

# Integrated Design: A High Performance Solution for Affordable Housing



The Levy Partnership, Inc.

PI: Emanuel Levy, President

PM: Jordan Dentz, Vice President

(212) 496-0800 [jdentz@levypartnerhsip.com](mailto:jdentz@levypartnerhsip.com)

# Project Summary

## Timeline

- Start date: July 2015
- Planned end date: September 2019

## Key Milestones

- Manufactured home unoccupied monitoring meets comfort and energy criteria - May 2016
- Manufactured home occupied monitoring meets comfort and energy criteria - March 2018

## Budget

Total Project \$ to Date: \$884,368

- DOE: \$628,933
- Cost Share: \$255,435

Total Project \$: \$1,026,987

- DOE: \$749,987
- Cost Share: \$277,000

## Key Partners

- Habitat for Humanity
- Systems Building Research Alliance
- Mitsubishi Electric
- Panasonic
- State Industries
- Whirlpool
- DOW
- Clayton Homes
- Affordable Housing Alliance
- Champion Home Builders
- Owens Corning
- Lippert Industries
- Knauf
- Next Step Network, Inc.

## Project Outcomes

- 60% source energy savings in new single story affordable homes in CZ 4-5
- Integrated HVAC and envelope using point source space conditioning
- Actionable guidelines for industry tied to partner implementation

# Team



# Challenge

How to move a highly price-sensitive industry to exemplary levels of energy efficiency.

## Market Barriers

- 1<sup>st</sup> cost is king
- Communicating energy benefits faces major hurdles
- Manufactured homes are sold by dealers like autos

## Technical Challenges

- Technologies must be production/volunteer friendly
- New building methods must be code approved

## Knowledge Gaps

- Industry mindset focused on 1<sup>st</sup> cost; must shift to total ownership costs
- Few examples of high performance homes
- HUD energy standards last updated in 1994, many iterations behind the IECC
- Habitat chapters lack expertise on staff



# Challenge

Develop and validate technologies and systems that meet RBI's MYPP goal of reducing building energy consumption by 60% in new homes.  
Stimulate market by partnering with major market players.

**High-performance home, so energy efficient,**  
that all or most annual energy consumption  
can be offset by renewable energy.

## MANUFACTURED HOMES

- Built in 120 plants; 5,000 dealers
- Uniform construction: 1-story, small
- ~70% of unsubsidized affordable housing
- 75% owner occupied
- 10% of new single family homes (70-100k/yr)
- 7 million homes use 0.47 quad/yr
- Highest \$/sf energy cost

## HABITAT FOR HUMANITY

- Site built largely by volunteers
- 3,000-4,000 homes/yr
- 1-2 story and modest size
- Affordable
- Owner occupied
- 1,400 U.S. affiliates
- Works in 70 countries

# Approach

For a defined market segment, a holistic solution, including:



Thermal envelope:  
wall, roof,  
airtightness,  
windows

Space  
conditioning  
and ventilation

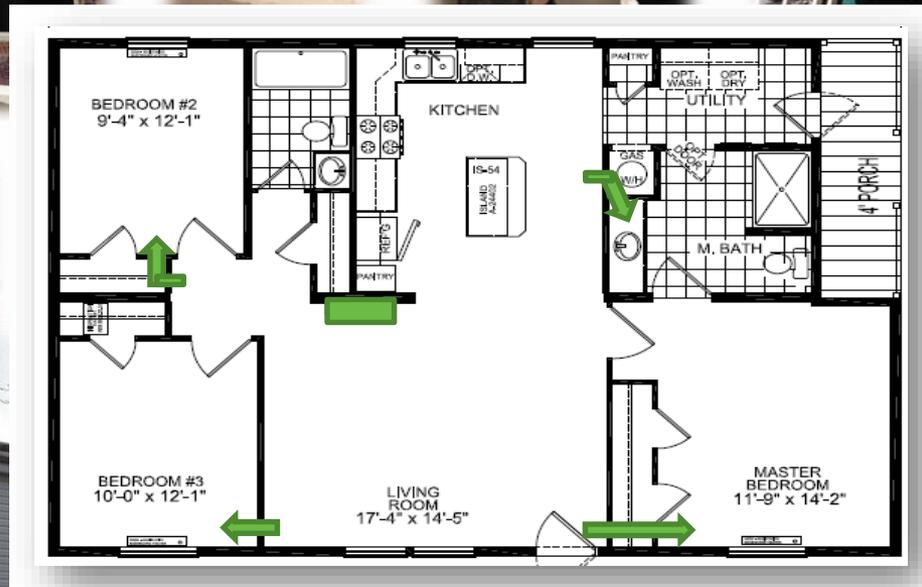
Integrating  
into the  
building  
process  
(production  
environment  
requires  
speed)

Cost and  
installation:  
quality key  
considerations

This is Integrated Design

# Approach

ID homes incorporate one or two ductless heat pumps, quiet fans to circulate air, thermal enclosures to keep loads down, other DOE Zero Energy Ready Home features



# Approach

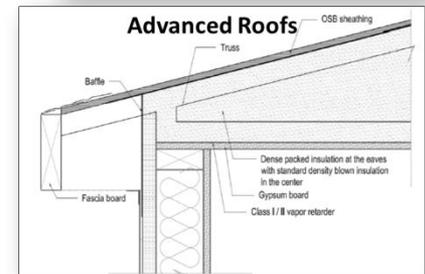
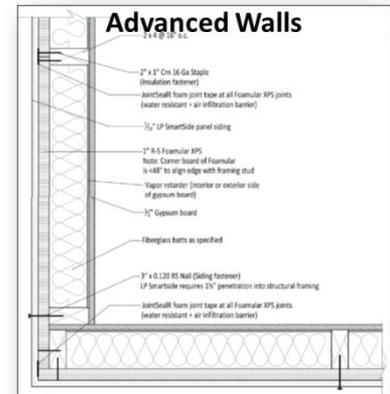
**Approach:** Extensive collaboration with targeted market segments to eliminate builder uncertainties by validating successful design approaches for low energy homes.

Accelerate integration into production building processes by providing clear and actionable guidance on point source space conditioning with superb thermal envelopes.

**Key Issues:** Affordability and assurance that the solution will succeed in terms of comfort, buildability and energy savings. The market is inching in this direction but needs validated solutions to rally around.

**Distinctive Characteristics:** Collective Impact; the commitment of a group of actors from different sectors to a common agenda for solving a specific problem, using a structured form of collaboration.

**Technologies:** Ultra-efficient thermal envelope, low capacity ductless heat pump, innovative distribution system.



# Impact

## Contributions towards Residential Building Integration program's MYPP goals

- **Goal - Demonstrating and Integrating Technologies:** By 2020, develop and demonstrate cost effective bundles of technologies and practices...that can reduce EUI of new single-family homes by at least 60%.

We are developing an approach that does just this.

- **Goal - Proving Whole-House Solutions at Scale for New Homes:** Prove it's possible to cost-effectively reduce average EUI of new homes 40% by 2020, with no decline in performance. According to the BTO MYPP, one indicator of success is certifying at least 50,000 single-family ZERH homes.

We are proving a viable strategy for ZERH compliance.



**To achieve these goals requires an exemplary value proposition: Deliver higher quality at lower total monthly cost; with only small increase in first cost.**

# Impact

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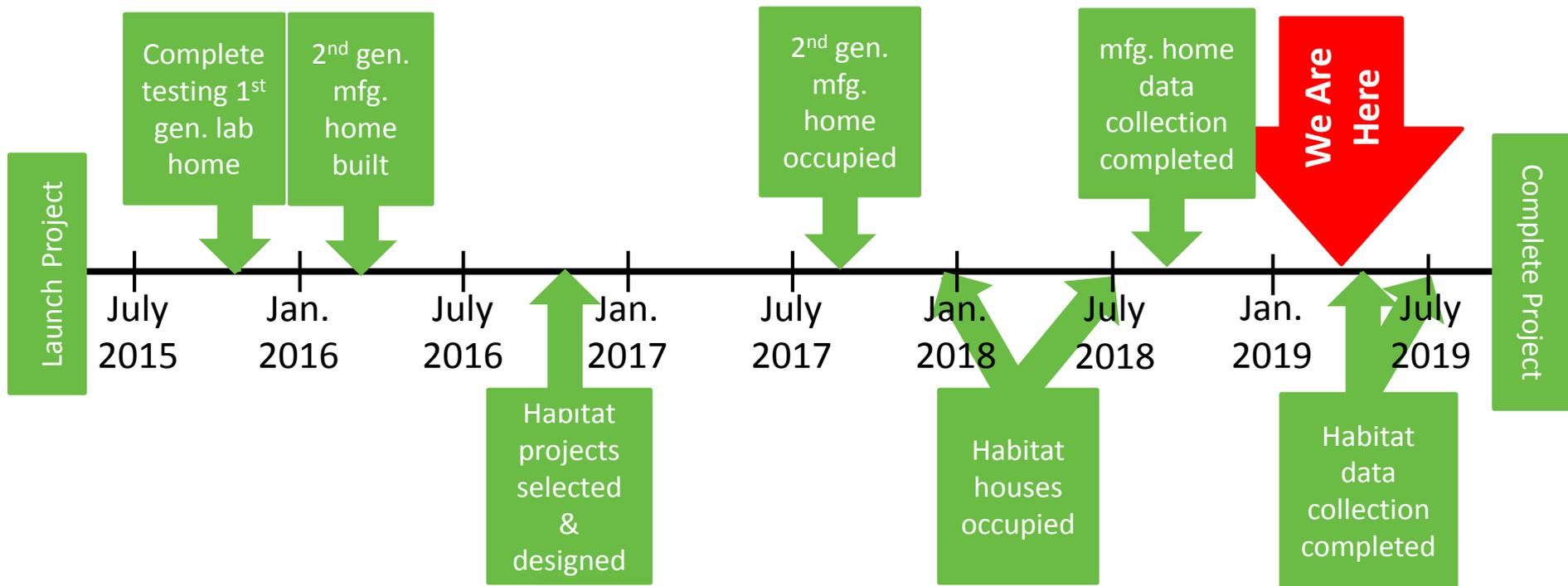
## **Building on prior and current Building America work**

- **Moisture Performance of High-R Wall Systems**
- **Structural Support of Windows in Walls With Continuous Insulation**
- **BAPIRC - Space conditioning systems with optimized comfort distribution and latent control**
- **Field Evaluation of Advances in Energy-Efficiency Practices for Manufactured Homes**
- **Field Evaluation of Four Novel Roof Designs for Energy-Efficient Manufactured Homes**
- **Simplified Space Conditioning in Low-Load Homes: Results from Pittsburgh, Pennsylvania, New Construction Unoccupied Test House**

## **Potential to influence**

- **Home manufacturer offerings**
- **Habitat for Humanity International standard construction practices**
- **Ability for builders to meet voluntary above-code programs**

# Progress: Project Plan and Timeline



Lab Homes

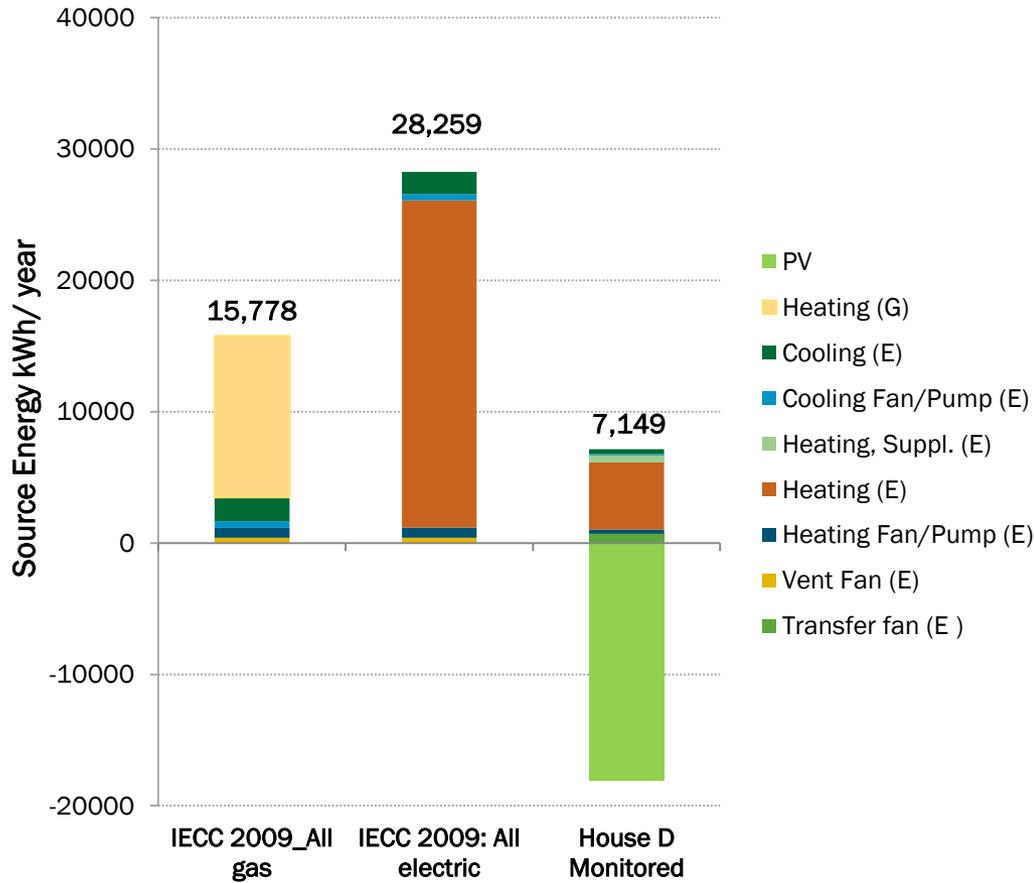


Verification in Unoccupied & Occupied Homes



Industry

# Progress: Occupied Manufactured Home



- 68% primary energy reduction
- 95% of hours within comfort compliance

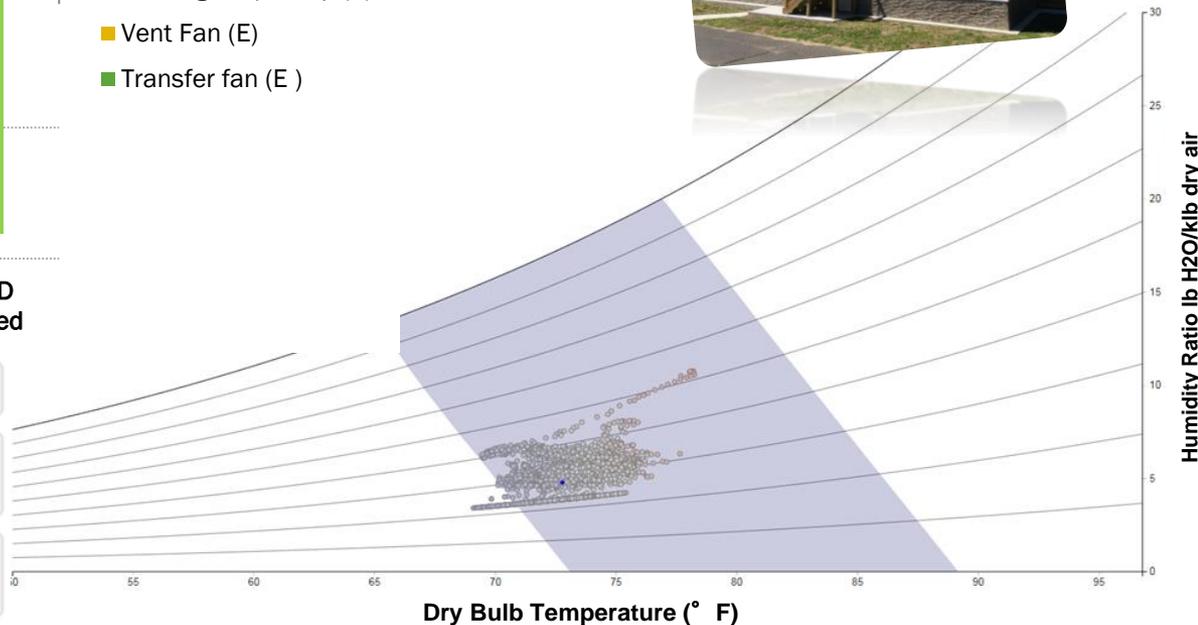


Average PMV: -0.20

# of measurements outside comfort zone: 130

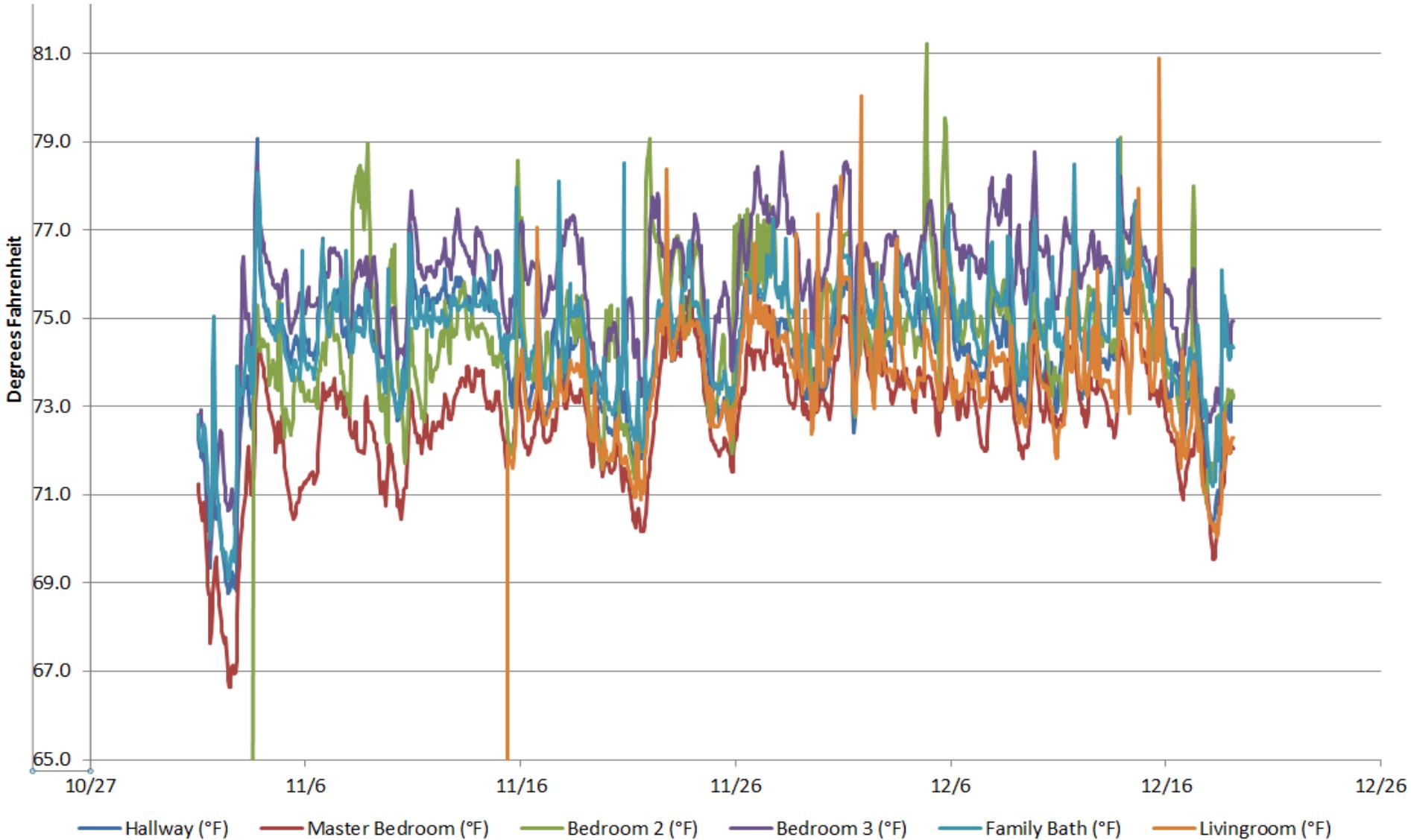
Weighted average exceedance intervals: 0.01

PMV = Predicted Mean Vote





# Progress: Occupied Habitat Home 1



# Stakeholder Engagement

SBRA spearheads technological innovation for the bulk of the industry

Clayton and Champion together produce nearly 60% of all factory-built homes

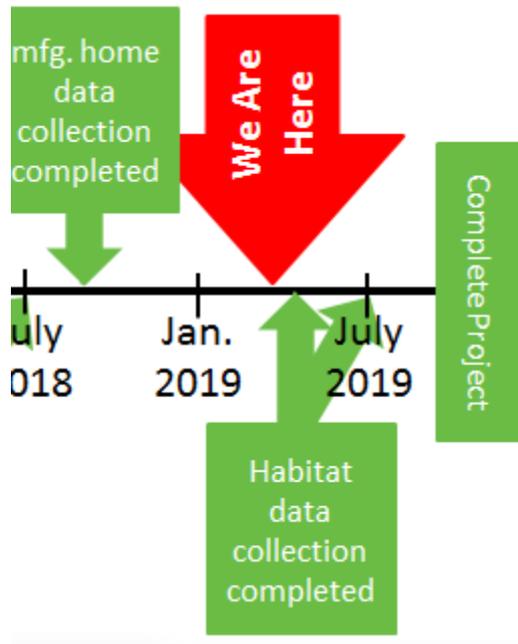
Habitat is a trendsetter in the affordable housing space

Suppliers are on board because of the interest in these key home producers



# Remaining Project Work

- Analysis and reporting from two Habitat homes
- Complete industry guidelines
- Guidance to focus on CZ4 and 5 and distinguish between central and end-loaded ranch-home floor plan types
- Continue supporting industry in their efforts to adopt and integrate this approach to building



**U.S. DEPARTMENT OF ENERGY** Energy Efficiency & Renewable Energy  
Technology Solutions for New and Existing Homes

**Building America Case Study**

**Southern Energy Homes, First DOE Zero Energy Ready Manufactured Home**  
Russellville, Alabama

**PROJECT INFORMATION**  
Project Name: First DOE Zero Energy Ready Manufactured Home  
Location: Russellville, AL  
Partners: Southern Energy Homes, seahomes.com; ARIES, ariespartnership.com  
Building Component: Whole building  
Application: New construction; single-family  
Applicable Climate Zone: Mixed-humid, SA

The country's first Zero Energy Ready manufactured home that is certified by the U.S. Department of Energy (DOE) is up and running in Russellville, Alabama. The manufactured home was built by a partnership between Southern Energy Homes and the Advanced Residential Integrated Energy Solutions Collaborative (ARIES), which is a DOE Building America team. The effort was part of a three-home study including a standard-code manufactured home and an ENERGY STAR® manufactured home. Cooling-season results showed that the building used half the space-conditioning energy of a manufactured home built to the U.S. Department of Housing and Urban Development's (HUD's) Manufactured Home Construction and Safety Standards. These standards are known collectively as the HUD Code, which is the building standard for all U.S. manufactured housing.

**PERFORMANCE DATA**  
Home Energy Rating System (HERS) Index: 37  
Projected annual utility costs: \$799  
Projected annual energy cost savings compared to 2009 IECC: \$372  
Builder's added cost over HUD Code: \$2,502  
Annual energy savings: 4,658 kWh

The home and the study have gained the attention of the manufactured housing industry; factory building organizations across the nation have run articles in their publications describing the home and its advances. Articles have also run in industry press such as *Builder* magazine (July 28, 2014). David Brewer is the general manager for Southern Energy Homes; he was impressed by the results of the study. "We're excited about the project," he said. "It will be highly marketable."

**Building America**  
U.S. Department of Energy

**U.S. DEPARTMENT OF ENERGY** Energy Efficiency & Renewable Energy

**Field Evaluation of Advances in Energy-Efficiency Practices for Manufactured Homes**  
E. Levy, J. Dentz, E. Ansanelli, G. Barker, P. Rath, and D. Dadia  
ARIES Collaborative  
March 2016

**Building America**  
U.S. Department of Energy



# Thank You

**ARIES**  
Collaborative

The Levy Partnership

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(212) 496-0800



THE **LEVY** PARTNERSHIP

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# REFERENCE SLIDES

# Project Budget

**Project Budget: \$1,026,987** total budget including **\$277,000** in cost share

**Variances:** No budget variances.

**Cost to Date: \$884,368** of **\$1,026,987 (86%)** expended through Dec. 2018

**Additional Funding:** \$277,000 cost share from industry in-kind and cash contributions; \$341,747 NYSERDA-funded complimentary project in NY

## Budget History

July 2015 – FY 2018 (past)		FY 2019 (current)		FY 2020 (N/A)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$594,009	\$247,412	\$155,978	\$29,588	\$0	\$0

# Project Plan and Schedule

- **Go/No-go 1: Unoccupied home meets comfort and performance criteria: ACCA Manual RS, ASHRAE 55-2010 and 62.2, source space conditioning and ventilation energy savings ~50% compared to baseline: July 2016**
- **Go/No-go 2 Occupied home 1 meets same comfort and performance criteria: March 2018. Delayed from original plan due to extra time needed to sell and occupy Home 1.**

