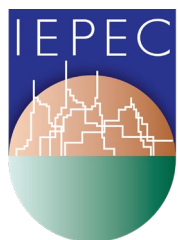


Persistence of Low-Income Weatherization Savings

Andy Lick | Maddie Koolbeck | Scott Pigg



IEPEC | NOVEMBER 1-4, 2022 | San Diego, CA

Why Study Weatherization (Wx)?

Equity: What does Wx savings (\$390 in 2020) represent for a household living on less than \$15K/year?

~15% of rent



~100% of protein



~20% of health care

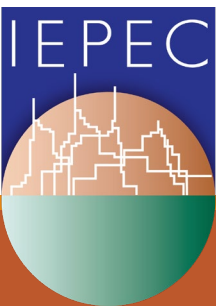


Why Study Persistence?

1. Wx studies about first year savings while measures are long lived.

2. Assume that measure savings persist but... little evidence.

Measure	Lifetime (years)
Attic insulation	30
Wall insulation	30
Floor insulation	30
Heating system	20
Water heating system	15
Refrigerator/Freezer	15
Lighting	10

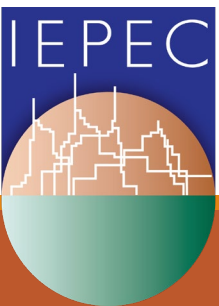


Persistence Studies are Hard

- Long wait, limited funding interest
- Permission to access utility data
- Utility billing system churn
- Tricky questions about baselines – aka the ***one-armed angler*** problem

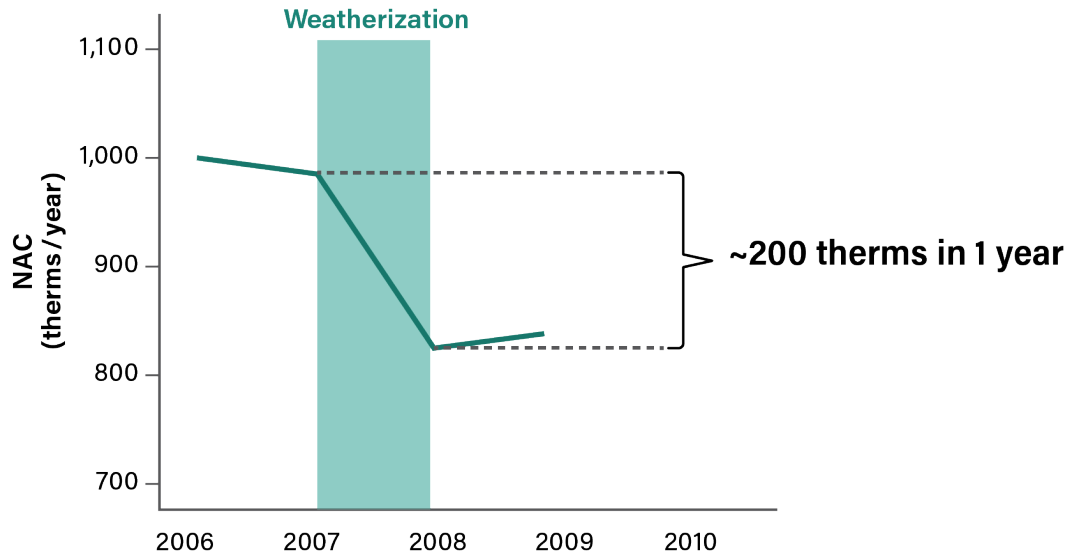
They are also rare and dated...

- 4 well known studies from the 80's 90's; all show persistent savings
- *No studies since the early 2000s...?*

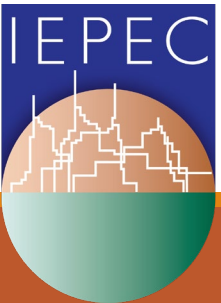
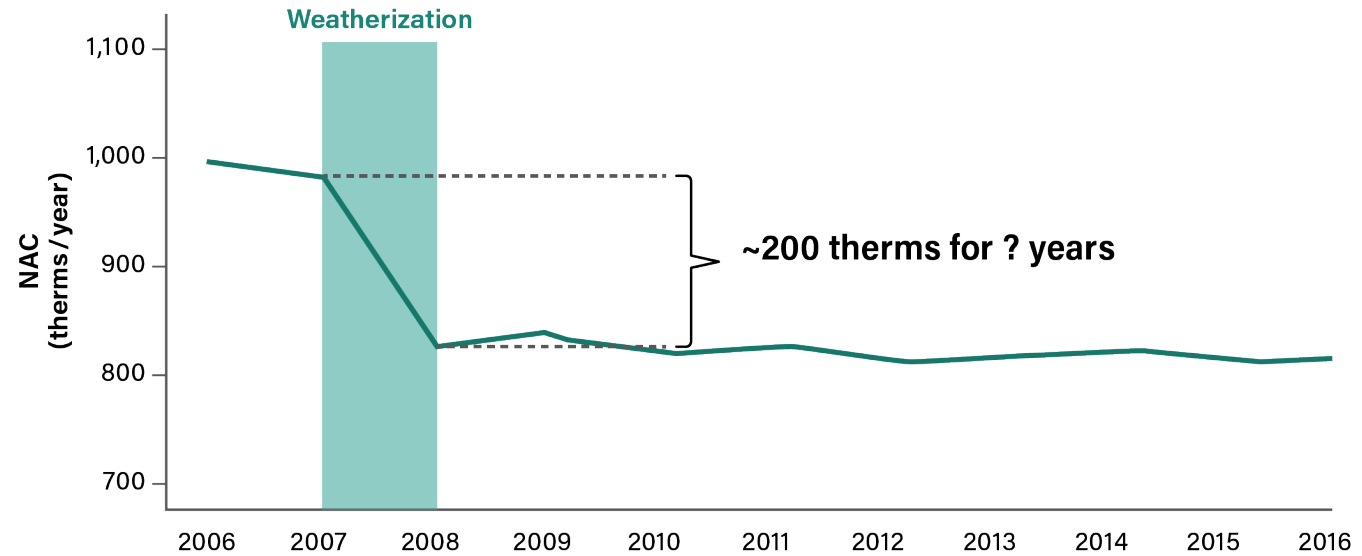


First-year Savings vs. Persistence

First-year savings



Persistence



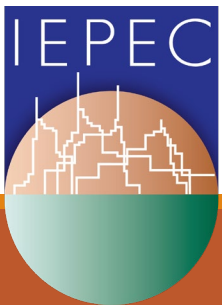
The Data: Multiple Years, Fuels, Housing types

Data

- Complete 13-year billing histories
- 8,000 homes heated with natural gas
- 8,700 homes heated with electricity
- Single family ~80% of all homes
- NAC (normalized-annual consumption) by calendar year
- Grouped homes by the year weatherized

Wx Cohort	Calendar Year												
	2006	2006	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2007		Wx											
2008			Wx										
2009				Wx									
2010					Wx								
2011						Wx							
2012							Wx						
2013								Wx					
2014									Wx				
2015										Wx			
2016											Wx		
2017												Wx	

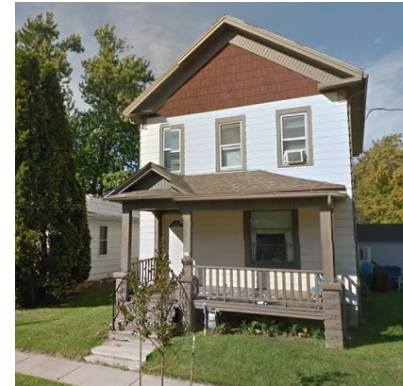
Pre weatherization Wx = weatherization Post x = x years after weatherization



Data Sources and Procedure

nac	delta_nac	calendar_yr	actualyear	delta_yr	wx_group	wx_group_2yr	wx_group_str
1128.1787	.	2010	2012	2009-2010	pre	pre	pre
1844.7854	716.5267	2011	2012	2010-2011	pre	pre	pre
1286.8396	-558.6658	2012	2012	2011-2012	wx	wx	wx
915.98352	-370.8561	2013	2012	2012-2013	wx	wx	wx
885.5246	-30.45892	2014	2012	2013-2014	post1	post1-2	post1
947.99585	62.47125	2015	2012	2014-2015	post2	post1-2	post2
869.5733	-78.42255	2016	2012	2015-2016	post3	post2-3	post3
873.88886	4.38756	2017	2012	2016-2017	post4	post2-3	post4
879.93885	6.04999	2018	2012	2017-2018	post5	post3-4	post5
962.21686	.	2009	2012	2007-2008	pre	pre	pre
901.63293	-60.58393	2009	2012	2008-2009	pre	pre	pre
981.06787	79.43404	2010	2012	2009-2010	pre	pre	pre
933.40857	-47.0593	2011	2012	2010-2011	pre	pre	pre
974.69879	41.29822	2012	2012	2011-2012	wx	wx	wx

Utility billing data



Tracking database



Weather data

Household Level

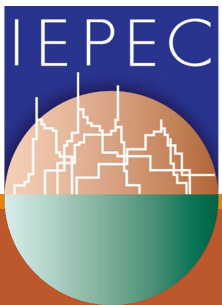
Combine billing/tracking data

Weather normalization

Program Level

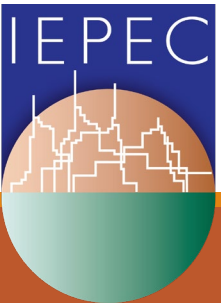
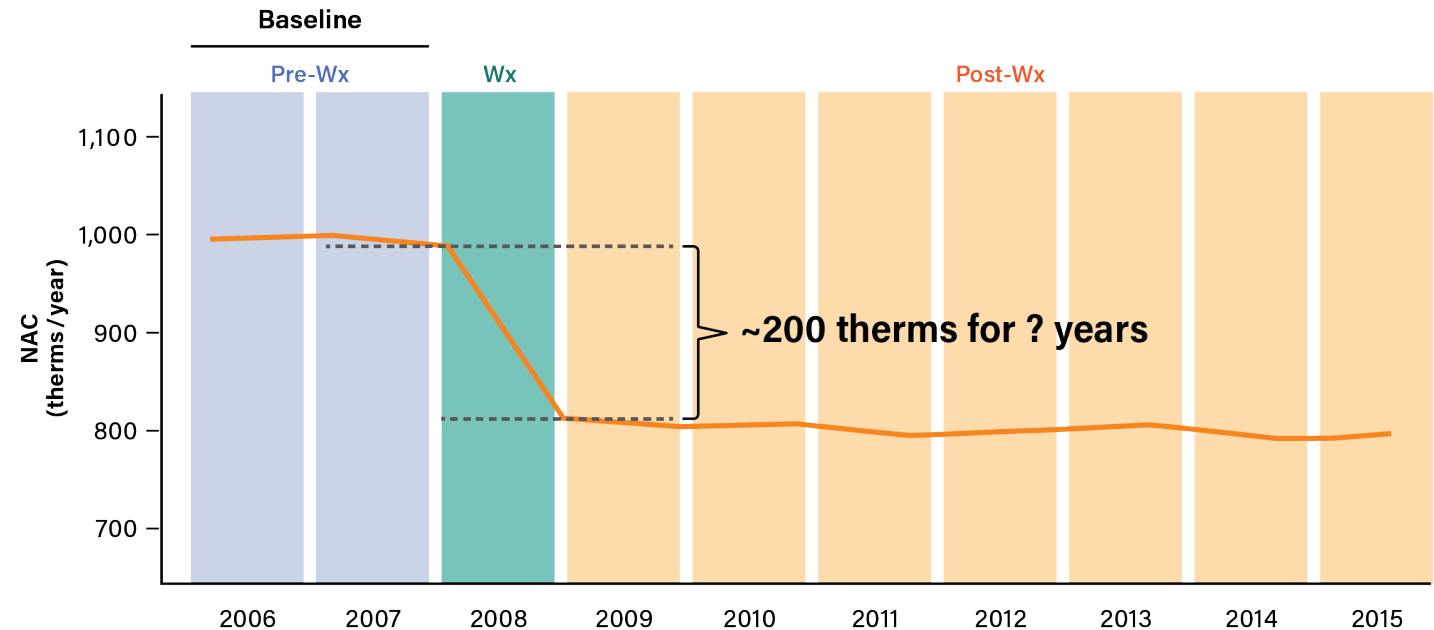
Savings analysis of normalized-annual consumption

Additional modeling procedures

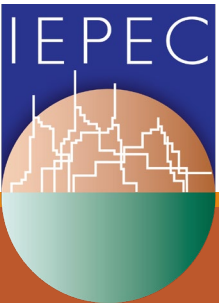
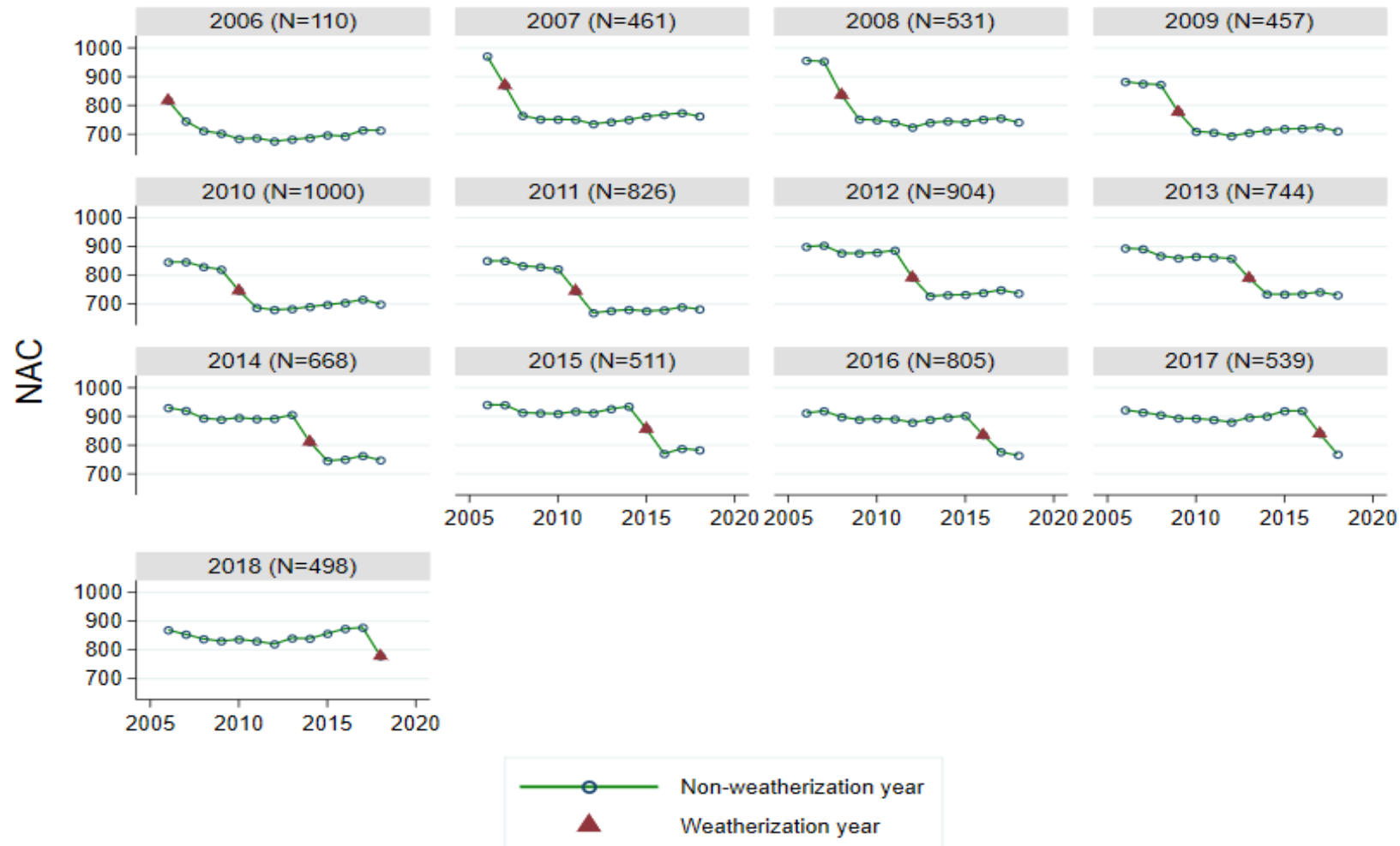


NAC Analysis: Baseline and Methods

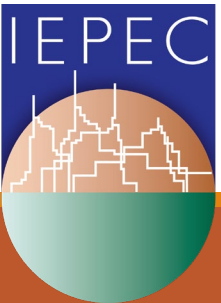
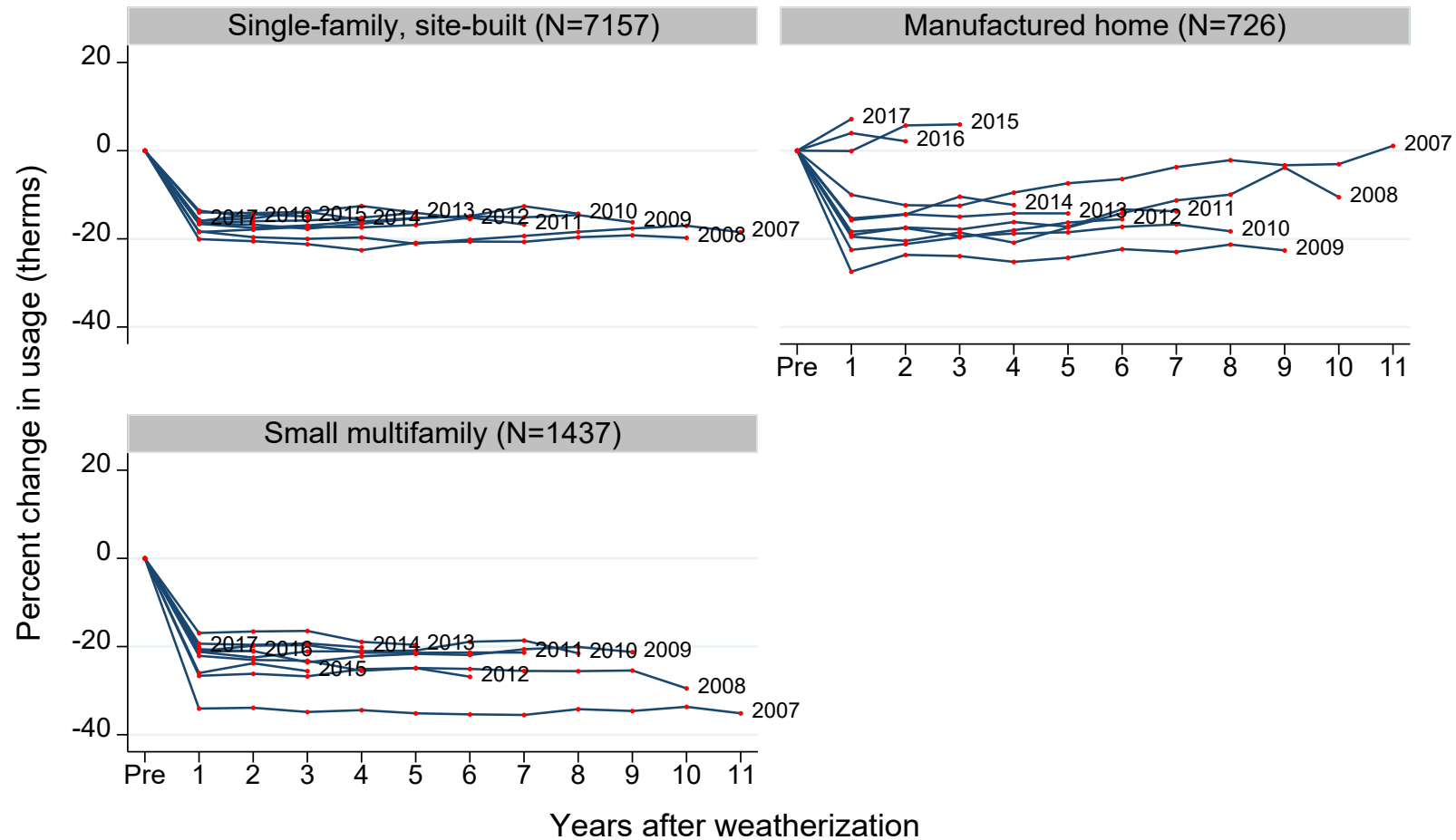
- **Baseline:** Pre-weatherization year(s)
- **Unit of analysis:** *Levels* of consumption
- Basic story about consumption as a time trend:
 - Calendar year
 - Years before and after the year of weatherization
 - Percentage change for each post-Wx year compared to the average pre-Wx-annual usage



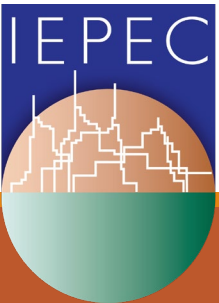
Natural gas: Declines Following Wx



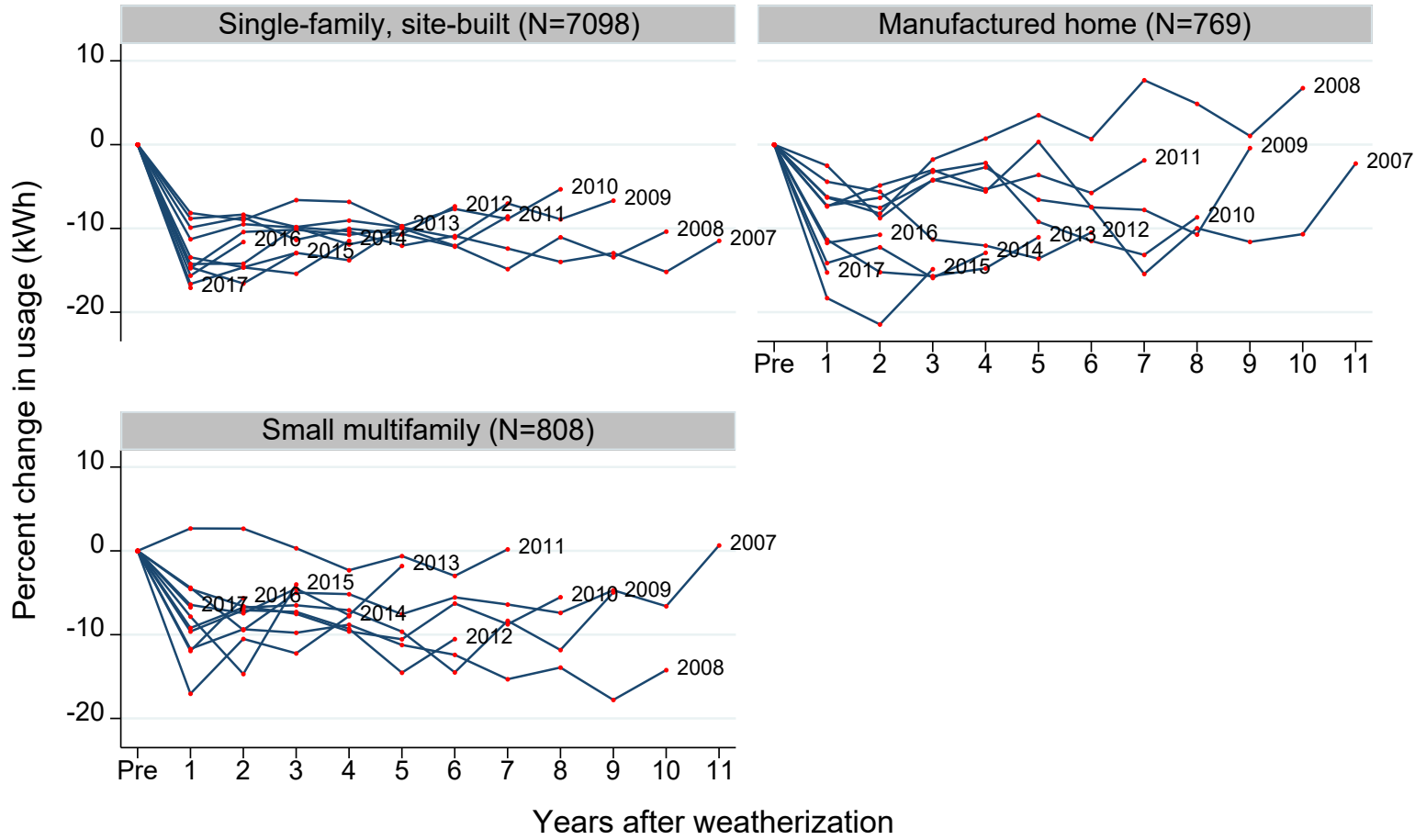
Natural Gas by Housing Type: Sustained Declines



Electricity: Declines After Wx Less Clear



Electricity by Housing Type: More Ambiguity

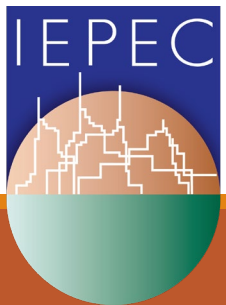


Regression Analysis: Baseline and Methods

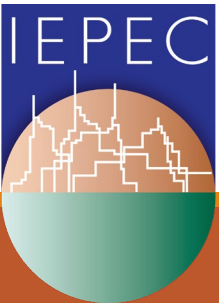
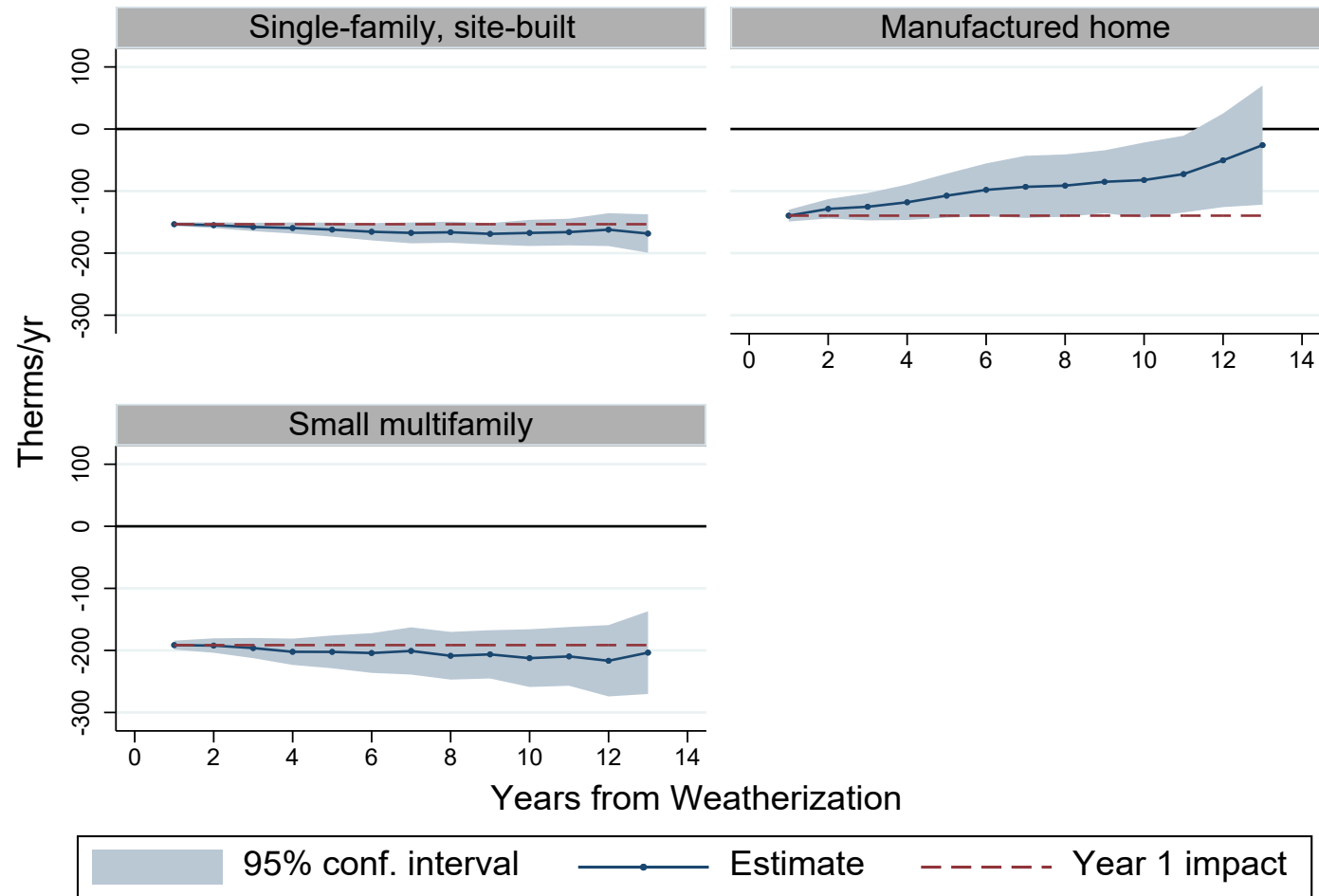
- **Baseline:** Pre-weatherization year(s)
- **Unit of analysis:** *Changes* in consumption (Δ NAC)
- PreWx data for later participants determines calendar-year (non-program) effects

Regression models

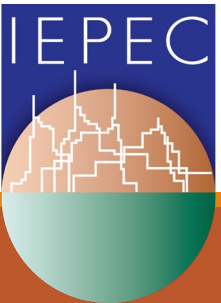
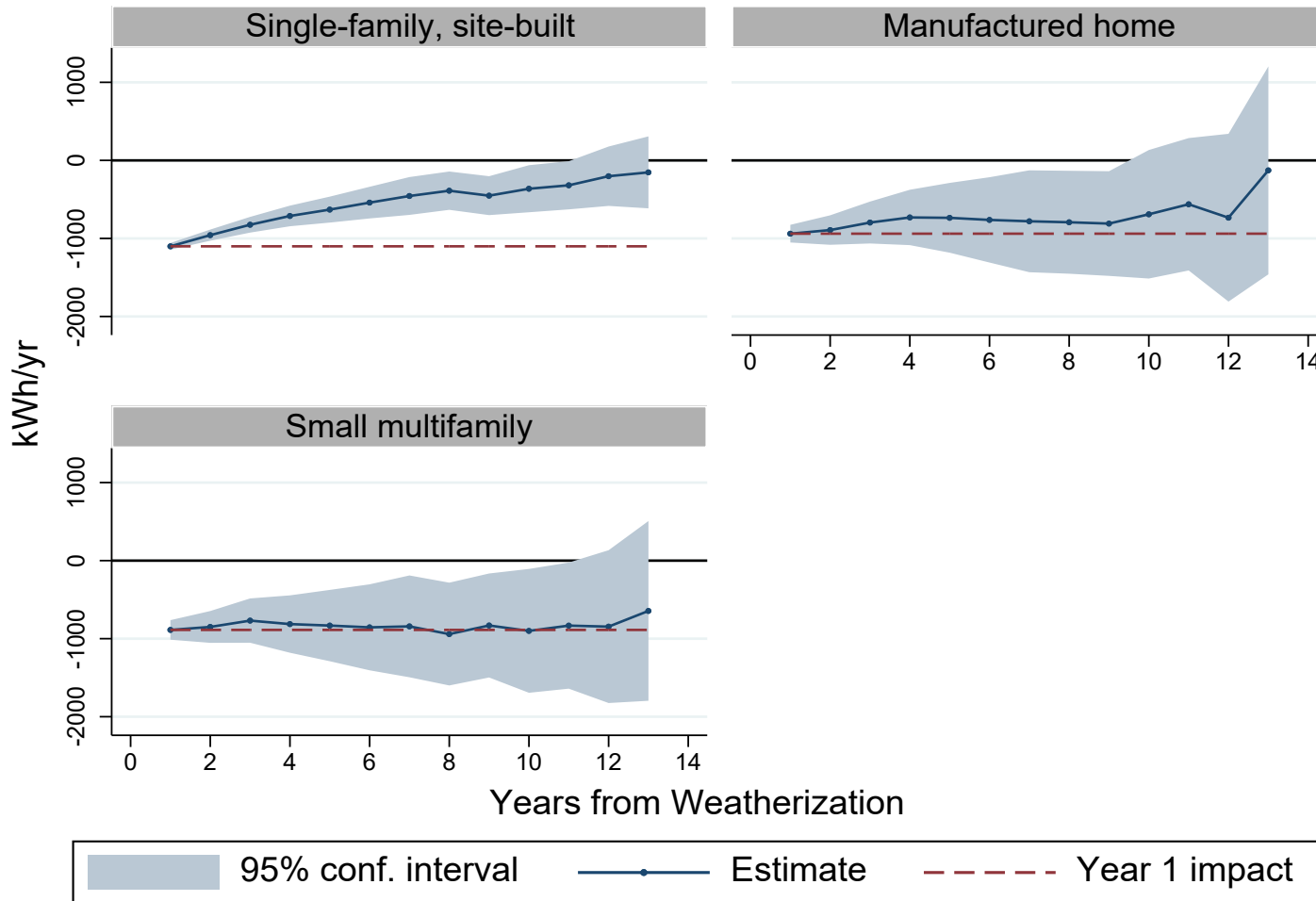
Fitting Procedure	All Available Data		Full-Span Data Only	
	Untrimmed	Trimmed	Untrimmed	Trimmed
Ordinary Least Squares	Model 1	Model 2	Model 3	Model 4
Mixed Effects	Model 5	Model 6	Model 7	Model 8
Robust	Model 9		Model 10	
Quantile	Model 11		Model 12	



Natural Gas: Sustained Declines, Mostly



Electricity: Initial Declines but Erosion



Conclusions and Limitations

NAC story

- Gas: Persistence visible ~12 years after Wx (15–20% SF homes)
- Electricity: Persistence ambiguous (8 to 15% SF homes, but erosion)

Mixed-model story

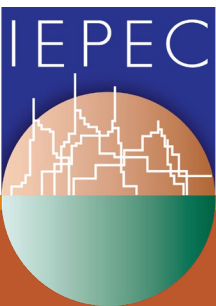
- Supports NAC story but with controls for non-program effects

Equity impact for basic needs in Wisconsin

- Persistence research to answer question “**what level?**” and “**how long?**”

Limitations

- Control for participant population
- 12 years of evidence but not more



Questions?



Andy Lick

Analyst II | Slipstream
alick@slipstreaminc.org



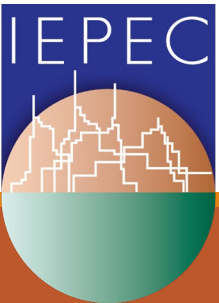
Maddie Koolbeck

Analyst | Slipstream
mkoolbeck@slipstreaminc.org

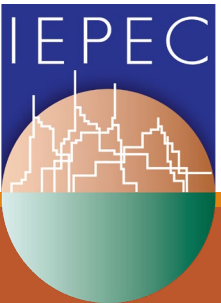


Scott Pigg

Principal Researcher | Slipstream
spigg@slipstreaminc.org



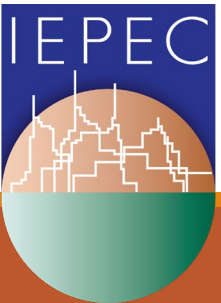
Additional Slides



Regression Analysis: Baseline and Methods Cont'd

$$\text{Year 5 cumulative impact} = \beta_{\text{yr1}} + \beta_{\text{yr2}} + \beta_{\text{yr3}} + \beta_{\text{yr4}} + \beta_{\text{yr5}}$$

- Number of years after weatherization (PostYr) is main predictor
- Coefficients for each PostYr term capture average change in NAC between two post-weatherization years
- Cumulative persistence calculated as the sum of the PostYr coefficients.



Equity and persistence

Basic needs in Wisconsin*

- 87.6% of households with incomes <\$25,000 used stimulus for basics expenses
- Of those who spent immediately
 - 80% on food
 - 77% on rent, mortgage or utilities

*Sharma, Shreela V., et al. "Peer Reviewed: Social Determinants of Health–Related Needs During COVID-19 Among Low-Income Households With Children." *Preventing chronic disease* 17 (2020).

Weatherization

- \$390 in 1st year following Wx

Persistence

- \$390/yr for **30** years (3%) = \$7,800

