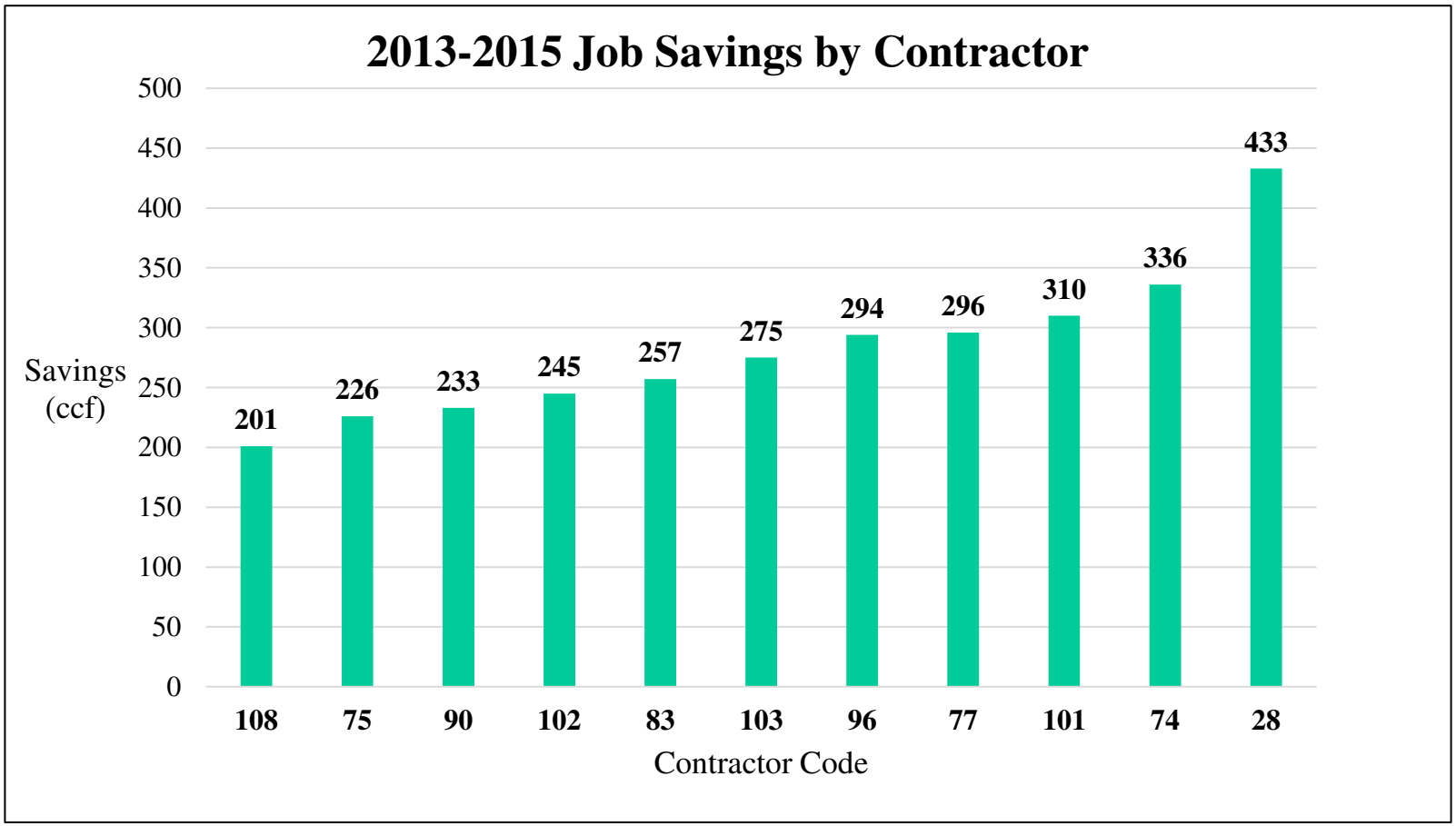
Savings by Contractor

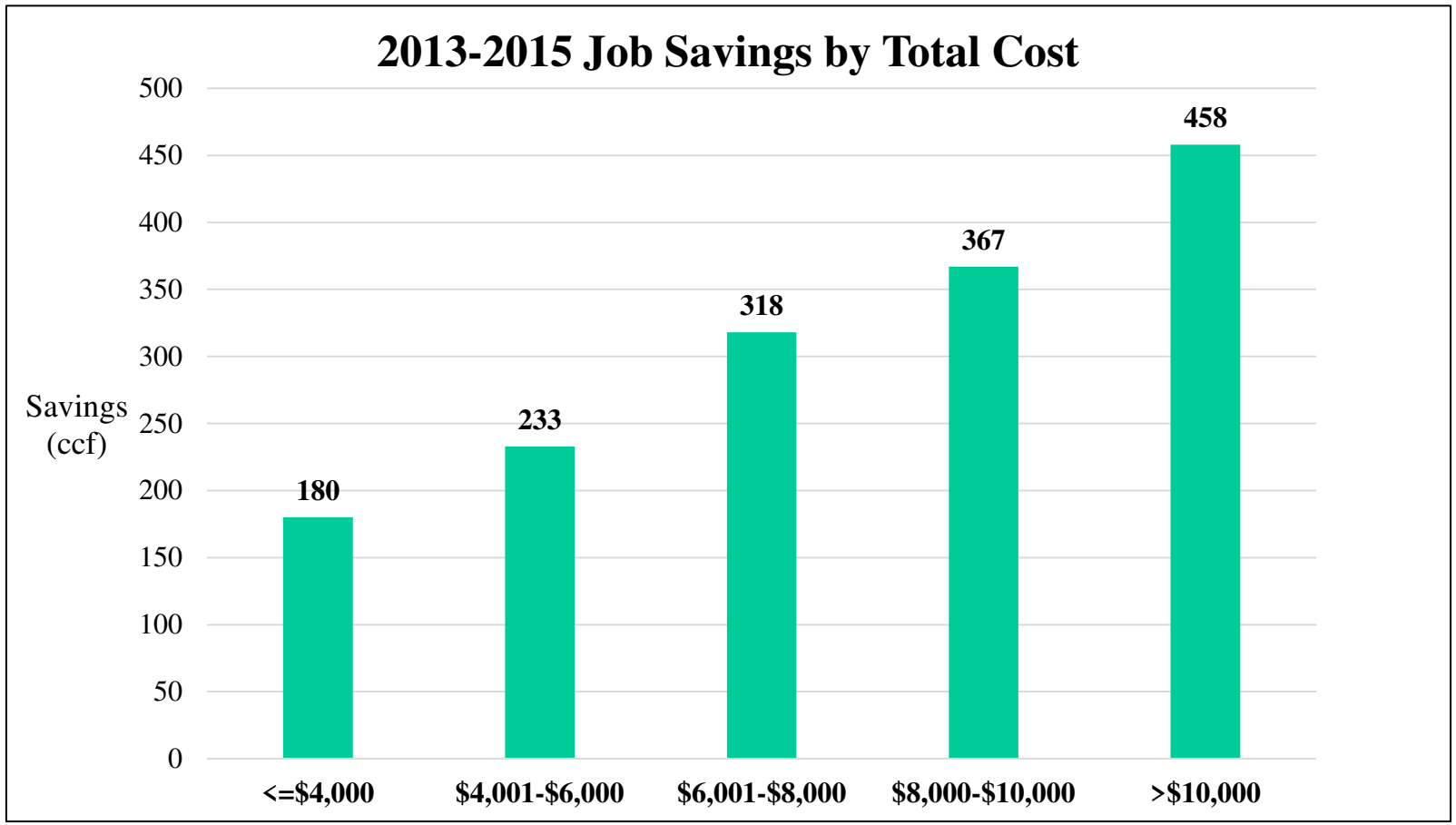


Savings by Contractor

Contractor Code	2013-2015 Participants					
	Obs.	Mean Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
28	306	$8,184	1,573	1,140	433**	27.5%
83	169	$4,968	1,528	1,270	257**	16.8%
101	121	$8,322	1,478	1,168	310**	21.0%
74	108	$7,836	1,458	1,121	336**	23.1%
96	98	$5,160	1,436	1,141	294**	20.5%
90	96	$7,046	1,420	1,187	233**	16.4%
102	81	$5,105	1,619	1,374	245**	15.1%
77	78	$5,979	1,467	1,171	296**	20.2%
108	76	$8,052	1,317	1,116	201**	15.3%
75	66	$5,445	1,526	1,299	226**	14.8%
103	57	$7,677	1,716	1,441	275**	16.0%
Others	142	$7,852	1,558	1,306	253**	16.2%

**Denotes significance at the 99 percent level.

Savings by Total Cost

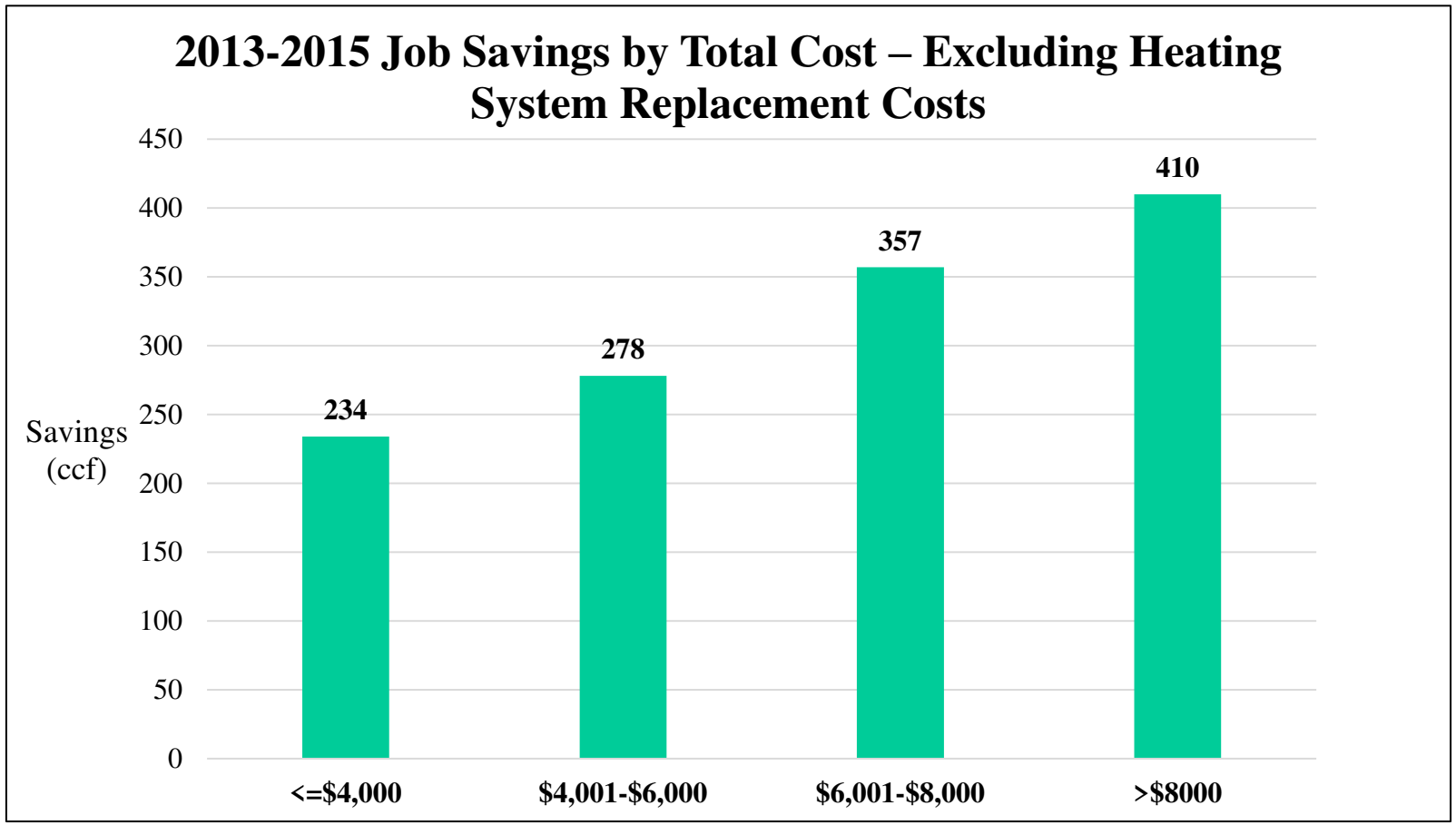


Savings by Total Cost

Total Cost	Obs.	Mean Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
<=$4,000	264	$2,806	1,492	1,312	180**	12.1%
$4,001-$6,000	336	$5,112	1,505	1,272	233**	15.5%
$6,001-$8,000	320	$6,970	1,511	1,192	318**	21.1%
$8,000-$10,000	230	$8,898	1,504	1,137	367**	24.4%
>$10,000	248	$12,288	1,571	1,113	458**	29.2%

**Denotes significance at the 99 percent level.

Savings by Total Cost



Savings by Cost – Excluding Heating System Replacement

Total Cost (Excluding Heating System Replacement)	2013-2015 Participants					
	Obs.	Mean Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
<=$4,000	451	$2,434	1,505	1,271	234**	15.5%
$4,001-$6,000	374	$5,101	1,497	1,218	278**	18.6%
$6,001-$8,000	353	$6,966	1,488	1,131	357**	24.0%
>$8,000	220	$11,341	1,612	1,202	410**	25.4%

**Denotes significance at the 99 percent level.

Savings by Measures Installed

Measure Installed	2013-2015 Participants					
	Observations	Mean Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
Blower Door Test						
Yes	1,282	$7,188	1,513	1,204	310**	20.5%
No	116	$4,902	1,537	1,291	247**	16.0%
Blower Door Guided Air Sealing						
Yes	618	$7,110	1,517	1,195	323**	21.3%
No	780	$6,909	1,514	1,224	290**	19.2%

**Denotes significance at the 99 percent level.

Savings by Measures Installed (cont.)

Measure Installed	2013-2015 Participants					
	Observations	Mean Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
Blower Door Guided Air Sealing & Insulation						
Yes	563	$7,403	1,513	1,173	339**	22.4%
No	835	$6,724	1,517	1,236	281**	18.5%
Heating System Repair						
Yes	390	$7,394	1,467	1,191	275**	18.8%
No	1,008	$6,845	1,534	1,218	316**	20.6%
Heating System Replacement						
Yes	599	$8,762	1,526	1,133	392**	25.7%
No	799	$5,676	1,508	1,269	239**	15.8%

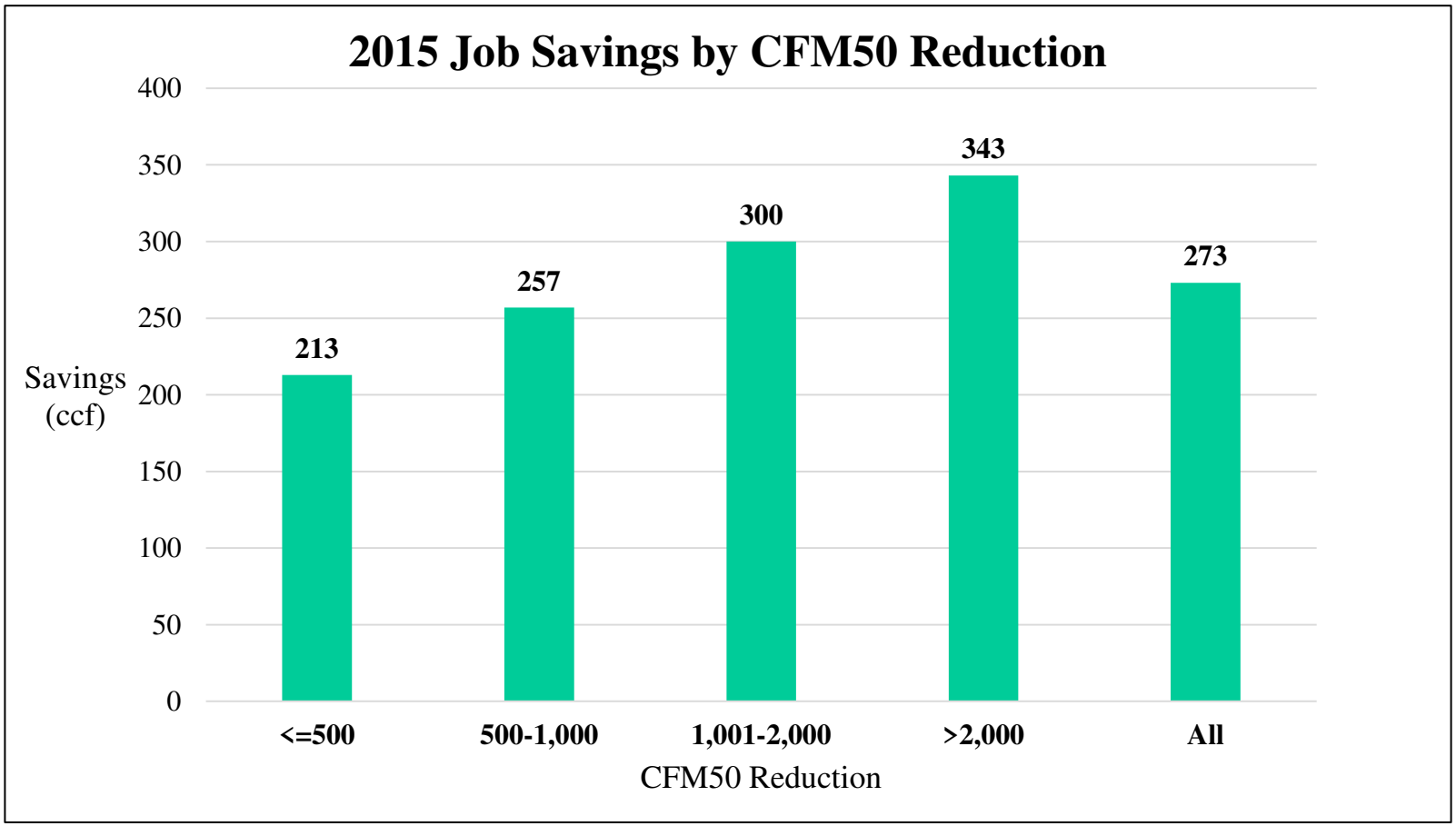
**Denotes significance at the 99 percent level.

Savings by Measures Installed (cont.)

Measure Installed	2013-2015 Participants					
	Observations	Mean Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
Duct Work						
Yes	546	$7,097	1,458	1,115	343**	23.5%
No	852	$6,935	1,552	1,272	280**	18.0%
Health & Safety Repairs						
Yes	1,028	$7,433	1,508	1,190	317**	21.0%
No	370	$5,789	1,537	1,267	270**	17.5%

**Denotes significance at the 99 percent level.

Savings by Leakage Reduction



Savings by Leakage Reduction

CFM50 Reduction	2015 Participants					
	Obs.	Mean Total Cost	Usage (ccf)		Savings	
			Pre	Post	ccf	%
<=500	140	$7,183	1,437	1,224	213**	14.8%
500-1,000	80	$6,771	1,430	1,174	257**	17.9%
1,001-2,000	111	$7,373	1,408	1,107	300**	21.3%
>2,000	96	$8,880	1,585	1,242	343**	21.6%
All	427	$7,537	1,461	1,188	273**	18.7%

**Denotes significance at the 99 percent level.

POTENTIAL SAVINGS FOR HOMES WITH HEALTH AND SAFETY PROBLEMS

Potential Savings

- Predict energy savings
- Regression analysis
- Job-related factors

Regression Analysis 2013 - 2015

Variable	2013-2015 Participants (1,372 observations)		
	Coefficient	95% Confidence Interval	
Pre-Treatment Usage (ccf)	0.30	0.27	0.32
Home Age	-1.06	-1.51	-0.61
Square Feet	-0.09	-0.11	-0.07
Blower Door and Air Sealing Cost	0.05	0.04	0.05
Heating System Replaced (yes/no)	154.56	131.84	177.28
Duct Sealing (yes/no)	55.80	32.41	79.19
Contractor #74	79.58	36.48	122.67
Contractor #77	73.69	23.52	123.86
Contractor # 102	-72.10	-119.97	-24.22
Contractor # 103	-106.37	-162.50	-50.24
Constant	-73.01	-135.24	-10.79

DECISION FRAMEWORK FOR ADDITIONAL HEALTH AND SAFETY INVESTMENTS

Modelled Scenarios Decision Framework

- Determine how much to spend on health and safety remediation
- Modelled range of pre-treatment usage, home age, size, and measure investments
- Model calculates
  - Predicted ccf savings
  - % savings
  - Present discounted value of savings
  - Max that can be spent on H&S

Model Assumptions

- 12-year measure life
- Gas price at time of study: $1.04723/therm
- 5% discount rate
- Also shows results with no discounting

Model Scenarios – Scenario 1

User Entered Fields	Scenario 1
Pre-Treatment Therms	1,500
Home Age	50
Square Feet	1,500
Air seal + Insulation Cost	$800
Heat Sys Replace (yes=1)	0
Duct Sealing (yes=1)	0
Contractor 74	0
Contractor 102	0
Contractor 77	0
Contractor 103	0
Heat Sys Cost	0
Other Non H&S Costs	$800

Calculated Fields (5% Discount)	Scenario 1
Annual Savings (Therms)	214
Calculated % Savings	14%
PDV Savings (Therms)	1,897
Max Spending	$1,986
Total Non H&S Costs	$1,600
H&S Allowance	$386

Calculated Fields (No Discount)	Scenario 1
12-Year Savings (Therms)	2,568
Max Spending	$2,689
H&S Allowance	$1,089

Model Scenarios – Scenario 2

User Entered Fields	Scenario 2
Pre-Treatment Therms	1,600
Home Age	30
Square Feet	1,250
Air seal + Insulation Cost	$1,400
Heat Sys Replace (yes=1)	0
Duct Sealing (yes=1)	1
Contractor 74	0
Contractor 102	1
Contractor 77	0
Contractor 103	0
Heat Sys Cost	$0
Other Non H&S Costs	$800

Calculated Fields (5% Discount)	Scenario 2
Annual Savings (Therms)	301
Calculated % Savings	19%
PDV Savings (Therms)	2,672
Max Spending	$2,798
Total Non H&S Costs	$2,200
H&S Allowance	$598

Calculated Fields (No Discount)	Scenario 2
12-Year Savings (Therms)	3,618
Max Spending	$3,789
H&S Allowance	$1,589

Model Scenarios – Scenario 3

User Entered Fields	Scenario 3
Pre-Treatment Therms	2,500
Home Age	100
Square Feet	2,000
Air seal + Insulation Cost	$1,000
Heat Sys Replace (yes=1)	1
Duct Sealing (yes=1)	0
Contractor 74	0
Contractor 102	0
Contractor 77	0
Contractor 103	0
Heat Sys Cost	$3,500
Other Non H&S Costs	$1,000

Calculated Fields (5% Discount)	Scenario 3
Annual Savings (Therms)	578
Calculated % Savings	23%
PDV Savings (Therms)	5,126
Max Spending	$5,368
Total Non H&S Costs	$5,500
H&S Allowance	-$132

Calculated Fields (No Discount)	Scenario 3
12-Year Savings (Therms)	6,940
Max Spending	$7,267
H&S Allowance	$1,767

Model Scenarios – Scenario 4

User Entered Fields	Scenario 4
Pre-Treatment Therms	3,800
Home Age	100
Square Feet	3,200
Air seal + Insulation Cost	$2,700
Heat Sys Replace (yes=1)	1
Duct Sealing (yes=1)	1
Contractor 74	1
Contractor 102	0
Contractor 77	0
Contractor 103	0
Heat Sys Cost	$3,500
Other Non H&S Costs	$1,000

Calculated Fields (5% Discount)	Scenario 4
Annual Savings (Therms)	1,075
Calculated % Savings	28%
PDV Savings (Therms)	9,527
Max Spending	$9,977
Total Non H&S Costs	$7,200
H&S Allowance	$2,777

Calculated Fields (No Discount)	Scenario 4
12-Year Savings (Therms)	12,898
Max Spending	$13,507
H&S Allowance	$6,307

Model Scenarios – Scenario 5

User Entered Fields	Scenario 5
Pre-Treatment Therms	5,000
Home Age	100
Square Feet	3,200
Air seal + Insulation Cost	$5,000
Heat Sys Replace (yes=1)	1
Duct Sealing (yes=1)	1
Contractor 74	0
Contractor 102	0
Contractor 77	1
Contractor 103	0
Heat Sys Cost	$3,500
Other Non H&S Costs	$2,000

Calculated Fields (5% Discount)	Scenario 5
Annual Savings (Therms)	1,536
Calculated % Savings	31%
PDV Savings (Therms)	13,615
Max Spending	$14,258
Total Non H&S Costs	$10,500
H&S Allowance	$3,758

Calculated Fields (No Discount)	Scenario 5
12-Year Savings (Therms)	18,434
Max Spending	$19,305
H&S Allowance	$8,805

SUMMARY AND RECOMMENDATIONS

Summary and Recommendations

- Potential to spend more on health and safety
  - Still achieve cost-effective savings
  - For homes with high pre-treatment usage
- Potential results
  - High energy savings
  - Reduced costs for ratepayers for CAP participants
  - Increased affordability when customer leaves CAP
- Recommendation
  - Pilot approach for high-usage homes with significant H&S barriers
  - Assess savings

APPENDIX:
ADDITIONAL DATA

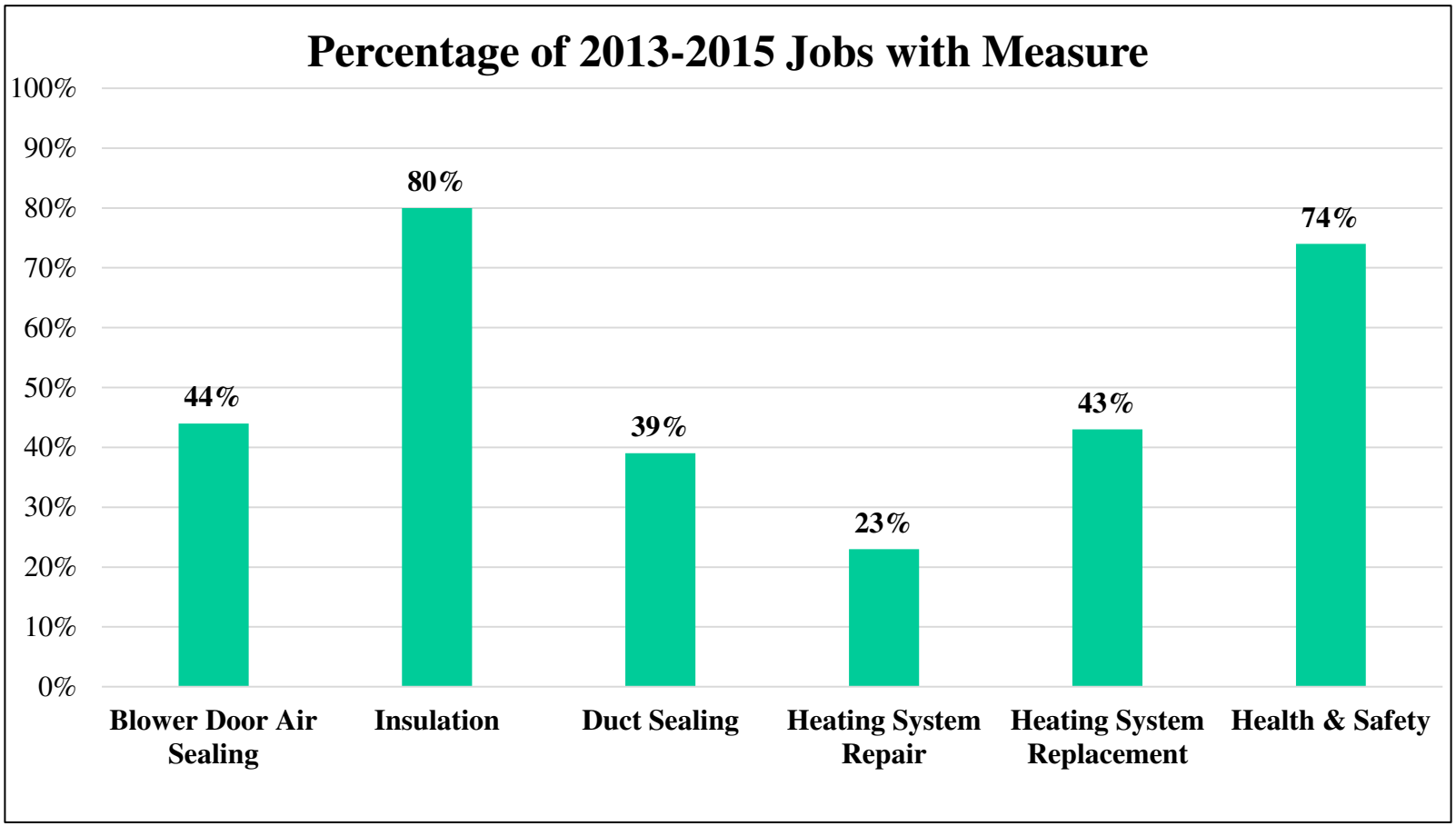
Measure Costs – Individual Measures

Measures	Mean	Min	Percentile					Max
			P10	P25	P50	P75	P90	
Blower Door Air Sealing	$147	$0	$0	$0	$0	$150	$424	$3,395
Insulation	$2,012	$0	$0	$302	$1,686	$3,260	$4,664	$10,514
BD Air Seal+Insul	$2,159	$0	$0	$487	$1,850	$3,439	$4,817	$10,854
Duct Sealing	$84	$0	$0	$0	$0	$89	$180	$6,700
Heating System Repair	$162	$0	$0	$0	$0	$80	$529	$7,269
Heating System Replacement	$1,557	$0	$0	$0	$0	$2,950	$4,550	$10,375
Health and Safety Costs	$333	$0	$0	$0	$140	$324	$774	$6,625

Measure Costs – Totals

Measures	Mean	Min	Percentile					Max
			P10	P25	P50	P75	P90	
Total Costs – Air Sealing – Insulation	$4,839	$0	$1,801	$2,770	$4,293	$6,376	$8,384	$20,302
Total Costs – Air Sealing – Insulation – Duct Sealing	$4,755	$0	$1,781	$2,688	$4,226	$6,285	$8,296	$20,302
Total Costs – Health & Safety	$6,664	$0	$2,875	$4,387	$6,333	$8,583	$10,685	$23,390
Total Costs	**$6,998**	**$0**	**$3,056**	**$4,656**	**$6,592**	**$8,930**	**$11,258**	**$23,597**

Jobs with Measure



Measure Costs
Jobs with Measure

Measures	Cost Statistics for 2013- 2015 Jobs with Measure					
	Mean	P10	P25	P50	P75	P90
Blower Door Air Sealing	$334	$75	$150	$170	$377	$725
Insulation	$2,520	$483	$1,151	$2,292	$3,655	$4,883
Duct Sealing	$215	$65	$85	$134	$180	$381
Heating System Repair	$580	$80	$175	$361	$696	$1,361
Heating System Replacement	$3,635	$2,483	$2,760	$3,162	$4,458	$5,560
Health & Safety	$453	$80	$105	$230	$440	$1,025
Total Costs	**$7,013**	**$3,094**	**$4,688**	**$6,602**	**$8,946**	**$11,258**