Building America - IBACOS

2014 Building Technologies Office Peer Review

IBACOS®
innovation

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

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Project Summary

Timeline:

Start date: January 2013

Planned end date: January 2015

(BA Teams operate on a CY timeline though funded with FY funding, this review includes FY13 & FY14)

Key Milestones (general BA project milestones)

1. Project Planning and Go/No-Go; previous Q3 – Q4
2. Detailed Project Test Planning & Review; Q2
3. Project Execution and Ongoing Evaluation; Q2 - Q4
4. Reporting and Communication; Q1 subsequent

Budget:

FY13 DOE $: $7,200k for all 10 BA industry partnerships (average $720k per team excluding cost share)

FY14 DOE $: $8,135k for all 10 BA industry partnerships (average $814k per team excluding cost share)

Total future DOE $: TBD (program up for re-solicitation)

Target Market/Audience:

Residential building industry stakeholders - developers, builders, trade partners, architects, whole house contractors, utilities and other program developers with focus on "above code" market actors.

Key Partners:

K Hovnanian Homes	Imagine Homes
Carrier Corp	Unico
GreenHomes America	NYSERDA
Trade Assoc'ns.	Best Practices Research Alliance
Brookfield Homes	Energy Logic; Built Green
NHQA Program	Wathen Castanos Hybrid Hones

Project Goal:

Develop and demonstrate **market-ready** building solutions that improve the energy efficiency of new and existing homes, with increasing comfort, health, safety, and durability. Conduct research with manufacturing and building partners to verify performance of new equipment/technology and aid in the advancement of newer, better, more cost-effective options. When fully deployed, proven solutions would reduce building-related energy use by **30 percent and 25 percent, respectively, in new and existing residential building stock by 2020, and 50 percent and 40 percent by 2030.**

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Purpose and Objectives – IBACOS Focus Areas

Problem Statement: Support RBI / BA problems identified and goals by developing market ready solutions in the areas of ***Simplifying Space Conditioning***, ***Proven Performance of Houses***, ***Business Success Metrics***, and a range of ***Retrofit Areas,*** spread across over **17 FY13 & 14 Projects**:

- Presentations & Publications
- **Simplified Space Conditioning: Evaluation of High Velocity Space Conditioning Systems**
- Modeled Risk Assessment of HVAC System Design Parameters in Low-Load Challenge Homes
- **Technical Justification for BA Innovation w/in Existing International Code Framework**
- **High Performance Occupied Test Houses (2@Denver, 1@San Antonio)**
- **Colorado Energy Efficient Builder Business Metrics Study**
- Attic Upgrades with Spray Foam on the Underside of the Roof Deck and Existing Attic Floor Insulation
- **Pressure Regain Supply Outlets for Retrofitted Forced Air Systems**
- Retrofit Packages for Better Buildings Challenge Partner
- Implementation of Community Scale Retrofits
- BA Team Meetings
- Performance Analysis of a Modular Small-Diameter Air Distribution System
- Large-Scale Study of House Temperatures/Operation
- **Industry Engagement for Codes and Standards Related to Ducts and Fire Separation Walls**
- **Building America Solution Center: Quality Management System**
- Stapleton Community Challenge Home Standards
- Exterior Attachment of Insulating Foam Sheathing: Stand-Off Furring
- Flex-Duct, Ductboard and Small Diameter Air Distribution Systems
- **Space Conditioning Implications of Deep Energy Retrofits**

Purpose and Objectives – BA Overall

Target Market and Audience:
At the individual project level, we focus on the innovators and early adopters that want to distinguish themselves from their competition. At the program level, our audience is all residential building industry stakeholders.

Planned Contribution to Energy Efficiency:
BA program outputs **enable** 30% near-term and 50% long-term source energy savings in new and existing homes. BA teams develop and demonstrate marketable system packages that **reliably** achieve these savings targets. Successful demonstrations are documented and disseminated via technical reports, measure guidelines, the Solution Center, trade journal articles, conference presentations, webinars, and videos.

Approach - IBACOS

Approach

1. Engage industry stakeholders to identify research areas
   - Best Practice Research Alliance (the Alliance)
   - Issued identified through IBACOS' private client network
2. Do Homework: Literature Search
3. Create Research Plan
4. Implement Research Plan activities
   a) Modeling, mockup / test, full scale house test, community
   b) Directly through project engagement (e.g. build a house)
5. Disseminate though the Alliance, reports, BA Solution Center content, etc.

Key Issues

IBACOS is focused on developing solutions in the areas of Simplifying Space Conditioning, Proven Performance of Houses, Business Success Metrics, and a range of Retrofit Areas.

Approach - Distinctive Characteristics:

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Best Practices Research Alliance®

Private innovation company, serving three areas:

1. **National production home builders**
   Support their ability to manage overall construction quality and risk.

2. **U.S. and International residential building product manufacturers**
   Innovation, applied R&D linkages to the residential construction industry, mockups / field tests, and measuring / monitoring whole house interactions and performance.

3. **The Alliance**

   – Catalyze the new construction industry in the US around higher performance housing.
   – Over 75+ builder members representing over 150,000 annual housing starts in the US.

To the extent possible, all of these activities are integrated and leveraged into the work we do with the Building America Program

Bayer MaterialScience · Carrier · DOW · Panasonic · DUPONT · JM · SIMPSON StrongTie

Brookfield Homes · Wathen Castanos · K Hovnanian Homes · ImagineHomes · U.S. DEPARTMENT OF ENERGY · Energy Efficiency & Renewable Energy

Simplifying Space Conditioning - Purpose and Objectives

Problem Statement :

- Loads and airflows are significantly reduced in low load houses.
- Space conditioning systems in low load houses must maintain comfort and IAQ for the occupant, old “rules of thumb” are not optimal
- Builders would like to see reduced cost, better product options, simplified system design and zero defect installation
- To meet DOE goals must also be energy efficient.
- Manufacturers need volume to produce new equipment competitively

Target Market and Audience

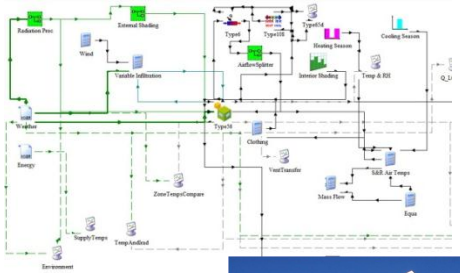
Residential new & retrofit, SF and multifamily (~113M). Builders, arch / engineers, retrofit contractors, HVAC product manufacturers, Program design / admin

Planned Contribution to Energy Efficiency:

- Prove alternate systems can meet occupant comfort; otherwise risk is too high for builders and retrofit contractors to adopt at scale in 50% savings houses
- Clear guidance on terminal conditions (in room) is needed
  - For house and system designers and installers
  - For manufacturers to create appropriate HVAC product solutions

Approach

- Engage with multiple stakeholders (builder, designer, trades, code officials)
- Modeling
  - –TRNSYS modeling of instrumented unoccupied test houses, limited CFD modeling
- Unoccupied Test houses
  - –Low load house in Pittsburgh PA, Low Load retrofit house in Fresno CA
- Occupied Test houses
  - –Roseville CA, San Antonio TX, West Tisbury, MA, Urbana IL, Denver CO



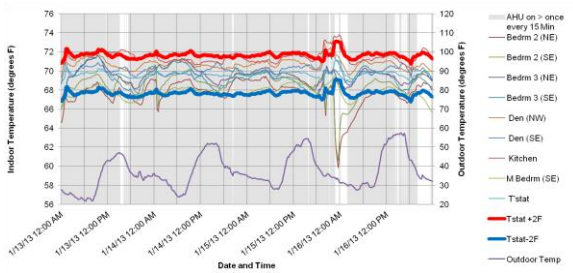
Approach

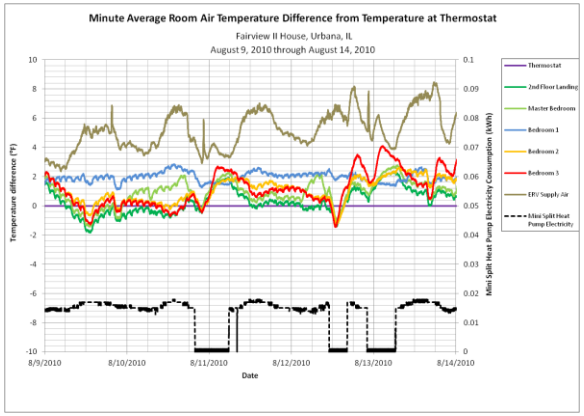
Key Issues:

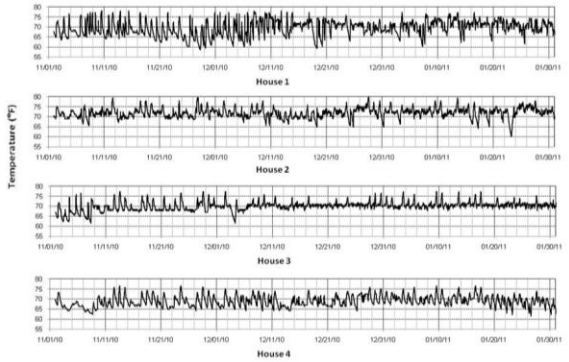
- How much air distribution is needed in low load houses?
- What temperature differences are experienced?
- How do these compare to “right sized” systems?
- How does door operation and thermostat locations / setback influence temperature differences?
- Occupants must not perceive their EE house to be uncomfortable

Distinctive Characteristics:

Iterative feedback and application between simulation modeling and test houses. Collaborations with “bleeding edge” and mainstream builders







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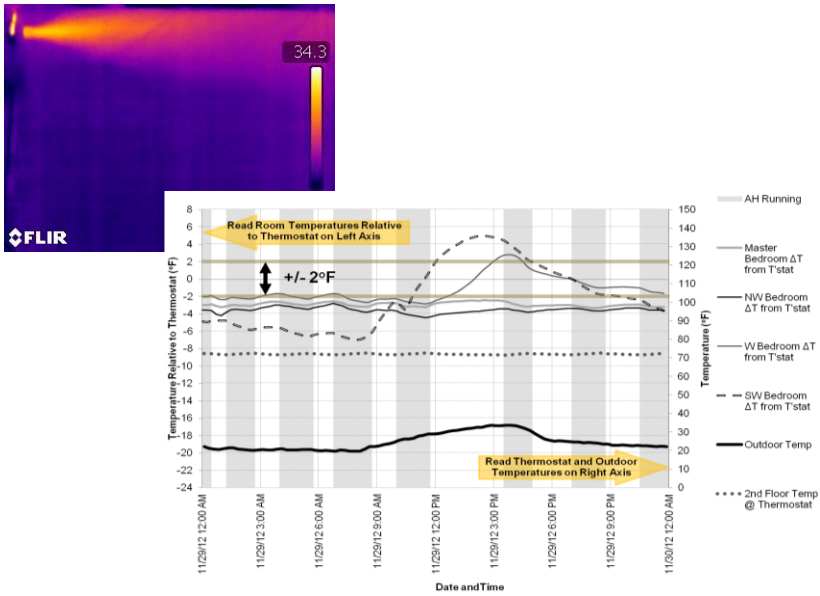
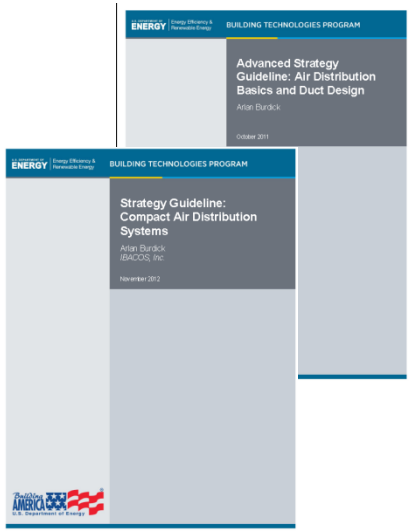
Progress and Accomplishments - SSC

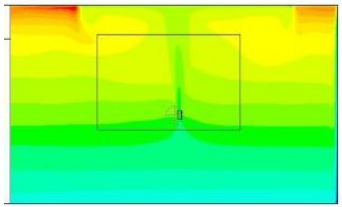
Discoveries: Solar gains can have a large impact on room-to-room temperature differences in low load homes, regardless of HVAC system strategy. Door operation (always closed) can drive significant temperature differences, regardless of HVAC operational mode.

Accomplishments: Lower delivery air temperature and longer run times contribute to better temperature uniformity. Occupants are problematic. New control strategies and sensor deployment may be needed in low load homes to optimize comfort.

Project Contribution to Energy Efficiency: 13 reports / measure guidelines / strategy guidelines published







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Proven Performance of Houses - Purpose and Objectives

Problem Statement :

- Builders are risk adverse – they follow. It's risky to lead
- Code barriers exist that make higher levels (or even code levels) of efficiency difficult

Target Market and Audience

Residential new construction. Production builders, arch / engineers, trade partners, manufacturers, Program design / admin, code bodies & assoc stakeholders

Planned Contribution to Energy Efficiency:

- Documentation of lessons learned and 50% savings solutions that can be cost effectively adopted at scale for new construction builders
- Support BT Net Zero Ready Home program goals of 5% market share by 2020
- Enable higher efficiency HVAC systems and air tight fire separation assemblies

Approach

Identify leading builders, establish trusted relationship, build prototype house and monitor performance, document successes and failures.

Develop long term builder relationships that can have higher impact regionally or nationally

Identify code barriers where there is no one vested interest who will champion change and facilitate stakeholder engagement process to develop progress towards goals or indentify insurmountable barriers

Approach

Key Issues:

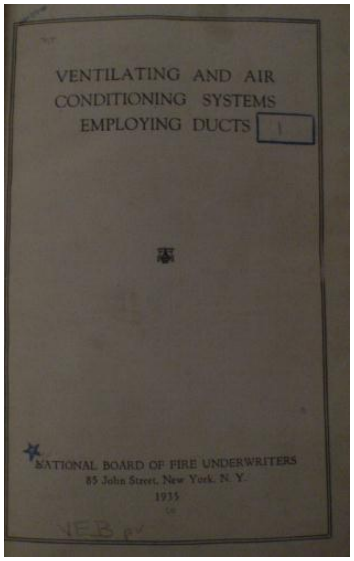
- Systems tradeoffs for optimal efficiency at lowest first cost
  - –Evaluate new technologies / strategies for simplifying space conditioning with advanced enclosure
- Flammability of materials in HVAC systems limit use of materials that could improve efficiency, reduce cost (e.g. plastic fan blower, plastic ducts)
- Fire Separation assemblies are not airtight as currently tested (ASTM E119)

Distinctive Characteristics:

- Leveraging relationships at individual builder level into national spotlight
- Stakeholder engagement to facilitate mutually acceptable (not consensus) way to proceed (code change, new test, etc.)

Progress and Accomplishments

Discoveries:
Geometry matters at higher energy savings levels. Duct/ plastics flammability issues in building codes since early 1900s; conceptual discontinuities in fire safety in current codes (flame spread and smoke developed).



Accomplishments:

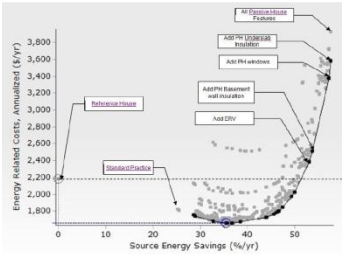
Imagine Homes – ~37% savings vs. 50% DOE savings goal. IBACOS / BA Relationship started w/management team in 90's; Imagine is in a partnership with Beazer Homes (~4,500 homes per year)

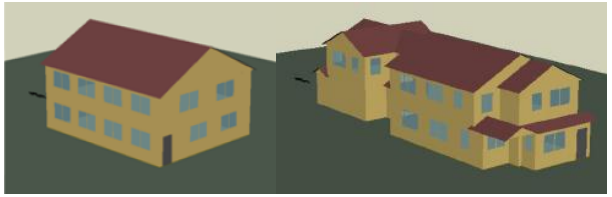
- Beazer 2014 EPA ENERGY STAR Builder of the year.
  - "The [building] criteria were developed by Beazer, in conjunction with their partner Imagine Homes, an award winning Green builder, as a system of features to optimize energy efficiency, reduce water consumption and improve indoor air quality."

Progress and Accomplishments

Brookfield Homes – 2012 Startup. Mgmt team worked previously with IBACOS & BA . Standard Production House ~25% savings vs. 50% DOE savings goal

- Undertook Passive House as next gen exploration
- Met stringent criteria but not cost effective
- Geometry matters (shell to volume ratio)





New Town Builders – IBACOS / BA Relationship started in early 2000's, resumed 2013

- 2013 introduced ZENhome (Zero Energy Now) at Stapleton community in Denver, sold out
- ~50% savings vs. 50% DOE savings goal
- Working together on ZENhome townhouse
- Master Developer now moving to NZER home as minimum in Stapleton
- 2013 Challenge Home Grand Winner Production

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Progress and Accomplishments

Project Contribution: Work with innovator helped prove whole house solutions to early and lead adopters (e.g. Imagine Homes → Beazer ES 2014 POY). 6 reports published / planned

IBACOS is working (*non DOE funded*) with:

- Manufacturer who is developing high efficiency equipment for low load houses (anticipated sales at 30 – 40K units per year)
- One national homebuilder (>5K units per year) implementing integrated design and compact HVAC designs in all product
- Assisting two national builders (> 20K units / years) for quality & performance across all divisions

Awards/Recognition:

- San Antonio Test house received 2014 NAHBGreen Award Winners "Project of the Year: Single-family – Production"
- Denver CO test house featured in Builderonline.com article "Passive Expressive" (~52% savings vs. 50% DOE Savings goal)
- Blog Posts by third parties (e.g. Greenbuilder.com, Energy Vanguard)

Business Success Metrics - Purpose and Objectives

Problem Statement: Alternate business processes can integrate high performance at lower cost; proof is needed that these processes will not adversely impact the bottom line.

Target Market and Audience:
Residential new construction, whole house retrofit, Single or multi divisional production homebuilder, Small volume builder, HVAC businesses. “C “and “VP” level, Architecture, Sr. Design / Engineering / Field Staff

Planned Contribution to Energy Efficiency:

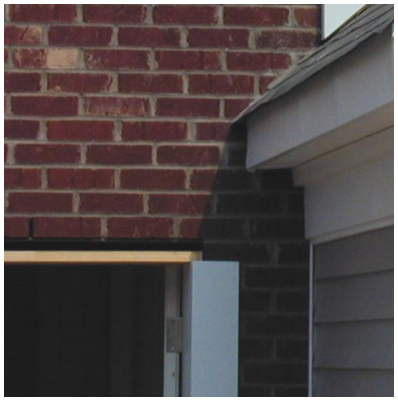
- Profitability of business using EE processes *MUST* ≥ Profitability of status quo
- What are the best practices and metrics associated with a production builders’ business operation that are demonstrated to result in lowest first cost implementation of BA energy efficiency strategies and proven innovations that are applicable across all aspects of the “brave new world” (post crash, post 2012 energy codes)of homebuilding?

Approach

- Document QM best practices (e.g. NHQA, Baldrige Award, etc.); map differences in business operations (code vs. EE)and develop strategies to implement (done 2010)
- ID and document key performance indicators against which companies can measure their progress / success
- Identify “bell cows” and document their transition and success strategies
- Test strategies with industry partners (e.g. builder, HVAC contractors, retrofit contractors)

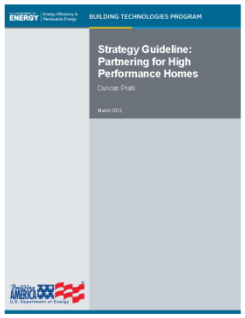
Key Issues: Low barriers to entry may translate to relatively low level of business sophistication in smaller businesses. Little cross functional realization of costs at larger builders (e.g. failure cost vs. design decisions)

Distinctive Characteristics: Use existing programs / recognition programs to emphasize successes, create public benchmarks.

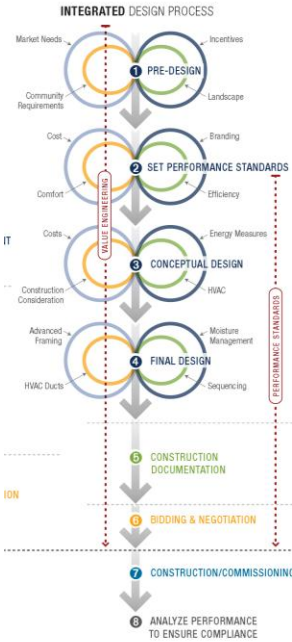


Progress and Accomplishments – OS

Discoveries: Process change very difficult in builders (typically stovepipe) organization. HVAC contractors not very receptive to branching out to whole house contracting. Small retrofit companies not necessarily adept at running a zero defect small business (e.g. what is ISO 9001?) Risk, Risk, Risk.



Accomplishments: Expert meetings & reports (2010 & 11) 50+ attendees, Disaggregating results for BASC. Incorporated key health / safety / durability / efficiency criteria in NHQA Judging Criteria. Non DOE contract to support integrated design / comp[act ducts in national builder (>4,500 starts / yr).



Project Contribution to Energy Efficiency: 4 NREL published reports for Builders and HVAC contractors to transition to whole house retrofit.

Awards/Recognition: DOE Top Innovation Award for Quality Management (2013). Alliance Builder Partners include 5 ENERGY STAR Partners of the Year and 12 Leadership in Housing awards ; 7 “Builders of the Year”; 11 “America’s Best Builders”; and 30 National Housing Quality awards

Retrofit Areas - Purpose and Objectives

Problem Statement: In retrofit houses with new HVAC, balance of system (especially old gravity systems) may be grossly oversized, causing poor air mixing / delivery imbalances in rooms, resulting in discomfort for occupants.

Target Market and Audience: Entire Pre 1990's housing stock (~90M) houses. Whole House retrofit contractors and HVAC retrofit contractors, Programs

Planned Contribution to Energy Efficiency: Communicate potential comfort and duct leakages implications of simply replacing the air handler in retrofitted homes

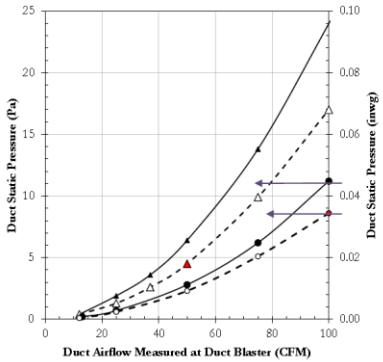
1. Near term – field testing in occupied homes (underway)
2. Mid term – Integrate into HVAC system "package retrofit"
3. Duct sealing and registers addressed as part of HVAC retrofits in HPwES and similar programs

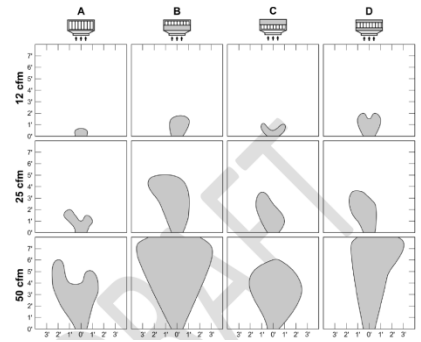
Progress and Accomplishments

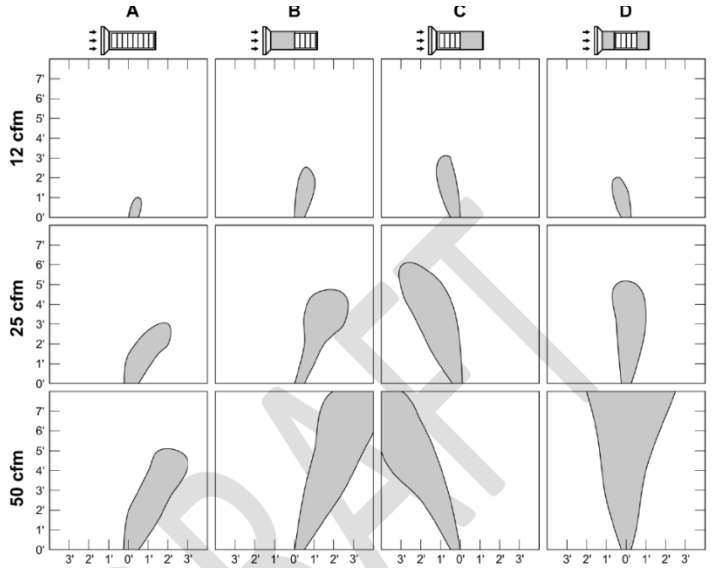
Discoveries: Houses may be so bad pre-retrofit, anything is a comfort improvement for occupants. Interactive effect of duct leakage and register performance may mean duct sealing for comfort, not energy. 50% peak load reduction easily achievable

Accomplishments: Measuring space temperatures in deep retrofit houses in Syracuse NY; Lab testing complete on various register / boot configurations and duct leakage

Project Contribution to Energy Efficiency: 1 tech report & 1 case study in peer review process







Project Integration and Collaboration- All Projects

Project Integration: All projects are collaborative by nature of BA program and stakeholders engaged throughout to inform research. Results fed forward to stakeholders through NREL, Best Practices Research Alliance.

Partners, Subcontractors, and Collaborators: K. Hovnanian, Imagine Homes, S&A Homes, Brookfield Homes, South Mountain Company, eco-lab, Wathen Castanos Hybrid Homes, Insight Homes, Brookfield Homes, Carrier Corporation, Bayer MaterialScience, Dow, DuPont, JM, Simpson Strong Tie, Unico, Best Practices Research Alliance, GreenEarth Equities, NREL. Code committees, ASTM members, product manufacturers, NFPA, raw material suppliers, trade associations, National Housing Quality Awards program and judges, Denis Leonard, Built Green, Energy Logic, Metro Study, Woodland O'Brien & Scott, Avid Ratings, GreenHomes America, NYSERDA, CLEAResults.

Communications: 12+ conference presentations: NESEA Building Energy, EEBA, Greenprints, RESNET, ACI, Data not Dogma, Best Practices Research Alliance meetings. Magazine / Web: Builderonline.com, Greenbuilder.com, energyvanguard.com, avid.com. BA Publications and BASC

Next Steps and Future Plans – All Projects

Next Steps and Future Plans:

- Wrap up projects associated with 2010 – 2015 contract
- Finish deliverables
- Prepare for recompete with anticipated modified direction of BA program

Risks

- Industry groups resistant to change
  - Understand objections and redirect research to demonstrate proven solutions, and that implementing solutions can be done profitably

BTO Support

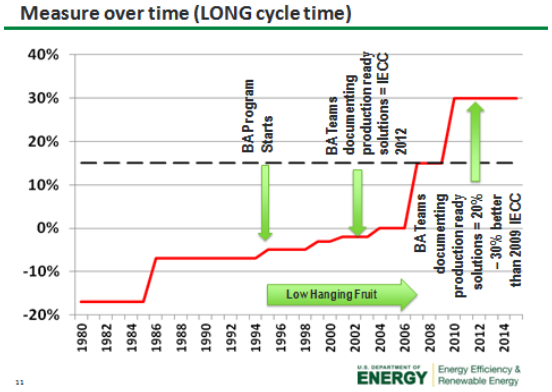
- As the BA teams are engaged with a large cross section of residential stakeholders, better BTO coordination and planning with all BA Teams across all residentially focused BTO activities would be useful, e.g.
  - Clear material → product → system → whole house requirements in ET program
  - BA team involvement in field tests under ET program funding
  - DOE & EPA rationally and collaboratively integrate BA results into MT programs (above code and code change)

Relevance to BTO needs and objectives

RB Goal:
"…reduce building-related energy use by 30 percent and 25 percent, respectively, in new and existing residential building stock by 2020, and 50 percent and 40 percent by 2030."

IBACOS' BA Research:
Technical and market barriers exist that increase the risk and cost of adopting higher levels of efficiency. Residential new construction industry is large and fragmented. Increase in efficiency is long term and comes from larger market engagement than IBACOS (or BA) can directly track.

Leading indicators include HERS Index prevalence, advance of energy codes, non energy measures to reduce risk included in code and above code programs



Approach/Project Management

- IBACOS develops and fosters industry networks and engages market leaders to share in the collaborative effort of identifying barriers and developing market ready solutions.
- Internally, IBACOS uses PMI Practices for project management of projects. Given the nature of the industry partnerships, actual scheduling has to remain somewhat fluid based on the market realities of our partners
- Key issues IBACOS is currently addressing include Simplifying Space Conditioning, Proven Performance of Houses, Business Success Metrics, and a range of Retrofit Areas.
- Private sector work with production homebuilders, manufacturers, and The Best Practice Research Alliance gives IBACOS a deep reach with key decision makers into at over 75 homebuilders, representing over 150,000 housing starts per year, which translates to engagement opportunities and market insight . All these companies recognize the need and importance of higher performance in their houses. IBACOS seeks out market leaders ("bell cows") to demonstrate success

Progress, Accomplishments, and Impact

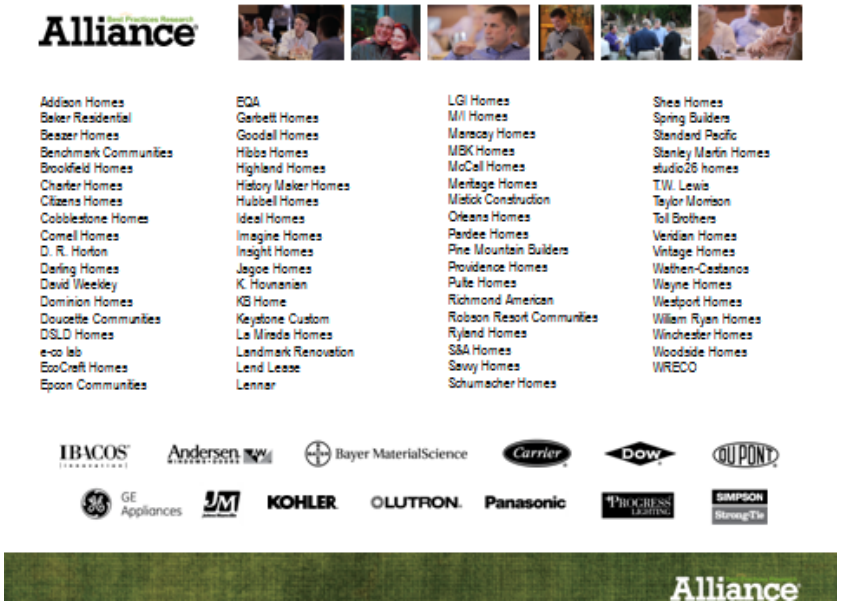
- Demonstrated cost effective achievable 20% - 30% whole house savings with cold and hot-humid climate production builders (Brookfield, and Imagine Homes)
- Alliance engagement – grown from 30 to over 75 builders, 8 to 12 paying sponsors.
- Nationally (not just IBACOS, but as a program…)
  - >**200,000** houses got HERS index in 2013 **(~ 45%** of new construction market)
  - Average 2013 HERS Index is **64 (~20%** better than 2009 IECC)
  - The BASC had over **161,000 page views** (more than **53,000 unique visitors**) with consistent monthly averages, more than **11,500 document downloads** and more than 500 new registered users.
  - Building America publications were downloaded by more than **45,000 users in 2013**.

Progress, Accomplishments, and Impact

- One top 10 builder (>4,500 starts) has HVAC Design Standards, including integrated design process and all ducts in conditioned space
  - Their Mid-Atlantic HVAC trade partner saw a 50% reduction in service calls after implementing the builder's HVAC standards across their customer base, which was facilitated by IBACOS and BA
- Two top 10 builders pay IBACOS for annual all divisions quality checkups to help identify and limit their risk, including many BA related issues (e.g. health, safety, durability, efficiency)

Project Integration and Collaborations

- **Project Integration**: All projects are collaborative by nature of BA program and stakeholders engaged throughout to inform research. Results fed forward to stakeholders through NREL, Best Practices Research Alliance.
- **Partners, Subcontractors, and Collaborators**: wide range of partners, new construction, retrofit, manufactures, state funded research
- **Communications**: Conferences include: NESEA Building Energy, EEBA, Greenprints, RESNET, ACI, Data not Dogma, Best Practices Research Alliance meetings. Magazine / Web: Builderonline.com, Greenbuilder.com, energyvanguard.com, avid.com. BA Publications and BASC



Next Steps and Future Plans

- 2014
  - Work with partners to wrap up existing projects
  - Position partners for recompete, to align with DOE / BTO / RBI mission and goals
  - Develop proposal for 2015 – 2020 activities
  - Risk Mitigation – IBACOS not successful in recompete, aligning partners to “pull plug” in early 2015 on projects.
- BTO Support
  - As the BA teams are engaged with a large cross section of residential stakeholders, better BTO coordination and planning with all BA Teams across all residentially focused BTO activities would be useful, e.g.
    - Clear material → product → system → whole house requirements in ET program
    - BA team involvement in field tests under ET program funding
    - DOE & EPA rationally and collaboratively integrate BA results into MT programs (above code and code change)

REFERENCE SLIDES

Project Budget

Project Budget: Building America is a multi-year research program. FY13 and FY14 face-value contract amounts have been summarized here (excluding overhead burden and management).
Variances: Budgets are executed as planned.
Cost to Date: Projects are accrued linearly and managed on a calendar year cycle. For FY14, approximately 30% of project cost has been accrued.
Additional Funding: All BA team contracts have at least 20% cost-share from industry partners.

Budget History					
January 2013 – FY2013 (past)		FY2014 (current)		FY2015 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$7,200k	>20%	$8,135k	>20%	TBD	TBD

Project Plan and Schedule

Building America Team Project Planning and Execution:

- BA teams are funded under a multi-year Task Ordering Agreement managed by NREL. Project portfolios are selected on an annual basis. 2014 is the final year of this agreement.
- All BA Teams go through rigorous annual project proposal and review process, including review and coordination by NREL technical and DOE program management.
- Each project has the following deliverables: detailed test plan, report, case study and BA Solution Center content. Test plans are reviewed by technical program managers and all other publications undergo a peer review process before being communicated to the broader residential industry.