

Integrated Design: A High Performance Solution for Affordable Housing

2017 Building Technologies Office Peer Review



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Jordan Dentz, JDentz@levypartnership.com
The Levy Partnership, Inc.

Project Summary

Timeline

- Start: July 2015
- Planned end: June 2018

Key Milestones

- Unoccupied home meets comfort and performance criteria; July 2016
- Occupied home meets comfort and performance criteria; July 2017

Budget

Total Project \$ to Date:

- DOE: \$495,717
- Cost Share: \$157,158

Total Project \$:

- 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 Enterprises
- Owens Corning
- Lippert Industries
- Knauf
- Next Step Network, Inc.

Project Outcome:

- **60% energy savings in single story affordable homes in mixed and cold climates**
- **Integrated HVAC and envelope using point source space conditioning**
- **Actionable guidelines for industry tied to partner implementation**

BTO Needs and Objectives: Target Markets

BTO Objective: Develop and deploy technologies and systems that reduce building energy consumption by 60%; stimulate market by partnering with major market players.

RBI Markets: single family, multifamily, manufactured housing

High-performance home, so energy efficient,
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 homes (70-100k/yr)
- 7 million homes use 0.47 quad/yr
- Highest \$/sf energy cost

HABITAT FOR HUMANITY

- Site built largely by volunteers
- 1-2 story and modest size
- Affordable
- Owner occupied
- 1,400 affiliates
- 3,000-4,000 homes/yr

Purpose and Objectives: Benefits and Impact

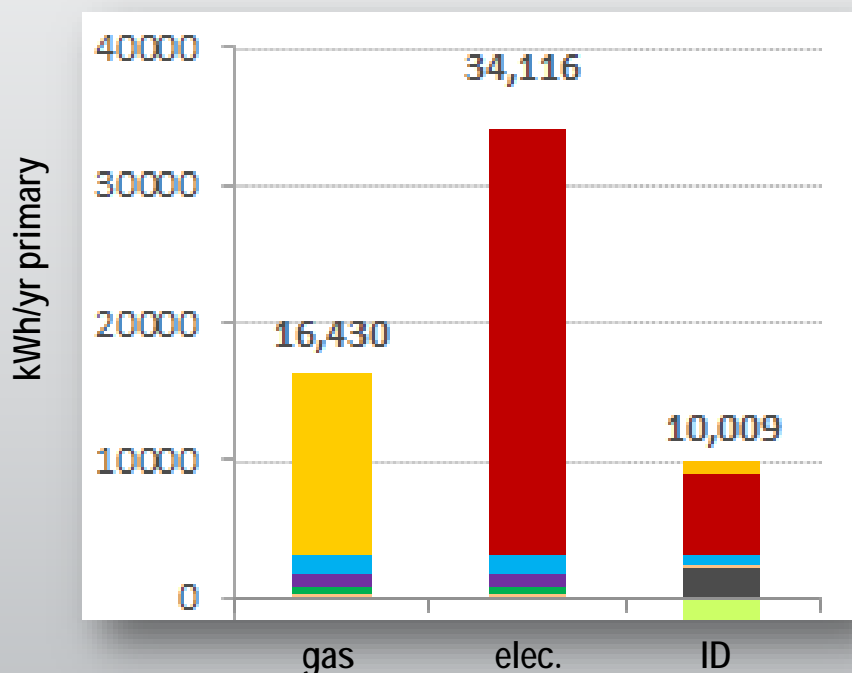
60% space conditioning energy savings, at similar cost.

30 trillion BTUs saved over 10 years

\$6 million annual utility bill savings*

ROI 400:1 over 10 years

Meeting Energy Objectives

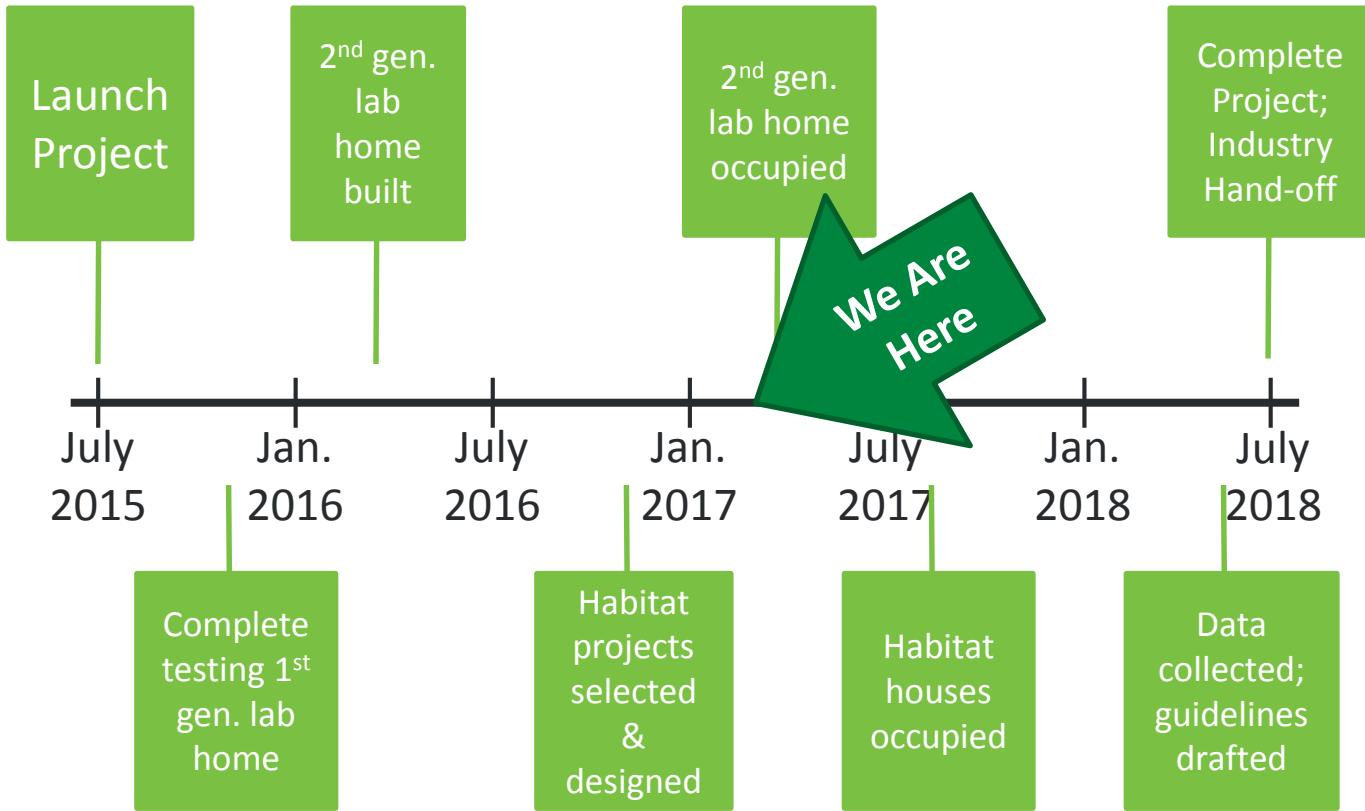


Road to Impact

- **Output: Demonstrated solutions for affordable, high performance homes; clear guidelines for plants and builders**
- **Measurement: Number of homes built using guidelines**

*Assuming 30% market penetration

Approach: Project Plan and Timeline



Lab Homes



Verification
in Occupied
Homes



Industry

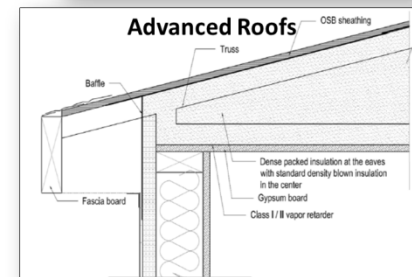
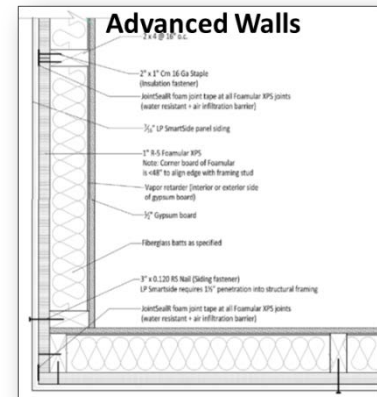


Approach

Approach: Extreme collaboration with targeted market segments to demonstrate successful approaches to low energy homes. Accelerate movement in this direction by eliminating builder uncertainties and providing clear guidance for point source space conditioning with superb thermal envelopes.

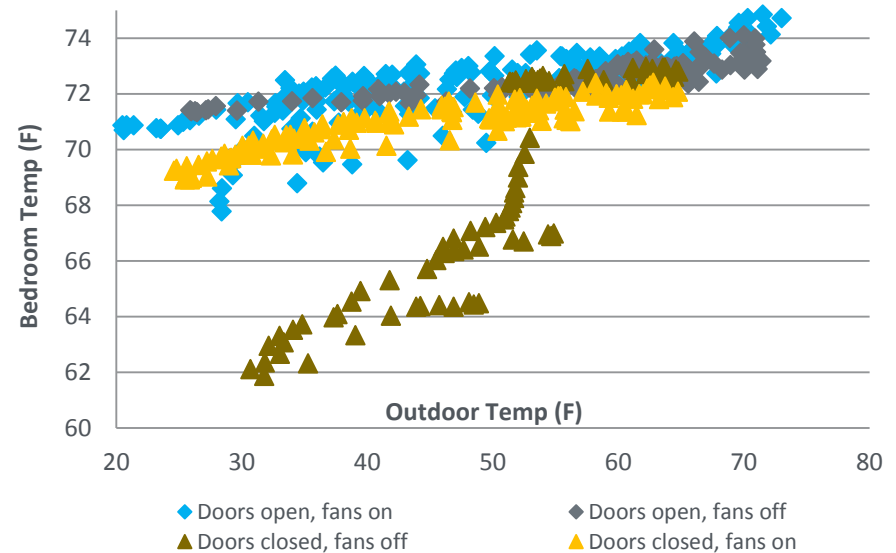
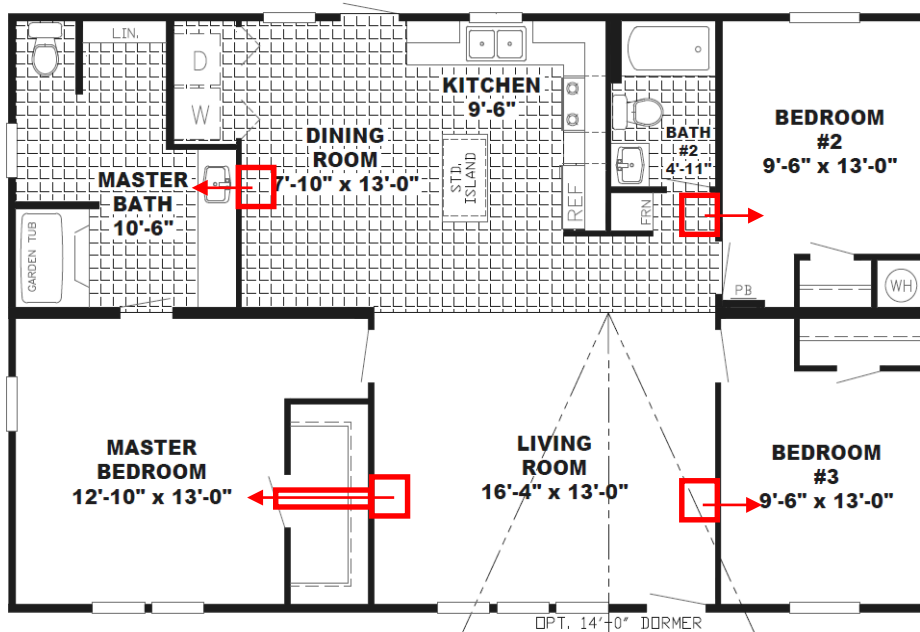
Key Issues: Affordability and assurance that the solution will succeed in terms of comfort metrics, buildability and energy savings. The market is inching in this direction but needs validated solutions to rally around.

Distinctive Characteristics: Unique aspects of our approach include 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 include ultra-efficient thermal envelope, low capacity ductless heat pump, innovative distribution system.



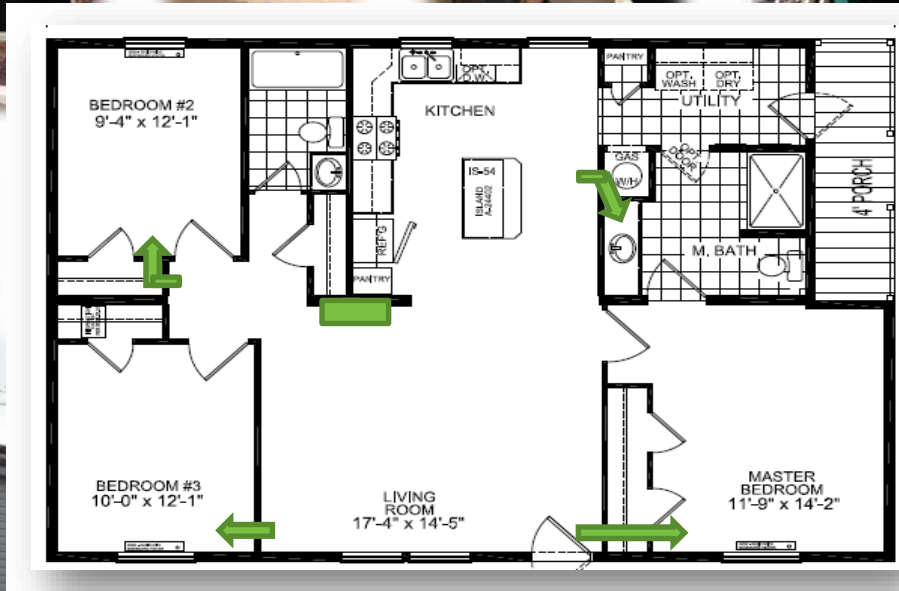
Approach: Point Source Space Conditioning

Point source space conditioning with transfer fans proven viable in Building America lab home (Russellville, AL).



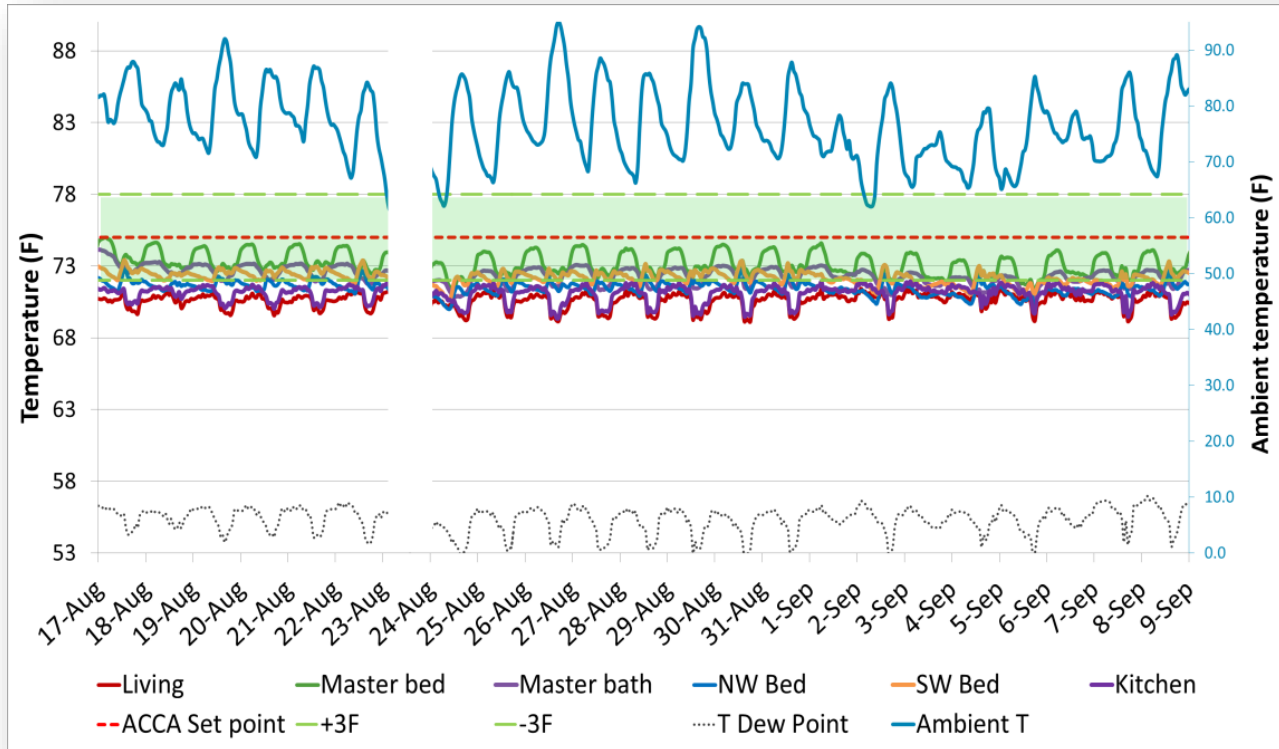
Progress and Accomplishments: 2nd Generation ID Home

2nd generation lab house in mixed climate (Eatontown, NJ) incorporating lessons learned from Russellville plus new features. Monitoring: 10-month unoccupied and 12 months occupied ongoing



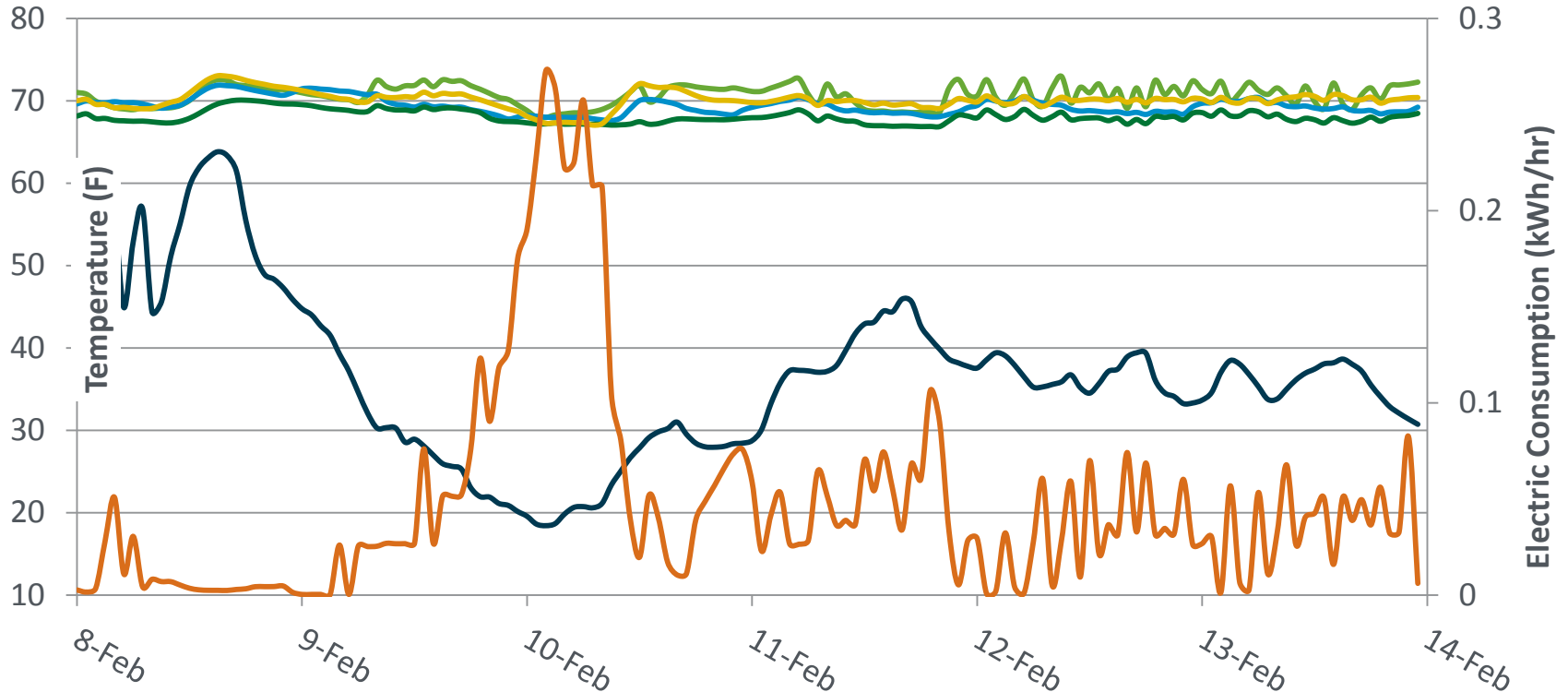
Progress and Accomplishments: Cooling Season

- Energy targets met
- Temperatures mostly in compliance



- Relative humidity exceeded target for large portions of cooling period – an issue endemic to low load houses, regardless of distribution system approach
- “Dry” mode reduced RH, but not enough, and temperature increased
- Reducing setpoint helps...but too cool

Progress and Accomplishments: Heating Season

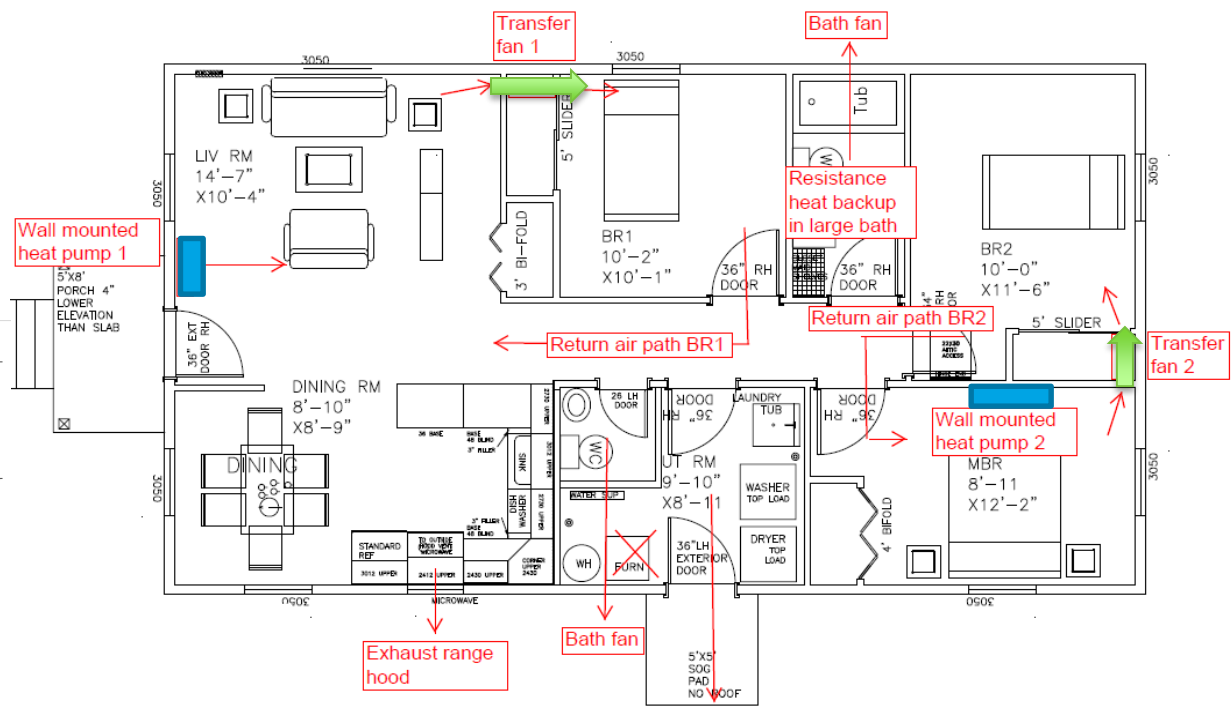
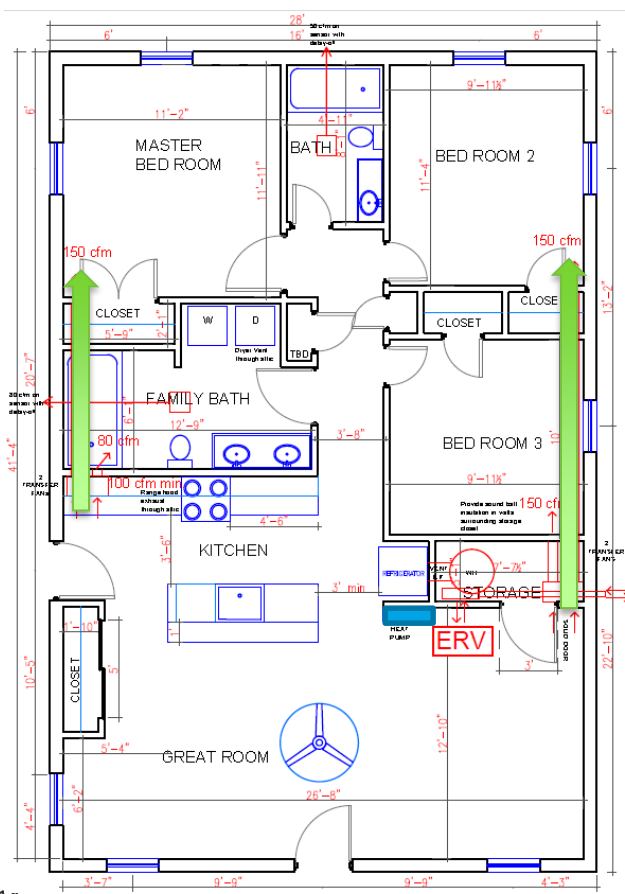


- living temp (F)
- Ambient temp (F)
- SW Bed temp (F)
- MBR temp (F)
- NW Bed temp (F)
- Total heaters (kWh)

- Energy targets met
- Temperatures mostly in compliance
- As planned, some resistance heat needed in bedrooms

Progress and Accomplishments: Habitat Projects Ongoing

- New Habitat houses designed
- Scheduled for completion spring/summer 2017
- Occupied monitoring



Progress and Accomplishments: Market Impact

- Collaborative approach with broad representative group from each respective industry steering the work
- Potential adopters involved from Day 1
- Already making an impact on other efforts, including:

Offshoot project:

Two ID home demonstrations in New York with Titan Homes
Funded by NYSERDA



Next generation of FEMA emergency housing units being developed by TLP with ID approach



Market uptake:

At least one mfg. seriously considering ID; working on one project now.

Progress and Accomplishments: Lessons Learned

Technical lessons learned include the following:

- Transfer fans can mix the temperatures well, but 100+ cfm per room is needed
- Backup heat in bedrooms: 15% site energy, approximately 6% of load
- RH, as expected is an issue for low-load homes
- VRF heat pumps may remove less moisture than non-VRF AC because they run at lower capacities and don't condense as much moisture when operating
- Solutions may include new heat pump features, more precise equipment sizing and/or supplemental dehumidification



Project Integration and Collaboration: Habitat

- Habitat Research Foundation formed 2015 with Building America expert meeting
- Representatives from affiliates throughout the Northeast and HFHI
- Habitat supplier contributors involved in test houses
- HRF Steering Committee oversees BA project and is poised to adapt and disseminate results



Project Integration and Collaboration: Factory Builders



Left to Right: Emanuel Levy, TLP; Brian Lieburn, DOW; Kevin Clayton, Clayton Homes; Bryan Mallon, DOW; Jim Morey, DOW; Sam Rashkin, DOE; David Brewer, Southern Homes at ARIES Lab House in Russellville, AL

Communications: Updates at industry meetings and conferences and publications.

Stakeholders participate and guide the work

Regular stakeholder conference calls

All major decisions owned by steering committee

Participation of many companies, not just those involved in the prototyping

More than 70% of industry

In-kind contributions

Demos/prototyping/testing at industry facilities

Project Integration and Collaboration: Partners



Next Steps and Future Plans

Understand how occupants interact with the home – 1 year monitoring at each house:

- Eatontown Manufactured Home: spring 2017 – spring 2018
- Worcester Habitat: summer 2017 – summer 2018
- Susquehanna Habitat: summer 2017 – summer 2018

Develop guidelines based on test house results and calibrated energy models:

- Manufactured housing industry
- Habitat for Humanity

Disseminate guidelines to industry via:

- MH industry meetings and publications and direct to manufacturers
- Habitat bi-annual conference, newsletters, HRF board members and HFHI Sustainable Building Specialists

REFERENCE SLIDES

Project Budget

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

Variances: None.

Cost to Date: \$625,875 of \$1,026,987 (64%) expended to date

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 2016 (past)		FY 2017 (current)		FY 2018 – June 2018 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$403,150	\$122,008	\$155,991	\$85,992	\$190,846	\$69,000

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: Moved from Feb 2017 to July 2017 due to postponement of home sale/occupancy**

