Evaluating the Health Benefits of Weatherization

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Over 1 Million Homes Weatherized during the American Reinvestment and Recovery Act Period (2009-2013)

OUTLINE

- Overview of Weatherization Assistance Program (WAP)
- Methods Used to Monetize Health and other Co-Benefits
- Selected Results: Asthma, Thermal Stress, Fire
- Conclusions

What is WAP?

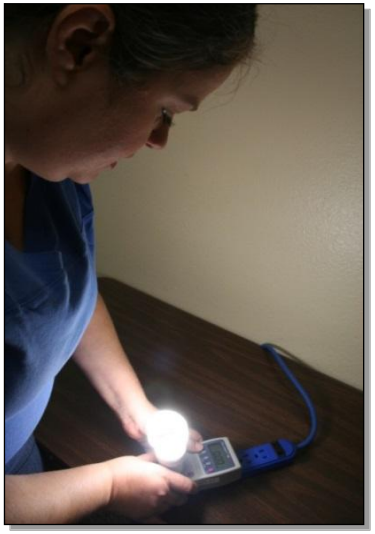
- **The Weatherization Assistance Program is the largest residential energy efficiency program in the U.S.**
- **U.S. Department of Energy (DOE) provides grants to states and territories based on funding formulas**
- **States provide grants to local weatherization agencies for free service delivery**

It's purpose, as established by law, is:

"…to increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential energy expenditures, and improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, the persons with disabilities, families with children, high residential energy users, and households with high energy burden."

WAP Services

- **Energy efficiency measures need a savings to investment ratio (SIR) of 1.0 or greater**
- **Per unit spending limits mean that sometimes measures with a SIR > 1.0 are not installed**
- **Typical Weatherization Measures Installed Include**
  - Air Sealing: Attics, doors, windows
  - Insulation: Attics, walls, rim joists
  - Ducts: sealing, insulation
  - Furnace: Tune-up, repairs



WAP Services

- **Health and Safety Measures**
  - **Combustion Appliances: Furnace, Water Heater, Stove/Oven, Dryer**
  - **Moisture Management: Kitchen and Bathroom Ventilation, Dryer Vents**
  - **Lead Safe Weatherization**
- **Health and Safety measures are subject to limits identified in each state WAP Plan (15% per job is the rule of thumb)**

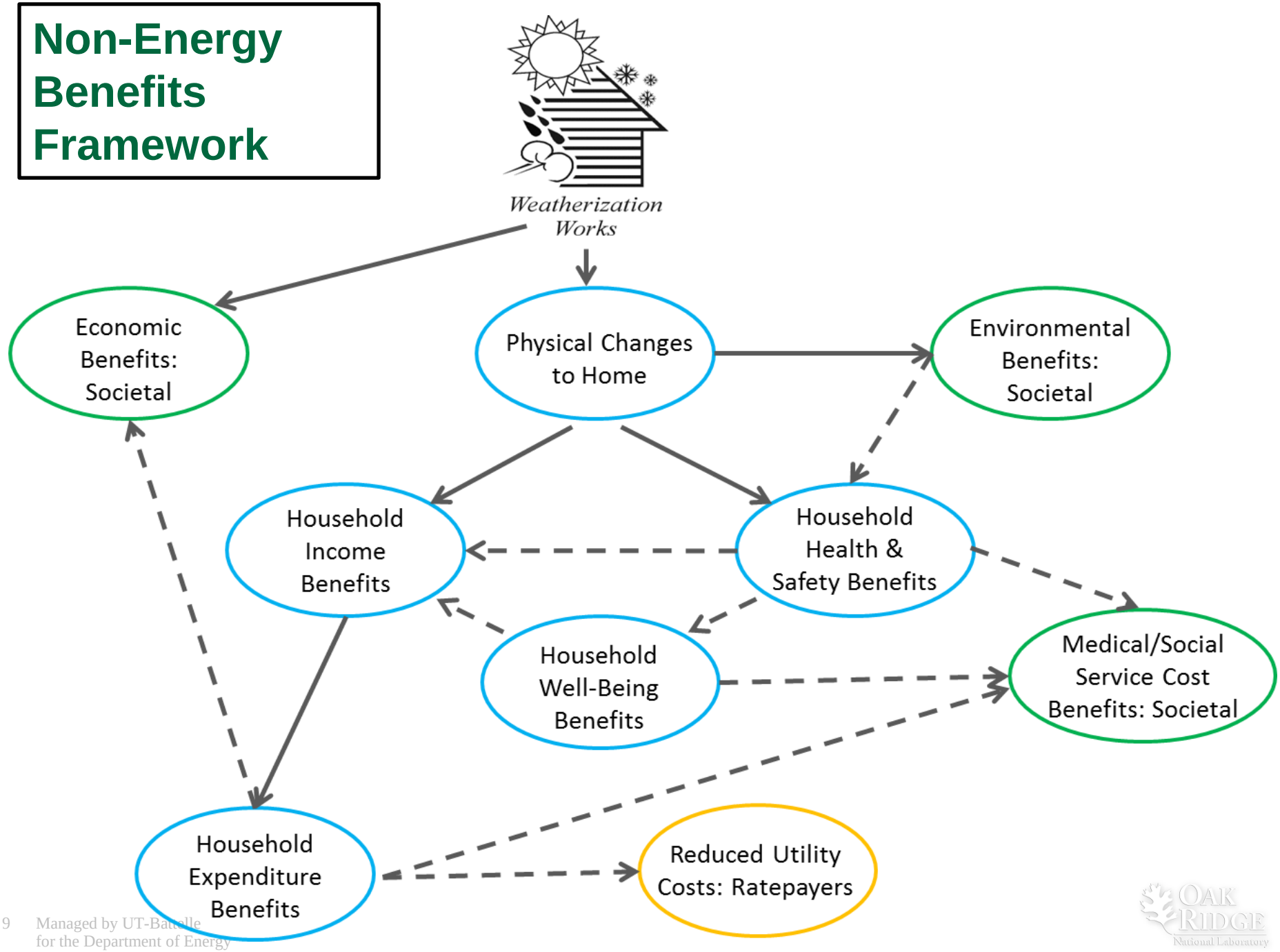
Steps for Evaluating Health and Other Co-benefits of Weatherization

- **Step 1: Develop a co-benefits framework**
- **Step 2: Collect data about your specific program**
- **Step 3: Develop approaches to monetizing the co-benefits of your program**
- **Step 4: Identify strengths and weaknesses of the methods and results**
- **Step 5: Assess the distribution of the co-benefits among program participants**

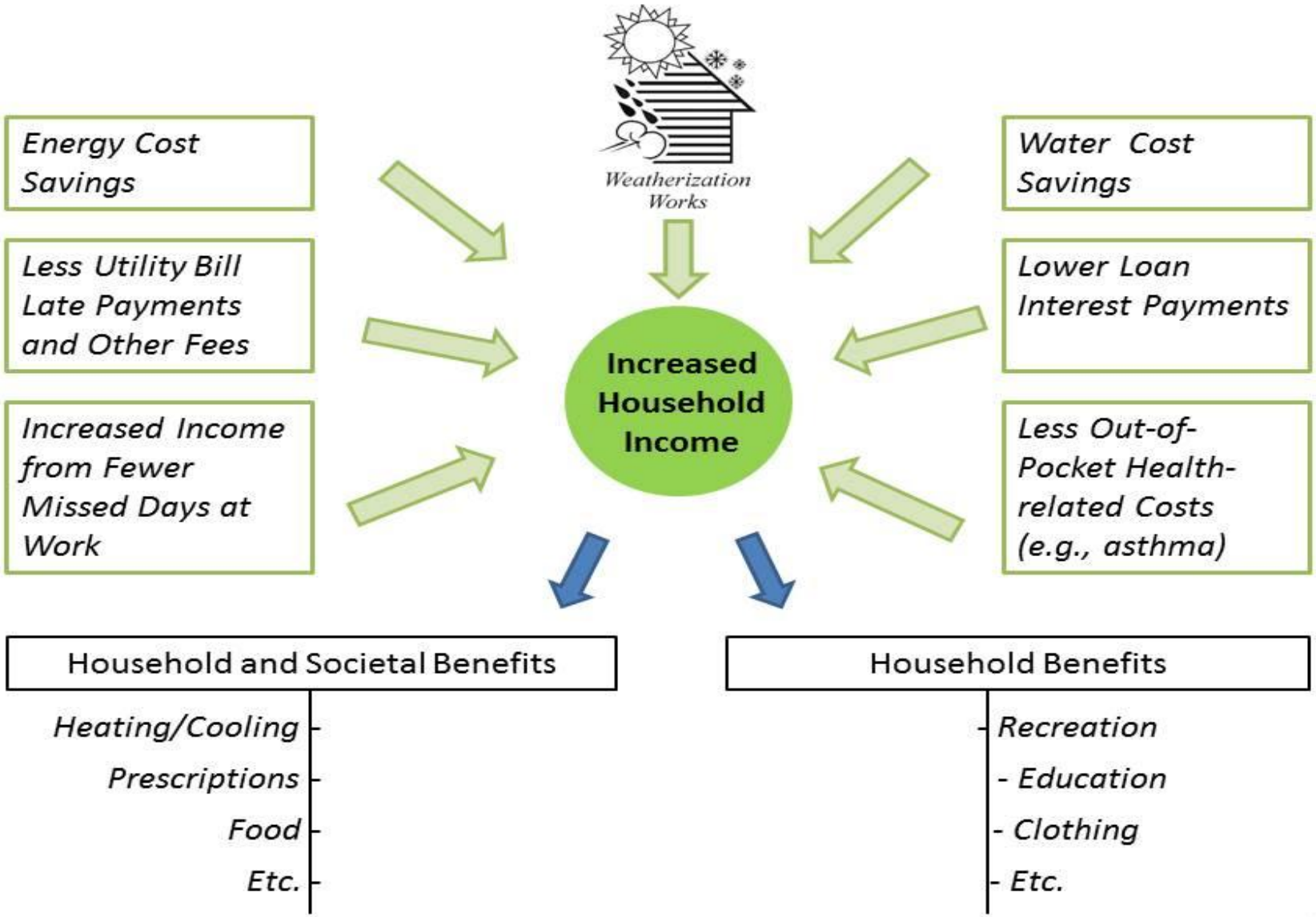
Step 1: Develop a Co-benefits Framework

- **Identify co-benefits *directly* attributable to the program**
  - Reductions in asthma symptoms, thermal stress
- **Identify co-benefits *indirectly* attributable to the program**
  - Energy cost savings used to purchase food, prescriptions

Non-Energy Benefits Framework



Household Budget Benefits



Step 2: Collect Data About Your Specific Program

- **Outputs**
  - Units weatherized
  - Smoke detectors installed
  - CO monitors installed
- **Outcomes**
  - Energy savings
  - Changes in health status
  - Changes in healthcare utilization (e.g., ED or inpatient hospital visits)

Occupant Survey Findings Treatment (pre) to Comparison

Survey Item	PreAudit Incidence	PostWX Incidence	Change
Dwelling Quality			
Home sometimes at unhealthy temperature	18.0%	9.2%	-8.8%
Home was observed to be drafty	70.2%	37.2%	-33.0%
Observed standing water in home	33.0%	19.3%	-13.7%
Frequent mildew odor or musty smell	30.2%	16.4%	-13.8%
Have seen mold in home	27.4%	18.7%	-8.7%
Home is somewhat, very, or extremely infested by insects	25.1%	16.2%	-8.9%
Home is somewhat, very or extremely infested by mice	10.4%	6.1%	-4.3%
All differences are statistically significant at the 95% confidence level			

Occupant Survey Findings Treatment (pre) to Comparison

Survey Item	PreAudit Incidence	PostWX Incidence	Change
Equipment			
Broken Heating Equipment (last 12 months)	14.9%	8.5%	-6.4%
Broken Cooling Equipment (last 12 months)	9.9%	5.5%	-4.5%
Clothes Dryer Vents Outdoors	80.9%	86.6%	+5.7%
Bathroom With Working Vent Fan	47.5%	60.5%	+13.0%
Home Has CO Monitor	44.7%	77.1%	+32.4%
Home Has Smoke Detector	88.4%	97.3%	+8.9%

All differences are statistically significant at the 95% confidence level

Occupant Survey Findings Treatment (pre) to Comparison

Survey Item	PreAudit Incidence	PostWX Incidence	Change
Equipment and Energy Behaviors			
Oven used to heat home sometimes, frequently, or all the time	11.4%	7.2%	-4.2%
Used portable heaters	33.1%	26.8%	-6.3%
Use cooking stove exhaust fan regularly	41.4%	49.2%	+7.8%
Heating system has air filter	66.6%	75.6%	+9.0%
Air filter is HEPA	15.5%	27.3%	+11.8%
Air filter is changed once or more every 6 months	48.3%	59.9%	+11.6%
All differences are statistically significant at the 95% confidence level			

Occupant Survey Findings
Treatment (pre) to Comparison

Survey Item	PreAudit Incidence	PostWX Incidence	Change
Trade Offs			
It is hard or very hard to pay energy bills	74.6%	58.5%	-16.1%
Did not buy food to pay energy bills	33.2%	23.1%	-10.1%
Went without food in the last four weeks	7.1%	5.7%	-1.4%
Worried household members would not have nutritious food	23.2%	14.9%	-8.3%
Did not fill prescriptions to pay energy bills	27.5%	18.5%	-9.0%
All differences are statistically significant at the 95% confidence level			

Occupant Survey Findings
Treatment (pre) to Comparison

Health & Safety Impact	Pre-Weatherization	Post-Weatherization
Asthma Symptoms (< 3 months since last)	70.5%	58.7%
Asthma Emergency Department Visits	15.8%	4.3%
Asthma Hospitalizations	13.7%	10.6%
Medical attention too hot	2.4%	1.5%
Medical attention too cold	3.2%	1.5%
Number of days previous month physical health not good	10.3	5.4
Number of days previous month mental health not good	7.1	3.7
Number of days previous month did not get enough rest or sleep	11.7	6.6
Persistent cold symptoms	21%	12%

Overall Changes in Health Since Weatherization

Since your home was weatherized, has the overall health of the members of your household improved, stayed the same, or gotten worse? How much do you think was due to your home being weatherized?

	Post-Weatherization Treatment	Post- Weatherization Comparison 2	Total
Number of Respondents	393	428	821
Improved	34%	32%	33%
Attribute All to Wx	9%	10%	10%
Attribute Most to Wx	13%	10%	11%
Attribute Some to Wx	9%	11%	10%
Attribute None to Wx	2%	1%	1%
Refusal	1%	0%	<1%
Stayed the Same	62%	62%	62%
Gotten Worse	4%	6%	5%
Attribute All to Wx	0%	<1%	<1%
Attribute Most to Wx	0%	<1%	<1%
Attribute Some to Wx	1%	1%	<1%
Attribute None to Wx	3%	4%	4%
Refusal	0%	<1%	<1%

Step 3: Develop Approaches to Monetize the Co-Benefits of Your Program

- **Identify Monetizable Co-Benefits**
  - Reduction in asthma episodes and related healthcare
- **Describe How the Program Produces Each Co-benefit**
  - Weatherization installs numerous measures that could lead to reductions in asthma symptoms, reductions in asthma symptoms reduces emergency department and hospital visits, thereby reducing health care costs
- **Build Approach for Each Co-Benefit**
  - Begin with a specific co-benefit
  - Identify evidence supporting a change attributable to the program
  - Identify data resources needed to monetize the benefit

Monetizable Health-related Benefits of WAP

- Reduced Carbon Monoxide Poisonings
- Reduced Home Fires
- Reduced Thermal Stress on Occupants
- Reduced Asthma-Related Healthcare and Costs
- Increased Productivity at Work Due to Improvements in Sleep
- Increased Productivity at Home Due to Improvements in Sleep
- Fewer Missed Days at Work
- Reduced Use of High Interest, Short-Term Loans
- Increased Ability to Afford Prescriptions
- Reduced Heat or Eat Choice Dilemma Faced by Pregnant Women
- Reduced Need for Food Assistance

Two Approaches to Monetizing Health & Household-related Benefits

1) Based on survey data pre- and post-wx with a comparison group (e.g., preventing thermal stress)

2) Based on measures installed and known impacts on health (e.g., installing CO monitors)

- **Health costs drawn from two U.S. national medical databases:**
  - **Medical Expenditure Panel Survey (MEPS); and**
  - **Health Cost and Utilization Project (HCUP)**
- **Value of a life saved - $7.5 million (EPA)**
- **Present value of health benefits calculated over 10 years using federally approved discount rates**

Making the WAP and Asthma Connection
- National Current Asthma Prevalence (2013)(CDC)

Characteristic	% with Current Asthma
National Asthma Prevalence	7.3%
Child (Age <18)	8.3%
Adult	7.0%
65+	6.3%
Males	6.2%
Males (Age <18)	9.3%
Females	8.3%
Females (Age <18)	7.3%
White NH*	7.4%
Black NH	9.9%
Hispanic	5.9%
Puerto Rican	14.6%
Below 100% of federal poverty level	**10.9%**
100% to less than 250% of poverty level	7.0%

***NH- Non-Hispanic, Retrieved from; http://www.cdc.gov/asthma/most_recent_data.htm**

Environmental Asthma Triggers

Environmental Tobacco Smoke (ETS)
Dust Mites
Pollutants from vehicle traffic infiltrating indoors (e.g., diesel exhaust)
Ozone
Outdoor allergens
Cockroach allergen
Rodents
Pets (cats and dogs)
Molds and fungi
Smoke from burning wood
Indoor VOCs
Thermal stress (extreme temps indoors)
Severity of the common cold
Psycho-social stress
Particulate matter from cooking; NO_2

WAP Asthma Impact Measures

Air Sealing
Insulation
Heating system replacement/maintenance/filters
AC system replacement/maintenance
Mechanical ventilation
Window replacement/repair
Door replacement/repair
Dryer venting
Health & Safety testing and measures
Ground vapor barrier
Energy cost savings
Incidental repairs (walls, ceiling, roof)
Referrals to other agencies

Asthma and the WAP Population

***Have you ever been told by a doctor or health professional that you have asthma?* (National Occupant Survey)**	
Survey Phase	% Responses = ***YES***
Phase 1 (2011; n=384/1897)	20.2%
Phase 2 (2013; n=208/948)	21.9%
***Do you still have asthma?* (National Occupant Survey)**	
Survey Round	% Responses = ***YES***
Phase 1 (2011; n=298/384)	77.6%
Round 2 (2013; n=166/203)	81.8%
% of all surveyed WAP respondents who still have asthma	
Phase 1 (2011; n=298/1897)	15.7%
Phase 2 (2013; n=166/948)	17.5%
Average	**16.8%**

Asthma: Reduced ED Visits

Not counting hospitalizations, during the past 12 months, did you go to an emergency room because of asthma? (National Occupant Survey)	
Pre-Weatherization	15.8%
Post-Weatherization	4.3%ǂ

ǂ sig. < .05

*No post-weatherization comparison group:

- Characteristics diverge across samples and groups
- Changes in occupants' exposure to asthma triggers should persist beyond one year (air sealing, HVAC measures, insulation, ventilation…)
- No pre-weatherization/post-weatherization comparison group

The non-energy benefit attributable to fewer ED visits was monetized as follows:

Benefit = (number of persons served by WAP in PY 2008) * (asthma prevalence for adults and children) * (reduction in ED visits)* (frequency of re-admittance (adults and children)) * (average ED costs (adults and children)) / (number of WAP households for PY2008)

Asthma: Reduced ED Visits

Input	Source
Number of Persons Served by WAP in PY 2008 – 199,825	S4 – National Occupant Survey: mean number of persons per household (2.487) * total households served in PY2008 (80,352)
Number of adults – 119,901 – and children – 79,934 – in WAP households	S4 – National Occupant Survey: Ratio of adults to children reported was used to proportion the total population served by WAP in PY2008
Percent of adults in WAP households with asthma – 16.8%	S4 – National Occupant Survey; average of phase 1 and phase 2 surveys
Percent of children in WAP households with asthma – 16% for children in African American households; 10.1% for children in non-African American households	CDC 2006-2008 national asthma rates: http://www.cdc.gov/mmwr/preview/mmwrhtml/su6001a18.htm
Reduction in ED Visits – 11.5%	S4 – National Occupant Survey; Treatment Group Whole Asthma Sample
Frequency of re-admittance to ED; all persons – 31.3%	Healthcare Cost and Utilization Project – HCUP http://www.hcup-us.ahrq.gov/reports/statbriefs/sb90.jsp ; http://www.cdc.gov/pcd/issues/2004/apr/03_0009.htm ; http://www.aaaai.org/about-the-aaaai/newsroom/asthma-statistics.aspx
Average hospital costs all persons – $512	Medical Expenditure Panel Survey- MEPS http://meps.ahrq.gov/mepsweb/
Total WAP households PY 2008 – 80,352	S1 – National State Program Information Survey

Asthma: Reduced Hospitalizations

During the past 12 months did you have to stay overnight in the hospital because of asthma? **(National Occupant Survey)**	
Pre-Weatherization (*treatment group*)	13.7%
Post-Weatherization (*treatment group*)	10.6%

The non-energy benefit attributable to fewer hospitalizations was monetized as follows:

Benefit = (number of adults and children served by WAP in PY 2008) * (asthma prevalence for adults and children) * (reduction in hospitalizations)* (frequency of re-admittance (adults and children)) * (average hospital costs (adults and children))/ (number of WAP households for PY2008)

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Reduction in hospitalizations – 3.1%	S4 – National Occupant Survey; Treatment Group Whole Asthma Sample
Frequency of re-admittance to hospital; adults – 27.3%, and children – 22.9%	Healthcare Cost and Utilization Project – HCUP http://www.hcup-us.ahrq.gov/reports/statbriefs/sb90.jsp
Average hospital costs per adult – $6,341	Medical Expenditure Panel Survey- MEPS http://meps.ahrq.gov/mepsweb/
Average hospital costs for all children – $3,616	Healthcare Cost and Utilization Project – HCUP http://www.ahrq.gov/research/index.html.
Total WAP households PY 2008 – 80,352	S1 – National State Program Information Survey

Asthma: Reduction in High-Cost Patients

***How long has it been since you last had any symptoms of asthma?* (National Occupant Survey)**

Range of Frequency of Asthma Symptoms: (<1 Day Ago; 1-6 Days Ago; 1 Week- <3 Months Ago; 3 Months-<1Year Ago; 1Year-<3 Years Ago; 3-5 Years Ago; >5 Years Ago; Never)

% of Head of Households Reporting Urgent Care (ED or Hospitalization) due to asthma by Group and by Sample and by High-Cost Patient	Low-Cost Patient	High-Cost patient
Whole Asthma Sample-Treatment Group (**Pre-Wx**; n=92)	5.6%	94.4%
Whole Asthma Sample-Treatment Group (**Post-Wx** 1-year; n=46)	16.7%	83.3%

Asthma: Reduction in High-Cost Patients

During the past 12 months did you have to stay overnight in the hospital because of asthma? (National Occupant Survey)	
Pre-Weatherization	70.5%
Post-Weatherization	58.7%

The non-energy benefit attributable to fewer hospitalizations was monetized as follows:

Benefit = (number of persons served by WAP in PY 2008) * (asthma prevalence for adults and children) * (reduction in high-cost patients) * (difference in high and low cost patients after extracting the ED visit and hospitalization costs already claimed)/ number of WAP households for PY2008

Asthma: Reduction in High-Cost Patients

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Percent of adults in WAP households with asthma – 16.8%	S4 – National Occupant Survey; average of phase 1 and phase 2 surveys
Percent of children in WAP households with asthma – 16% for children in African American households; 10.1% for children in non-African American households	CDC 2006-2008 national asthma rates: http://www.cdc.gov/mmwr/preview/mmwrhtml/su6001a18.htm
Reduction of high-cost patients moving from symptoms <3months ago to >3months ago – 11.8%	S4 – National Occupant Survey; Treatment Group Whole Asthma Sample
Other direct medical costs and indirect costs associated with high-cost asthma patients adjusted for inflation– $2,302	Total annual direct and indirect costs for high cost asthma patients=$5566. Of this 54% is attributed to ED/In-patient hospitalization costs. After these costs were extracted, the total costs for the purposes of measuring cost savings for other direct/indirect costs = $2561. Applying the same methodology, total costs for low-cost patients=$259 for a cost savings if a patient went from high to low cost of $2,302; Smith et al. 1997
Total WAP households PY 2008 – 80,352	S1 – National State Program Information Survey

WAP Population and Thermal Stress

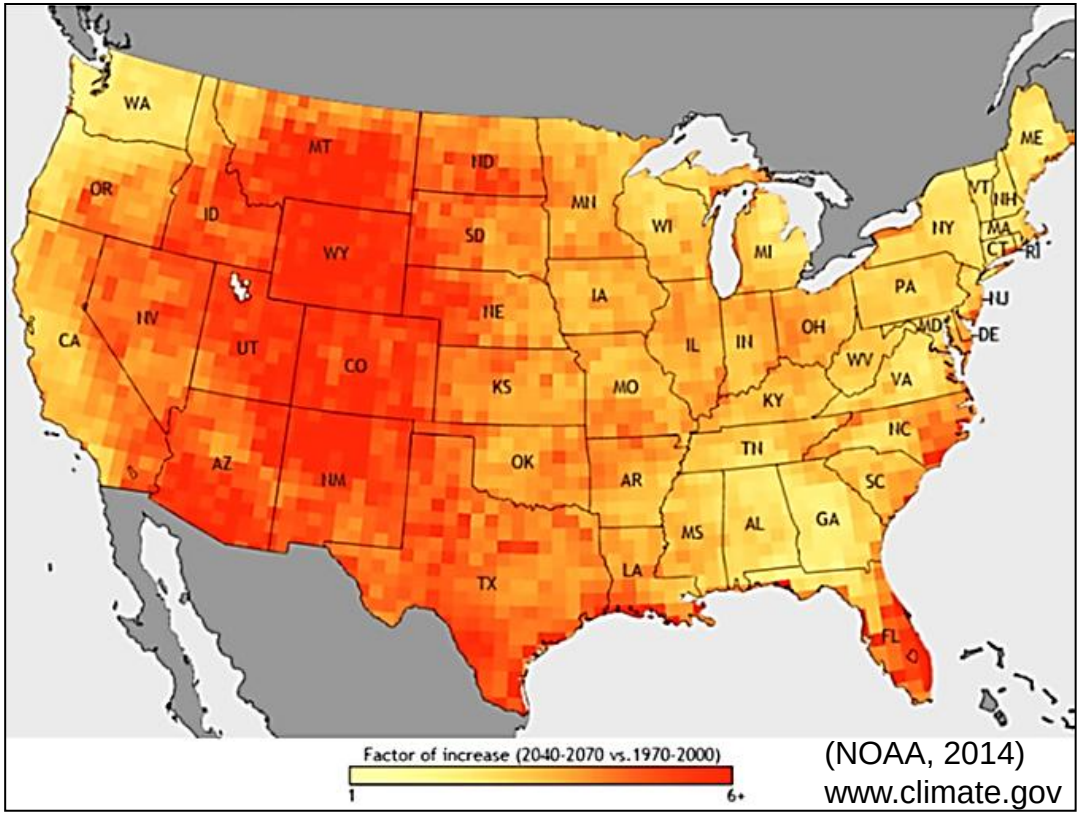
- Certain subpopulations are more susceptible
  - Elderly persons, pregnant women and toddlers/infants (CDC, 2005)
  - African-Americans (Anderson and Bell, 2009; Medina-Ramón *et al.*, 2006)
  - Individuals with chronic medical conditions, mental disorders or mobility impairments
  - Any individual with inadequate food, clothing, or heating/cooling systems
  - Additional risk factors: social isolation, low socioeconomic status, limited educational attainment, poor housing, lack of access to air conditioning, and less availability of health care services (Huang 2011).
- More likely to occur (Madrigano, J. et al., 2013):
  - At home than in institutions and hospital settings
  - Among those living in census tracts where more households received public assistance
  - In urban areas with less green space



Weatherization and Climate Change

- Increased frequency and duration of heat waves and extreme cold spells.
- Not just a projection, it's happening now!
- **Weatherization is a means of mitigating and adapting to climate change impacts.**

Heat-related morbidity and mortality are the most well understood, measurable, and yet preventable impacts of climate change on human health.
(Confalonieri et al., 2007)



Heat Wave Trends 1970 - 2070

Indoor Thermal Stress: Reduced Incidences

In the past 12 months, has anyone in the household needed medical attention because your home was too cold or too hot? **(National Occupant Survey from WAP evaluation)**		
Sample Group	**Too cold**	**Too hot**
Pre-Weatherization Treatment	3.2%	2.4%
Post-Weatherization Treatment	1.5%	1.5%
Post-Weatherization Comparison	2.1%	1.1%*
Rate of Reduced Incidences	**1.4%**	**1.1%**

- N = # of incidences avoided
- Type of medical treatment: a = hospitalization, b = emergency department (ED) visit, c = Physician visit:

N (a, b, c) *= [(number of weatherized units completed in PY 2008) * (decreased rate of seeking medical care) * (% of type of medical treatment (a, b, c)]*

Benefit *= [N (a, b, c) * (average total medical costs - out-of-pocket and payments by Medicaid, Medicare, and other insurance)]*

Indoor Thermal Stress: Reduced Incidences

Input
Number of single family and mobile homes weatherized (2008): **80,352**
Decreased rate of seeking medical care: Cold exposure, **1.4%;** Heat exposure, **1.1%**
Type of treatment sought for cold-related illnesses* Hospitalizations = **10%**, ED visits = **40%**, Physician Visits = **50%**
Type of treatment sought for heat-related illnesses* Hospitalizations = **4%**, ED visits = **11.5%**, Physician visits = **84.5%**
Total **out-of-pocket medical costs** paid (mean) -- treatment of cold-related illnesses** Hospitalization = **$87,428**; ED = **$53,918**; Physician Office Visit = **$12,509**
Total **out-of-pocket medical costs** paid (mean) -- treatment of heat-related illnesses** Hospitalization = **$15,944**; ED = **$104,030**; Physician Office Visit = **$2,263**
Total medical costs **paid by insurance** (mean) -- treatment of cold-related illnesses** Hospitalization = **$977,146**; ED = **$193,740**; Physician Office Visit = **$64,339**
Total medical costs **paid by insurance** (mean) -- treatment of heat-related illnesses** Hospitalization = **$189,228**; ED = **$361,802**; Physician Office Visit = **$11,640**
* Medical Expenditure Panel Survey- (MEPS): http://meps.ahrq.gov/mepsweb/ **Healthcare Cost and Utilization Project – (HCUP): http://www.ahrq.gov/research/index.html.

Monetization of Benefits - Reducing Indoor Thermal Stress on Occupants

Cold-Related Illnesses				
	First Year Per Household Benefit	PV Per Unit Benefit Over Ten Years	First Year Program Benefit	PV Program Benefit Over 10 years
Households	$1.91	$19.04	$153,854	$1,530,119
Society	$15.37	$152.88	$1,235,225	$12,284,587
Total	$17.29	$171.93	$1,389,079	$13,814,706

Heat-Related Illnesses				
	First Year Per Household Benefit	PV Per Unit Benefit Over Ten Years	First Year Program Benefit	PV Program Benefit Over 10 years
Households	$1.52	$15.13	$122,236	$1,215,668
Society	$7.00	$69.64	$562,669	$5,595,870
Total	$8.52	$84.77	$684,905	$6,811,538

Indoor Thermal Stress and Mortality

Deaths due to extreme thermal stress can be prevented through weatherization.

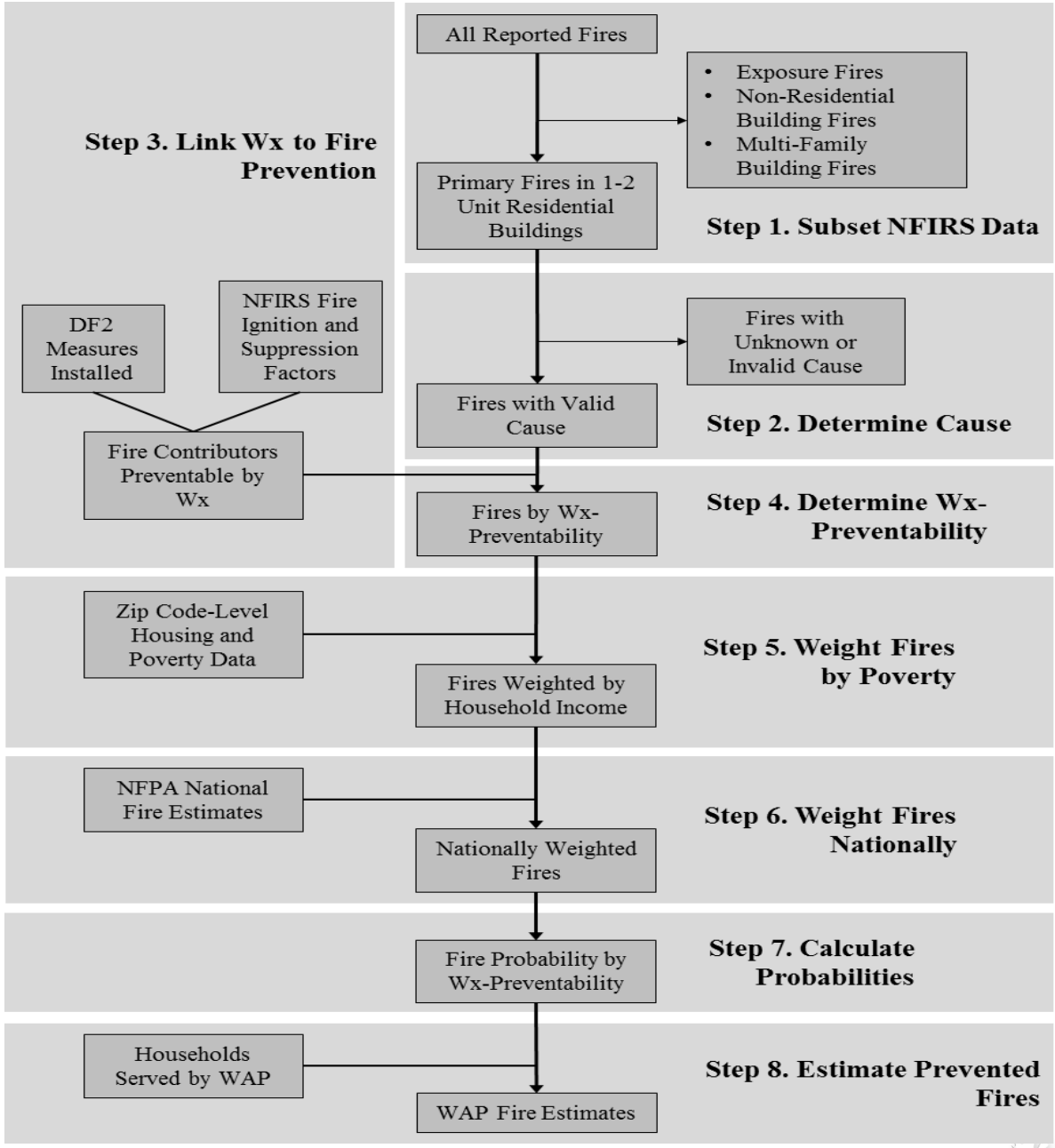
***# of lives saved** = [(% of hospitalizations resulting in deaths (U.S. population) * (# of hospitalizations prevented by WAP in PY 2008)]*

***Benefit** = # of lives saved by WAP * Value of Human Life*

- % of hospitalizations due to thermal stress resulting in deaths (U.S., 2008) – 4% (cold); 2% (hot)
- Number of hospitalizations prevented (WAP, PY 2008) – 113 (cold); 35 (hot)
- Number of lives saved (WAP, PY 2008) - 4 (cold); 1 (hot)

Non-Energy Benefit (Present Value per Household)	Total	Total (Value of Life Excluded)	Societal	Household
Thermal Stress-Cold	$3,911	$172	$3,892	$19
Thermal Stress- Hot	$870	$85	$855	$15

Reduced Home Fires



NFIRS – National Fire Incident Reporting System; NFPA – National Fire Protection Association

Reduced Home Fires

Fire Equipment Ignition and Suppression Factors Categories	Relevant Wx Measures	Weighted Wx Homes in PY 2008	Percent of Wx Units	WAP Weighted NFIRS Fires	Percent of Fires
EI1	Electrical	4,324	5.38%	8.85	2.96%
EI2	Heating	39,128	48.70%	10.76	3.60%
EI3	Cooling	4,969	6.18%	1.54	0.51%
EI4	Clothes Dryer	16,086	20.02%	6.18	2.07%
EI5	Refrigerator	11,918	14.83%	0.80	0.27%
EI6	Water Heater	44,340	55.18%	2.53	0.85%
EI7	Chimney	2,176	2.71%	1.88	0.63%
EI8	Fans	11,205	13.94%	1.38	0.46%
EI9	Lighting	51,556	64.16%	1.52	0.51%
No EI	No EI1-EI9	1,399	1.74%	263.40	88.14%
SF1	Smoke Alarm	36,619	45.57%	3.14	1.05%
SF2	Windows,Doors	39,805	49.54%	1.29	0.43%
SF3	Ventilation	19,229	23.93%	1.97	0.66%
SF4	Air Sealing	75,673	94.18%	1.28	0.43%
SF5	Wall	25,291	31.48%	2.28	0.76%
SF6	Roof,Attic,Ceiling	51,624	64.25%	6.53	2.19%
SF7	Floor	20,226	25.17%	1.11	0.37%
SF8	Gas	1,061	1.32%	0.47	0.16%
No SF	No SF1-SF8	1,667	2.07%	283.87	94.99%
Total	-	80,352	-	298.84	-

Reduced Home Fires

Summary Frequency and Monetization of Various Prevented Fire Damages

Damage	Frequency	Household	Society	Total
WAP Fires	46.99	$503,800	$874,843	$1,378,643
WAP FF Deaths	0.0022	$0	$16,791	$16,791
WAP Other Deaths	0.70	$0	$5,278,798	$5,278,798
WAP FF Injuries	4.64	$0	$27,377	$27,377
WAP Other Injuries	1.64	$1,563	$8,130	$9,693
Total	-	$505,363	$6,205,939	$6,711,302

Monetization of Benefits Attributable to Fire Prevention

Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over 10 Years	PV Per Unit Benefit Over 10 Years
Households	$505,363	$6	$5,025,946	$63
Society	$6,205,939	$77	$61,719,426	$768
Total	$6,711,302	$84	$66,745,373	$831

Step 4: Identify Strengths and Weaknesses of the Methods and Results

- **Consider Grouping the Co-benefits into Tiers**
- **Factors to Consider**
  - Is there a logical link between the program and the co-benefit?
  - Was the co-benefit directly observed or inferred?
  - Are the data representative?
  - Are the data high in quality?
  - Were the data generalized from another context/study?

TIERS – These Benefits Group By Strength of Data and Methodology

- Tier One contains the estimates with the relatively highest accuracy, which at the very least are based on observed survey results and do not have any major methodological issues.
- Tier Two contains estimates that may be based on observed survey data but have one or two methodological issues and/or be based on strong programmatic observations (e.g., installation of carbon monoxide monitors) but not on direct reports of health change.
- Tier Three contains the estimates that some may deem as the most speculative.

Monetized H&HHD Benefits of WAP (Tier #)

- Reduced Thermal Stress on Occupants: Heat and Cold (T1)
- Reduced Asthma-Related Healthcare and Costs (T1)
- Fewer Missed Days at Work (T1)
- Reduced Need for Food Assistance (T1)
- Reduced Use of High Interest, Short-Term Loans (T2)
- Increased Ability to Afford Prescriptions (T2)
- Increased Productivity at Work Due to Improvements in Sleep (T3)
- Increased Productivity at Home Due to Improvements in Sleep (T3)
- Reduced Heat or Eat Choice Dilemma Faced by Pregnant Women (T3)
- Reduced Carbon Monoxide Poisonings (T2)
- Reduced Home Fires (T3)

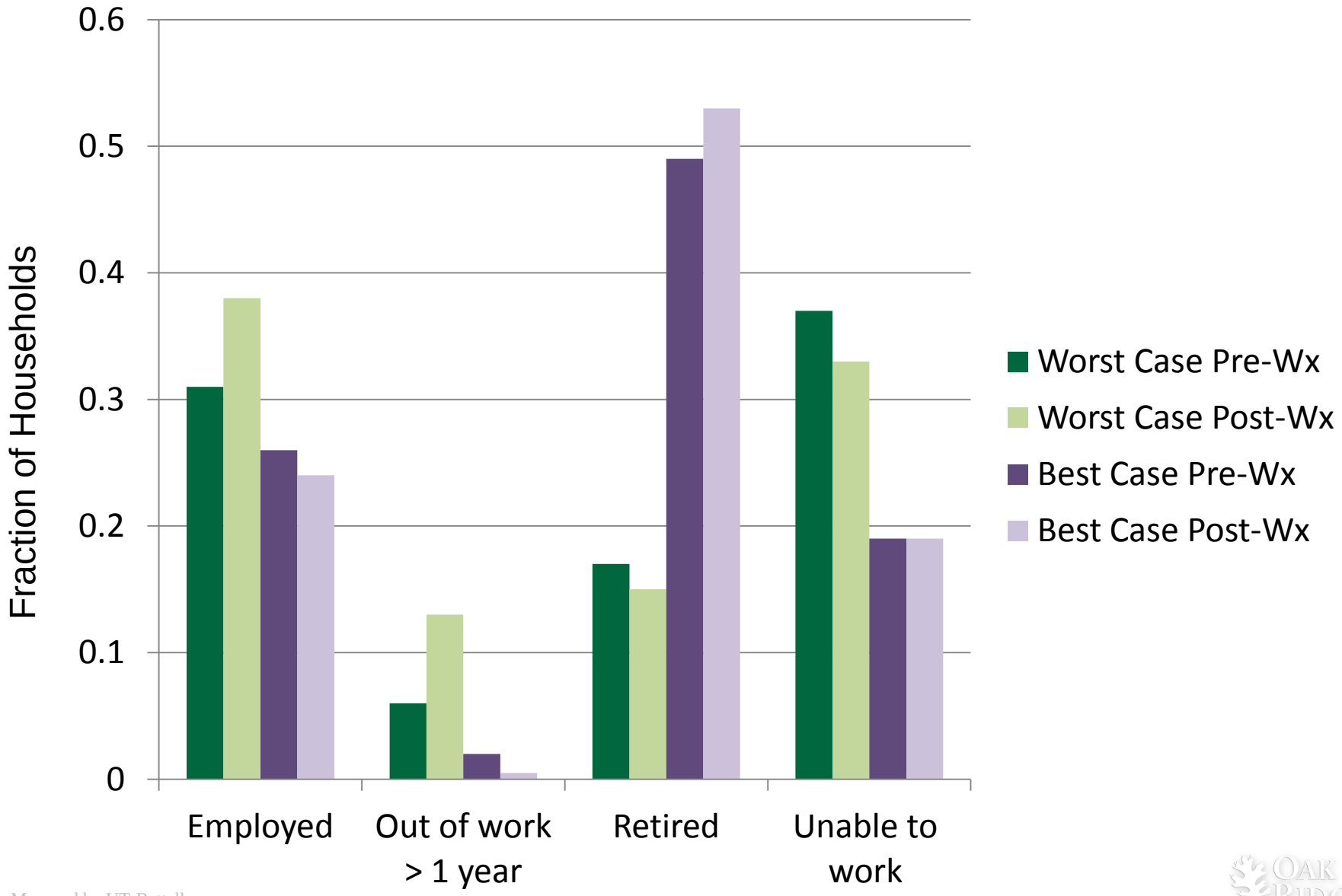
Step 5: Assess the Distribution of Co-benefits Among Program Participants

- **Do the co-benefits accrue equally across program participants or accrue within sub-populations?**
- **Low-income weatherization co-benefits appear to accrue to sub-populations of program recipients.**

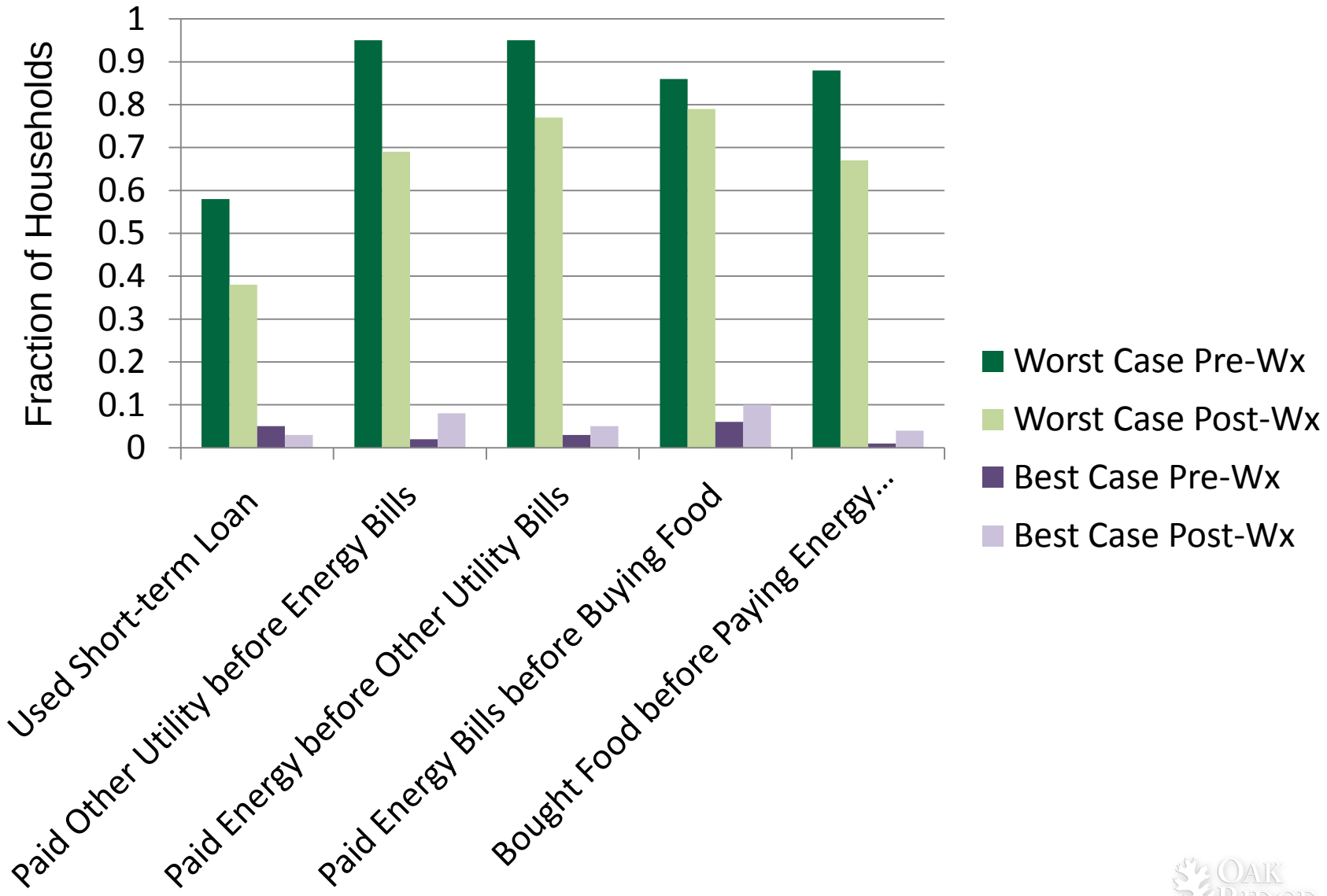
Clusters of WAP Households Dealing with Ten Budget Issues (n=644)

Cluster #	1	2	3	4	5	6
Cluster Description	Food & Medical Issues	Worst Case	Food Issues	Pervasive Bill Trade-off Issues	Best Case	Utility Bill Issues
N (%)	75 (12%)	65 (10%)	37 (6%)	87 (13%)	301 (47%)	79 (12%)
Avg. # of Budget Issues Pre-Wx	3.9	**7.8**	3.7	5.6	**0.8**	3.4
Avg. # of Budget Issues Post-Wx	2.8	5.9	2.7	3.9	0.9	2.9
Change Pre- to Post-WX	-1.1	**-1.9**	-1.0	-1.7	+0.1	-0.5

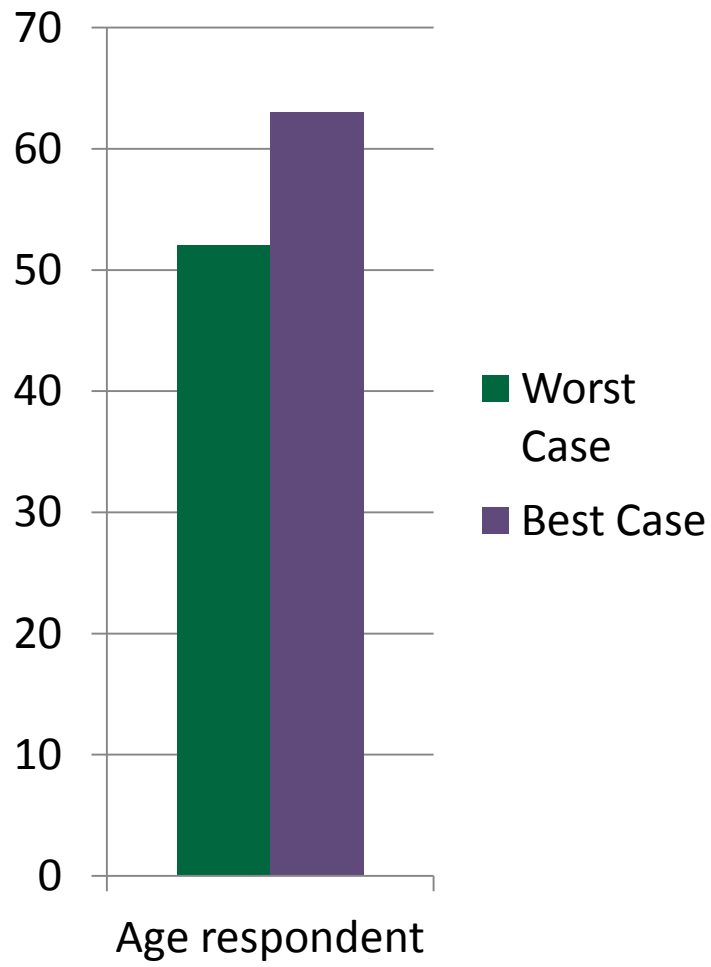
Working Age Households

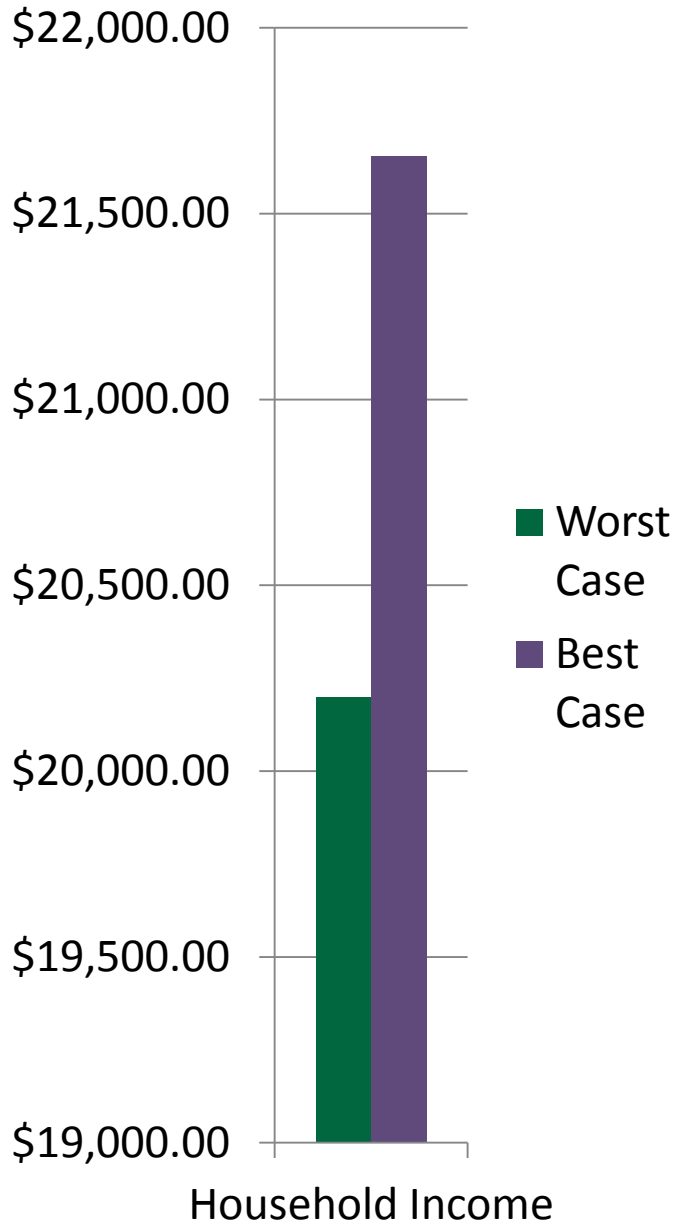


Substantial Differences in Budget Problems

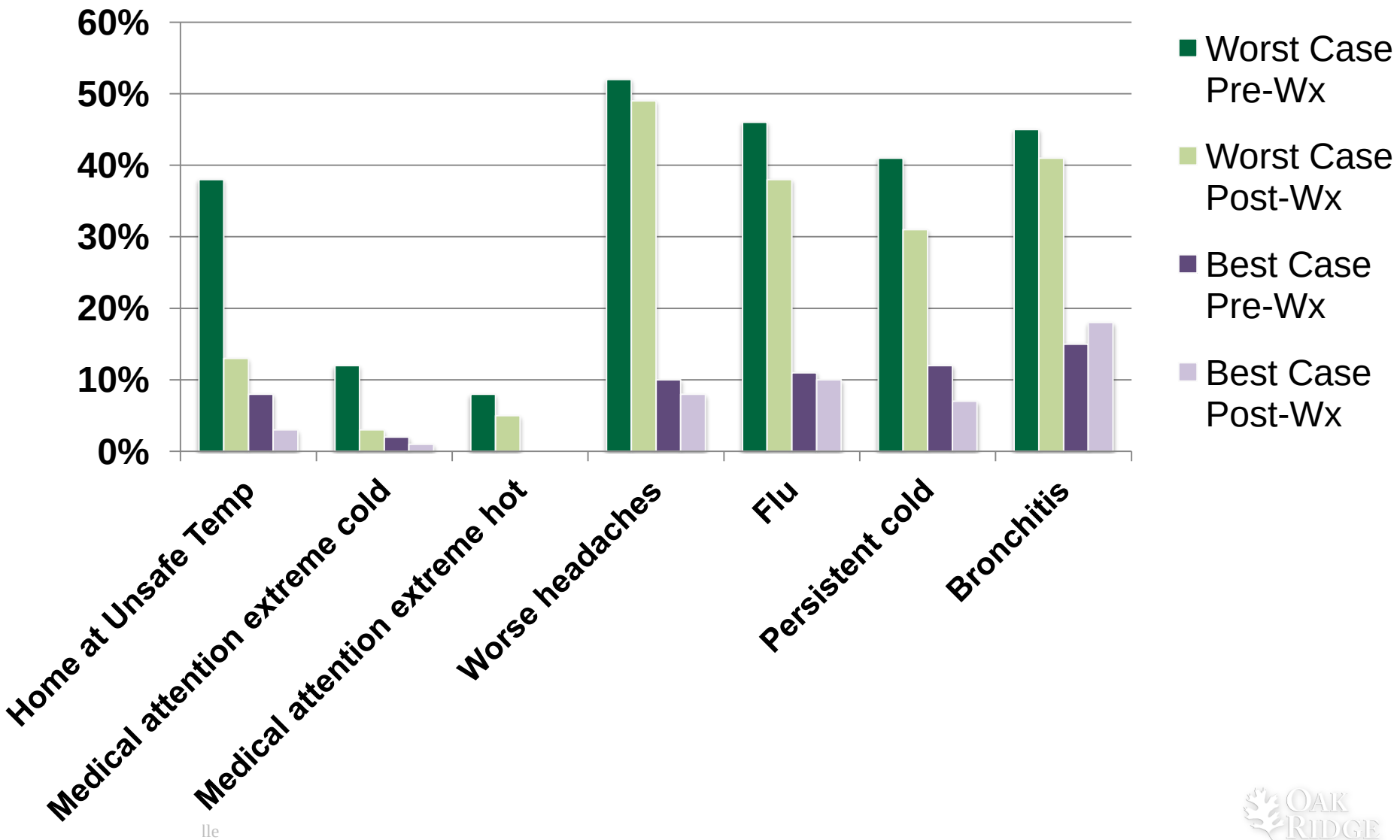


Who are the worst cases?





Housing and Health Conditions



Conclusions

- Health and household-related non-energy benefits can be monetized using survey and measure installation data, rates of usage of health-related services, and national costs for health-related services.
- Even more accurate estimates could be made using actual household medical costs pre- and post-wx (e.g., in the U.S., private insurance and Medicaid/Medicare records).
- There may be a non-energy benefits dividend of braiding weatherization with healthy homes measures.
- These and other measures can also improve the resilience of low-income homes to climate change and extreme weather events.