# Introduction to Mobile Homes

# Weatherization Installer/Technician Mobile Homes

Key Terminology

Base load

Certification label

Data plate

HUD code

I-beam

Incidental repairs

Manufactured home

Mobile home belly

Mobile Home Energy Audit (MHEA) software

Oak Ridge National Laboratory (ORNL)

Rodent barrier

Savings-to-Investment Ratio (SIR)

Site-built home

Steel chassis

Temperature rise

Thermal boundary

Thermal mass

U-value

U.S. Department of Housing and Urban Development (HUD)

Section Transition

Learning Objectives (Slide #3)

By attending this session, participants will become aware of:

* The history and development of mobile homes.
* Construction details and materials related to mobile homes.
* Problems related to energy efficiency of mobile homes.
* Differences between pre- and post-1976 mobile homes.
* Standard weatherization priorities for mobile homes.
* Opportunities for improving comfort, safety, and energy efficiency.
* Benefits of various retrofit options.

Image of a Mobile Home Community (Slide #4)

* From their pre-World War II beginnings, ***manufactured homes***, commonly referred to as mobile homes, were viewed as a quick fix to the American dream of home ownership.
* Compared to ***site-built homes***, mobile homes are quick and cheap to build. Because they are transportable, they can also be moved to any location.
* By 1998, more than 18 million Americans lived in mobile homes.
* They account for nearly 20% of new home sales nationwide and are an attractive community housing option.
* Mobile homes represent a large percentage of rural housing.

Opportunities (Slide #5)

Photo of two mobile homes connected by a foyer or conditioned breezeway.

* At least 25% of the households that qualify for weatherization are mobile homes.
* Advances in weatherization materials and retrofit techniques open up huge opportunities for energy savings.
	+ Mobile homes come in many shapes, sizes, and configurations.
	+ Mobile homes have received a bad rap for their light (cheap) construction and association with poverty.
	+ Their construction is unique and specialized retrofits are required.
	+ Mobile homes and the clients who occupy them deserve the same respect and attention to detail as other homes and clients.

Some Mobile Home Characteristics (Slide #6)

* Wooden frame bolted to a steel chassis.
* Constructed in long, narrow segments in a factory; delivered and completed on site.
* Shallow roof cavities.
* Interior panels provide structural rigidity.
* Single framing for door and window openings.
* Sealed combustion heating systems.

*Ask students how they think mobile home building construction details are different from site-built home building details. This discussion leads into the next slides on mobile home characteristics and components*.

Mobile Home Belly System (Slide #7)

* Mobile home (***HUD Code***) manufacturing processes haven’t changed much over the years.
* This photo shows typical construction details of a floor system more commonly known as the ***mobile home belly*.**
* The belly contains the insulation, duct system, and plumbing, and is enclosed by the sub- and finished floors on top and ***rodent barrier*** underneath.

Mobile Home Components #1 (Slide #8)

Drawings show the typical construction details of the floor system.

* The floor system has ***steel chassis***, floor joists, insulation, and duct system all sandwiched together.
* The double set of main ***I-beams*** provides center loading through the masonry piers and to the ground.
* Site-built homes are supported by a masonry foundation that supports the home along its outer perimeter.

Mobile Home Components #2 (Slide #9)

Photos of major mobile home components.

* The majority of existing mobiles are integrated, self-contained homes. The floor plans of these “single wides” range from about 700 to 1,000 square feet.
* Modern mobile homes can be built in multiple sections, known as “double wides” or “triple wides,” and bolted together on site.

Mobile Home Components #3 (Slide #10)

Photos showing wall detail and furnace installation.

* Walls are typically built from the inside out and attached to previously finished floors. (Note carpet and tile.)
* Mechanical components are installed before the interior partitions are built.

Problems and Opportunities #1 (Slide #11)

Mobile homes built before 1976 consume 1.5 to 2 times more energy than a site-built home. Why?

* Low ***thermal mass*** (thin and poorly insulated floors, walls, and ceilings).
* Conductive materials (metal window and door frames).
* Large open areas and penetrations in the floor system.
* High surface-to-floor area ratio.
* Poor duct design, components, and installation.
	+ “High surface-to-floor area ratio” means that all sides of a mobile home are exposed to ambient conditions.
	+ Site-built homes have basements, slabs, or crawl spaces to buffer them from the elements.

Problems and Opportunities #2 (Slide #12)

Photo showing typical kinds of duct leakage in mobile home belly cavity.

* This was a factory-built problem waiting to happen. (Note separated duct tape.)

Problems and Opportunities #3 (Slide #13)

Photo of a mobile home wrapped in plastic, underscoring the thermal and air convective losses associated with mobile homes.

* The homeowner took matters into his own hands to enhance comfort. As the weather warms, he removes the plastic and installs a fresh sheet in the fall.
* That must be a pretty good-sized twist tie holding it all together.

*Ask students what kinds of experiences they’ve had with mobile homes and what kinds of measures they’ve installed.*

*This is a good slide to talk a little bit about how air sealing, while very cost effective, should be accomplished with good indoor air quality in mind. As we tighten homes the need for adequate ventilation becomes very important for occupant health and the home itself.*

Problems and Opportunities #4 (Slide #14)

How many mobile home junkyards have you seen recently?

*Pose this question and wait for responses before proceeding with the explanation below.*

* There aren’t many, since even fairly beat-up homes tend to change hands often.
* These inefficient and poorly insulated units often fall into the hands of low- and fixed-income folks who can least afford the high fuel bills associated with heating and cooling.

Problems and Opportunities #5 (Slide #15)

Photo of a pre-1976 mobile home on a back lot of a Mobile Home Sales and Service Center.

Old mobile homes fall into the hands of low-and fixed-income people often because they are so inexpensive up front.

* It had a price tag of under $2,000 (excluding transportation and set-up charges).
* This 12 x 60 pre-1976 home was in pretty good shape to start with.
* The new owner got a very good value on this one.
* The floors, walls, and ceilings were reinsulated and ducts repaired in conjunction with a Pennsylvania Weatherization Training Center event.
* In this case, it really was a value since it was in good shape and got weatherized. In many instances, the low up-front cost is more than outweighed by high operating costs.

Mobile Home Construction Eras (Slide #16)

Construction era should drive retrofit strategies.

Pre-HUD Code (before 1976)

* Little or no insulation (less than R-6).
* x 2 or 2 x 3 stud walls.
* Jalousie windows.

HUD Code and upgrades (post-1976)

* Set insulation standards per climate zones.
* 2 x 4 exterior walls and single-hung slider windows.
* Bathroom and kitchen exhaust fans.
* Vapor barriers in ceiling.
* R-8 or better insulation levels.

*Ask how these insulation levels compare to insulation levels for code-compliant site-built homes (Refer to local IRC codes).*

* Recognizing when a mobile home was built should drive its retrofit strategies.
* Mobile homes built before 1976 were some of the worst in terms of an overall lack of energy efficiency. They were constructed in factories all over the nation and there were very few standards.
* A home built for a hot climate might find its way to the state of Maine and be unable to withstand the snow load, much less contain the proper insulation.
* In 1976, Congress passed the Manufactured Housing Safety and Construction Act, which established a federally enforced performance-based code.
* The ***U.S. Department of******Housing and Urban Development (HUD)*** was charged with rulemaking and enforcement of the HUD Code*.*
* Although HUD Code insulation standards were higher with R-8 minimums throughout, it is generally cost-effective under WAP to install additional insulation in post-HUD code mobile home, bellies, walls, and roof cavities where clearances allow.

Determining the Construction Era (Slide #17)

Scan of a ***data plate*** and a ***certification label*** for HUD Code homes.

* A data plate and certification label note the existence of ventilation fans and other distinctive features, but also indicate that a home was built under the HUD Code.
* Homes built before 1976 will not have these labels.
* The data plate is permanently affixed to the home, usually in a bedroom closet, the electrical panel box cover, or kitchen cabinet. The data plate contains the name and address of the manufacturer, serial and model numbers, date of manufacturer, and certification label numbers. It lists major factory-installed appliances, along with the wind and snow loads the home was designed for.
* The certification label is a metal plate fastened to the exterior of the home, showing that it meets all construction requirements under the HUD Code.
* The certification label will list factory insulation for all surfaces in “U” values. ***U-value*** is a measure of heat flow through building components. The lower the U-value, the better the energy performance.

Sample Measure Selection Priority List (Slide #18)

* This table shows a priority list developed by a state and approved by DOE based on the ***Mobile Home Energy Audit (MHEA) software*** developed at ***Oak Ridge National Laboratory (ORNL)***.
* By modeling various mobile home configurations and inputting fuel cost, climate data, material costs, and labor costs, DOE determined that shell measures such as duct sealing, air sealing, and insulation are cost-effective retrofits.
* Measures must have a ***savings-to-investment ratio (SIR)*** of 1 or greater, meaning the measure will save enough money by reducing energy bills to pay for itself within its lifetime.
* While windows and doors generally do not have favorable SIRs, replacements are allowable as infiltration measures and/or health and safety measures if the existing windows and doors are beyond repair.
* The interaction of mechanical, ***base load***, and building shell measures are considered in the evaluation.
	+ Base load use is defined as year-round energy consumption not related to space conditioning. Refrigeration, lighting, and domestic water heating are examples of base load use.
* The MHEA software calculates interactions automatically.

*Employ “Chalk Talk” and do a series of simple SIR or payback calculations on window replacement vs. belly insulation. (SIR = lifetime savings divided by cost) or (payback = cost divided by savings/year). The purpose is to demonstrate the relative differences between the cost-effectiveness of window and door replacements compared to other building shell retrofits such as roof or wall insulation.*

Retrofit Options – Duct Systems (Slide #19)

* Performance-based duct treatments are challenging but very important. They include:
	+ Visual and diagnostic assessment.
	+ Sealing and repair.
	+ Converting belly return system.
	+ Cleaning.
	+ Removing obstructions.
	+ System balancing.
	+ Replacing damaged registers.
	+ Post-repair diagnostics.
* Duct sealing and repair is probably the most cost-effective measure that can be applied to mobile homes.
* Ducts are located within the belly cavity and are therefore outside the ***thermal boundary***. All that separates them from the outdoors is a thin rodent barrier that is often torn or completely missing.
* Duct sealing and repair is difficult work, often with low clearances, a wet ground, and obstructions. The work requires attention to detail.

Retrofit Options – Heating Systems (Slide #20)

* Heating system retrofits include:
	+ Visual and diagnostic testing.
	+ Cleaning dirty burners.
	+ Cleaning and adjusting blowers.
	+ Replacing furnace filters.
	+ Repairing excessive ***temperature rise*** problems.
	+ Adjusting operating temperatures.
	+ Replacing unsafe or inefficient furnaces.
* Should only be attempted by qualified heating technicians.

Retrofit Options – Belly Insulation (Slide #21)

* Re-insulating the mobile home belly is almost always cost-effective.
* Benefits:
	+ Increases thermal performance.
	+ Air leakage reductions between 25% and 50% are possible.
	+ Enhances occupant comfort.
* Installing belly insulation is very challenging but possible with the right tools and good training. It involves:
	+ Air sealing all penetrations to the living area.
	+ Repairing the rodent barrier.
	+ Drilling access holes through the rim joist.
	+ Filling the belly cavity with loose-fill insulation.

Retrofit Options – Sidewall Insulation (Slide #22)

* Re-insulating sidewalls is also usually a very cost-effective retrofit.
* Benefits:
	+ Increases thermal performance.
	+ Reduces air leakage.
	+ Reduces noise.
* Technically not difficult or time consuming.
* Installing sidewall insulation involves:
	+ Partially detaching the siding.
	+ Pulling out the old insulation.
	+ Stuffing thicker fiberglass batts into the wall cavities.
	+ Reattaching the siding.

Retrofit Options – Roof Insulation (Slide #23)

* Re-insulating roof cavities on mobile homes is typically cost-effective.
* Benefits:
* Increases thermal performance, saving on heating and cooling bills.
* Reduces roof rumble: High winds can cause the metal roof panels of a mobile home to flex and buckle, causing noise. Additional roof cavity insulation can dampen this effect.
* Insulating roof cavities is moderately challenging but possible with the right tools and good training. It involves:
* Repairing ceilings.
* Accessing the roof cavity through the ends, top, sides, or interior ceiling.
* Filling the roof cavity with loose-fill insulation.
* Repairing access points.

Retrofit Options – Other Measures (Slide #24)

* Window and door replacement.
* Hot water conservation measures.
* Health and safety measures.
* Standard base load measures (refrigerator replacement, hot water tank improvements, and installation of compact fluorescent lamps).
* Cooling measures for hot climates, including:
* Reflective roof coatings.
* Shade screens and awnings.
* Window films.
* Incidental repairs.

Sequence of Retrofit Options (Slide #25)

* Perform blower door-guided air sealing. Assure that combustion appliances operate safely prior to air sealing.
* Diagnose, repair, seal, and improve duct systems.
* Diagnose and repair or replace the furnace.
* Prepare and insulate the belly cavity.
* Prepare and insulate walls.
* Prepare and insulate the roof cavity.
* Inspect and apply domestic water heater improvements and standard base load measures.
* Inspect and repair or replace windows and doors.
	+ The sequence of retrofit options follows a priority list based on the level of cost-effectiveness.
	+ Measures such as adding mechanical ventilation, floor repair, and furnace replacement are not considered under cost-effective criteria. They are covered under ***incidental repairs*** or health and safety categories in the WAP.

Summary (Slide #26)

* Mobile homes are throughout the U.S. and are here to stay.
* Mobile home construction details differ depending on the era the home was built.
* The year the mobile home was built drives the retrofit strategy.
* Huge opportunities exist for improving the efficiency of these structures through well-thought-out weatherization measures.
* Weatherization technicians should apply cost-effective retrofit options.