Challenges and Opportunities of Energy Star in Modular Home Construction: Lessons from the Field

Factory Built Housing Center
Pennsylvania College of Technology

RESNET Conference

February 18, 2009

Larry Armanda & Rick Terry

Today's Presentation…

- Who are we?
- FBHC Projects and Energy Star Program
- What is a modular?
- Modular vs. Manufactured
- Modular vs. Site Built
- The Modular Process
- Challenges to Energy Star with Modulars
- What we found and what is happening now
- Examples from the Plants
- A Case Study from the Site
- Challenges carry over to Green
- Conclusion and Questions

Factory Built Housing Center

- Established in 2003
- Part of Pennsylvania College of Technology's PHRC
- Grew out of the success of the Modular Housing Training Institute (MHTI) at the College
- Featured a 2 Day Course developed with industry and PA DCED to address industry recommended practices regarding site management of modular projects

MHTI
MODULAR HOUSING TRAINING INSTITUTE

FB HC
FACTORY BUILT HOUSING CENTER

FBHC Begins to Focus on Green & Energy Star

- Consult with plants to implement EPA process
- Bring in HERS rater to assess and certify some units as FBHC projects
- Become Energy Star Partner in 2008
- Sign letter of agreement with RESNET to train modular manufacturer QA/QC personnel as Field Inspector Raters and seek national certification
- Conduct Green Advantage Training for modular industry as part of Commonwealth of PA initiative (2 sessions)
- Hold NAHB Green Professional certification courses for modular industry; also PA initiative

What is a Modular?

- Built to same IRC codes as traditional site construction
- Some States my have some specific code exceptions for modulars; i.e. stair geometry, third party inspections and approvals, liability of on site code officials
- Challenges on site include proper building science applications, subcontractors and knowledgeable builders
- Set crew, builder, & subcontractor disturbance of the thermal envelope and work completed in plant
- Dealing with Cape Cod and 2 Story designs (i.e. separate ceiling and floor systems)

Modular is NOT Manufactured!

- Manufactured or HUD code homes are built to a different federal code
- Structures include integrated metal frames with, hitches, wheels and axles (Often removed on site)
- Have separate programs and options for Energy Star Certified Homes
- May be placed on permanent foundation or moved from site to site
- Much confusion in public eye and even within stakeholders of industry
- Some traditionally manufactured housing plants now building some modular “qualified” products based on their HUD products adding additional confusion

Manufactured vs. Modular

Manufactured (HUD)

Modular (IRC)

Manufactured vs. Modular

Manufactured (HUD)

Modular (IRC)

Modular vs. Site Built

Modular Production

Traditional Site Built

Modular vs. Site Built

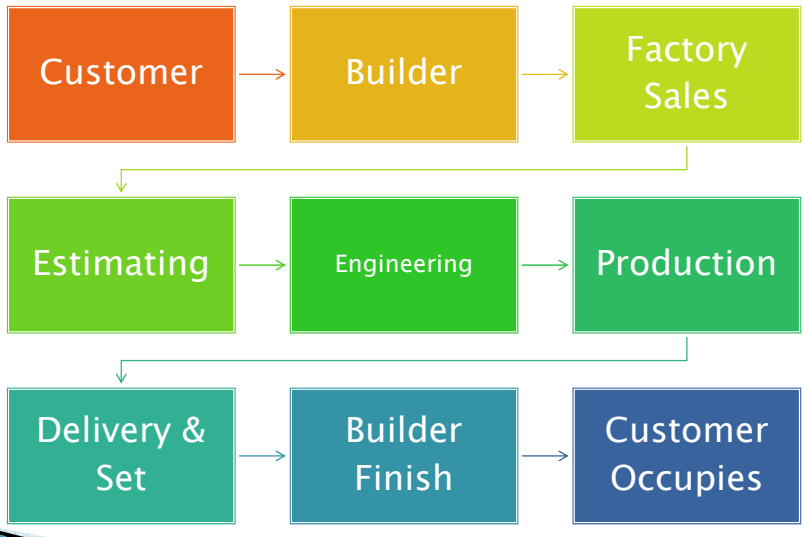
Modular Production

Traditional Site Built

Modular Housing Represents Nearly 22% of All Housing Starts in the Northeast!

PA has the most modular manufacturers in the country with 39 plants!

The Modular Building Process



Customer

- Customer decides to build a new home and starts process with builder
- Customer looks at building a certified Energy Star home because they saw a program about it on "DIY Network"

Builder

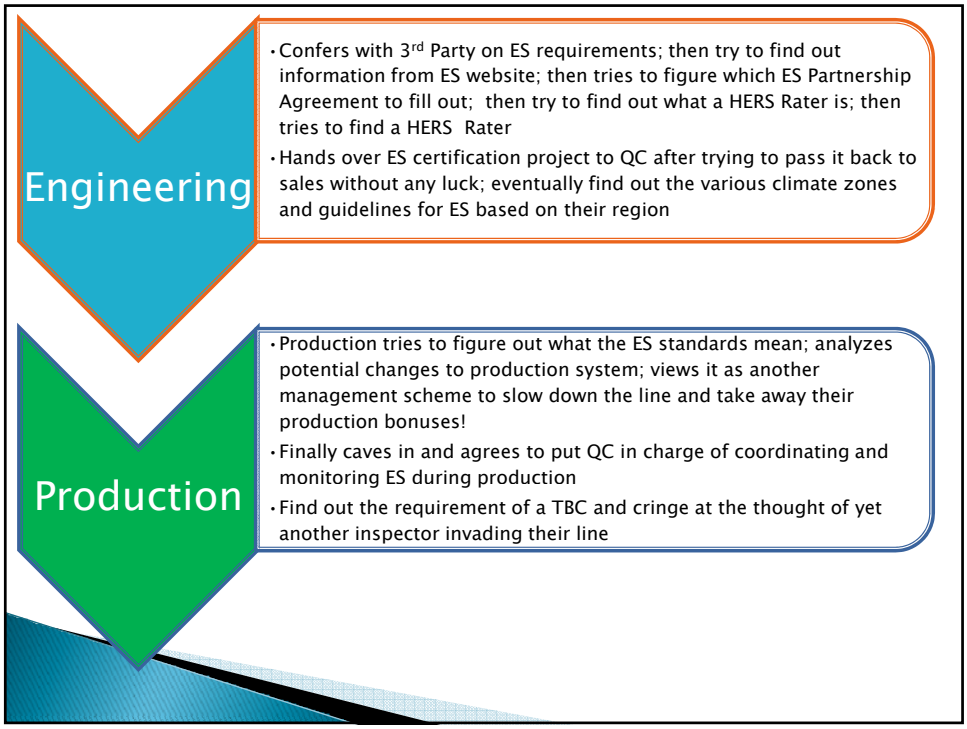
- Customer comes to builder and decides to move forward with design and estimate; asks builder about Energy Star and receives a blank stare; builder tells customer he'll have to get back to him on that
- Builder contacts plant and starts process for plans and estimate; forgets about Energy Star and/or thinks it already is Energy Star because everything has ES Label on it
- Finally mentions to the modular sales person that the customer is interested in Energy Star; sales person gives blank stare and tells builder that he'd have to get back to him

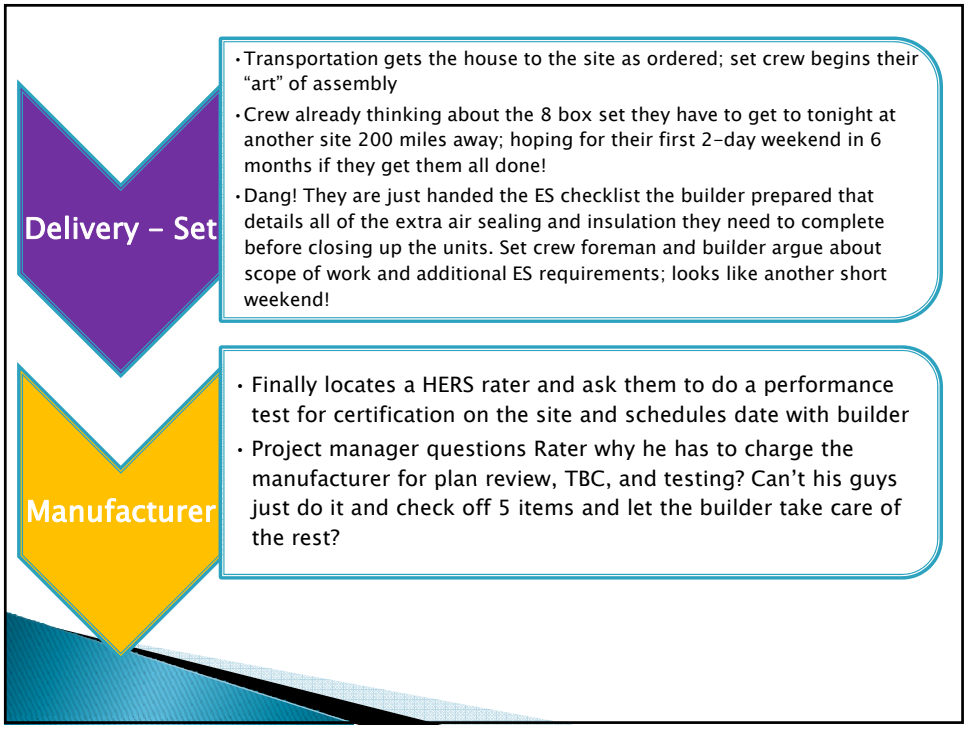
Factory Sales

- Factory sales person knows a little about Energy Star, but hasn't gone beyond knowledge of building products labeled Energy Star; figures that he'll take care of it once goes to production
- Asks estimating and engineering what Energy Star certification means; receives blank stare

Estimating

- Confers with engineering on Energy Star requirements; figures in added material costs for Energy Star labeled bath vent, windows and doors; appliances and HVAC "by Others"
- Work with purchasing to gather material costs and estimates project with ES labeled materials


Engineering
• Confers with 3rd Party on ES requirements; then try to find out information from ES website; then tries to figure which ES Partnership Agreement to fill out; then try to find out what a HERS Rater is; then tries to find a HERS Rater
• Hands over ES certification project to QC after trying to pass it back to sales without any luck; eventually find out the various climate zones and guidelines for ES based on their region
Production
• Production tries to figure out what the ES standards mean; analyzes potential changes to production system; views it as another management scheme to slow down the line and take away their production bonuses!
• Finally caves in and agrees to put QC in charge of coordinating and monitoring ES during production
• Find out the requirement of a TBC and cringe at the thought of yet another inspector invading their line


Delivery – Set
• Transportation gets the house to the site as ordered; set crew begins their "art" of assembly
• Crew already thinking about the 8 box set they have to get to tonight at another site 200 miles away; hoping for their first 2-day weekend in 6 months if they get them all done!
• Dang! They are just handed the ES checklist the builder prepared that details all of the extra air sealing and insulation they need to complete before closing up the units. Set crew foreman and builder argue about scope of work and additional ES requirements; looks like another short weekend!
Manufacturer
• Finally locates a HERS rater and ask them to do a performance test for certification on the site and schedules date with builder
• Project manager questions Rater why he has to charge the manufacturer for plan review, TBC, and testing? Can't his guys just do it and check off 5 items and let the builder take care of the rest?

HERS Rater

- HERS Rater is contacted by the manufacturer the week the house is going online to certify the project as meeting Energy Star standards
- Rater conscientiously explains the 3 Step Process of certification and asks for the plans to do a plan review to make sure the house meets standards ***before*** production
- Schedules date to complete the Thermal Bypass Checklist when the house is on the line; gets an email the day before TBC inspection that the unit will not be ready – postpone 1 day; receive email next day – not ready – postpone another day; no emails the next day so Rater travels 100 miles to plant to find only one unit out of four in position to be inspected; wait for rest of the day as 2 more units move down line; 9 hour TBC and still not done!
- Asks for appointment for next day to finish TBC at plant, but plant shuts down for hunting season and Thanksgiving break for a week so reschedule for re-visit in 10 days when production resumes.
- Rater returns for final TBC inspection 10 days later only to pass units pulling out of facility on their way to jobsite; plant forgot to tell Rater that a crew came in to finish the home during the break so it could be delivered before Christmas!
- Rater, discouraged and frustrated, travels 100 miles back home; swings by mail box to get mail before going into the driveway and pulls the full set of plans out from the manufacturer that Rater had requested to do the plan review several weeks ago!

Builder

- Builder receives the home from manufacturer; has it set on the foundation and begins the finish process
- Forgot to tell the manufacturer that the customer changed the HVAC units to the non-Energy Star spec'd units to save money so they could buy new furniture and a hot tub instead; house no longer qualifies for Energy Star, but didn't tell customer who still thinks they have an Energy Star home
- As builder finishes the final walk-through with customer, the HERS Rater pulls into the site after a 150 mile trip to complete the performance testing and certification; Rater speaks to builder, learns about changes, and heads home without testing

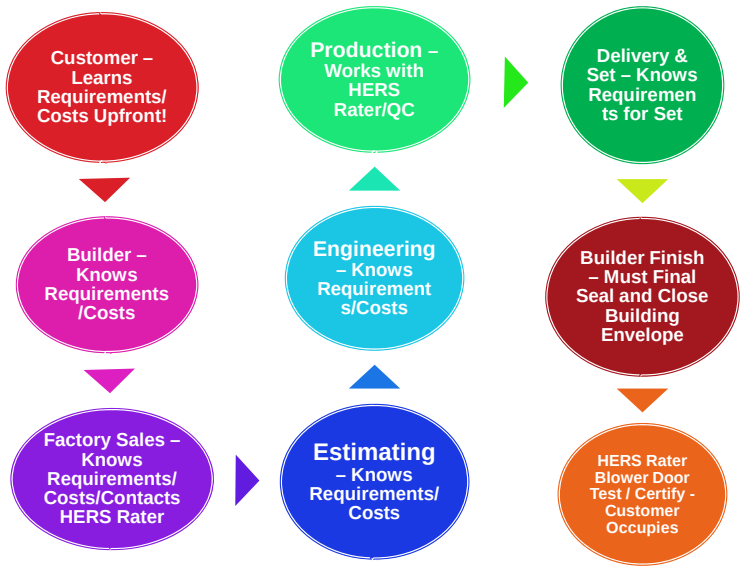
Customer

- Moves into home in April; has no complaints
- Gets first electric and gas bills for December and can't understand why it is double what was estimated by the utility company for an Energy Star home
- Begins to notice that the house is cold and drafty during the winter months and bills continue to climb
- Utility company arranges energy audit including infrared scan to determine possible issues

ES Challenges with Industry

- Lack of coordination between Builders and Manufacturers
- Connection of HERS raters near final project sites to manufacturers and builders
- Lack of education and training of builders, set crews, subs and manufacturers
- Energy Star process not a priority in the modular production process
- Lack of accuracy in predicting when units will be ready for TBC inspection by rater in plant and site testing

What Needs to Happen…



A Transition is Occurring…

- Earlier contact between rater and builder is starting to occur (but slowly)
- Vigilance on the QC/QA Front to insure that the standards are being met (improving but not fully implemented)
- Recent government actions at State and Federal levels are redirecting financial incentives to residential, commercial and industrial projects – existing and new construction

What are we seeing in plants…

Initially…

- No consistent contact person in plant
- ES process initiated with Rater after house on line
- Grade III or failing fiberglass insulation work
- Personnel changes after training in proper techniques
- Lack of air sealing strategies in place or sufficiently completed

Today…

- Plants starting to designate ES/Green specialist
- Starting to get activity in sales phase or early production phase
- Insulation work seeing great improvements; majority are Grade II/III
- More air sealing strategies recognized and implemented
- Still room for improvement!

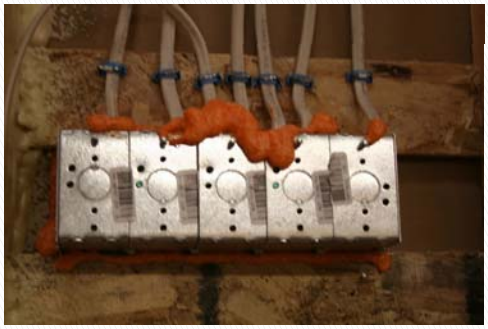
TBC In-Plant Inspections

Past

Present

Sidewalls – Exterior

In Plant Transition…



This…

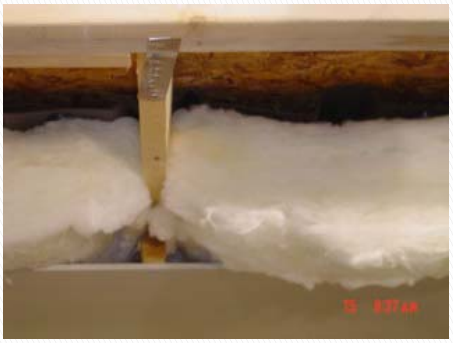
To this…

TBC Inspections…

Recessed Lighting…

Always a challenge…

TBC Inspections…



Insulation Installation…

Always a challenge…

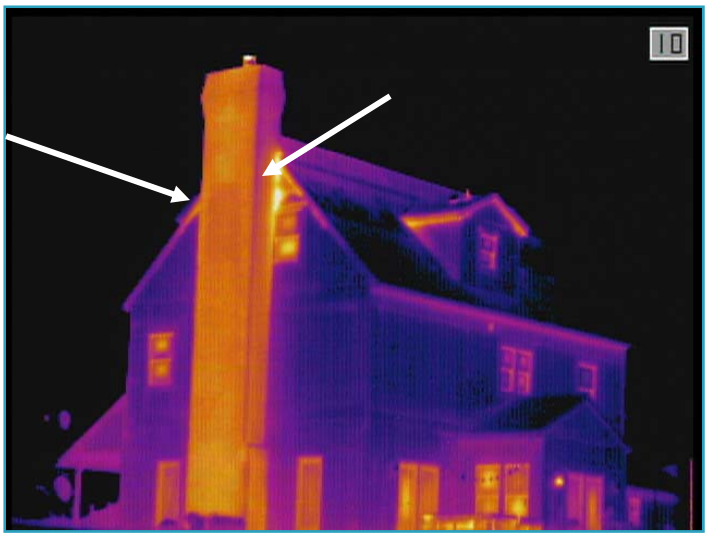
TBC Inspections…

Scan showing the results of that improper install…

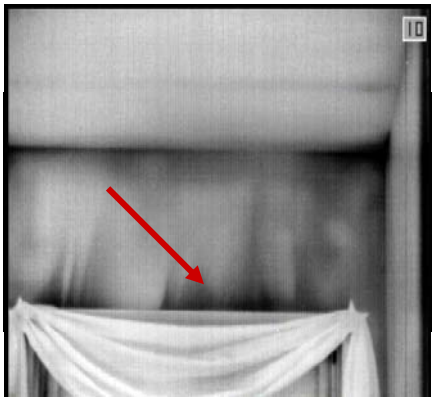
Large built in chaseways to accommodate mechanical systems

Contractor should air seal these chase ways in the attic as well as in the basement

Built in Chase Ways



Blower Door Tests: Pre-Energy Star Projects

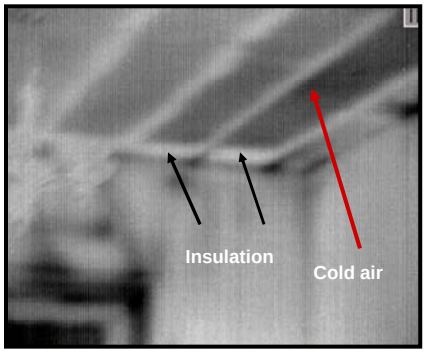


Air infiltration at drywall & window molding

Insulation Around Perimeter Band Joist

Common industry practice to put 3' – 4' of batt insulation from perimeter towards center of unit

Air Movement Between Floors

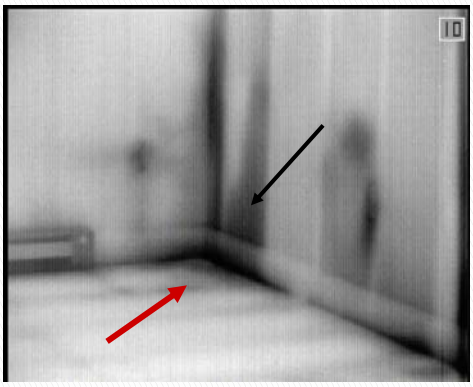


Insulation was installed on the exterior band joist across the ceiling three feet. This did not stop or reduce the amount of air flow across the ceiling to the marriage wall.

Compressed Insulation

Similar to site construction…Insulation installation is one of the least popular tasks often left to the newest hire or least skilled labor.

Garage Below Second Floor Bonus Room



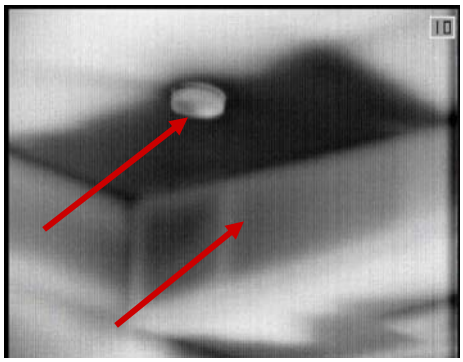
Air flow at base plate of wall and through fiberglass wall insulation

Wiring chase ways should be sealed.

Compressed insulation

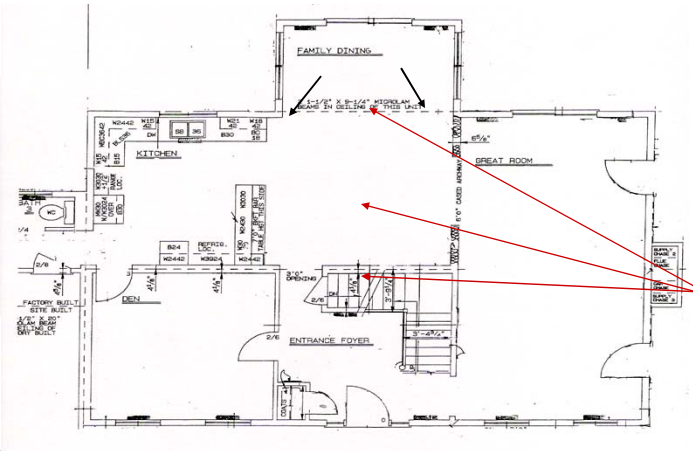
Electrical panel located on exterior wall. Allows air movement and moisture movement as well as limits the amount of insulation in the wall cavity.

Insulation Voids



Poorly fitting fiberglass batt insulation; subcontractor re-work breaches thermal envelope.

Bump Out Locations of Air Infiltration



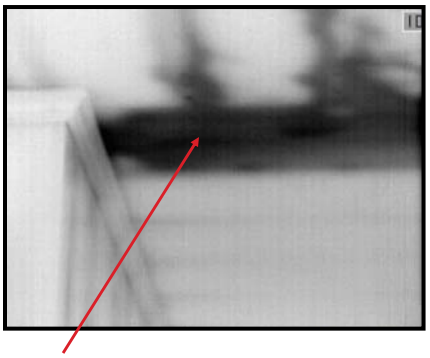
(Bump out Photo)

Cold air moving to center marriage wall from between mod 1 & 2

Multi-unit Connections

Bump out section where multiple modules connect. Cold air at center support beam.

Bump Outs / Additions



This dark area is where the modular first floor bump out was attached to the first floor rear section. Air is infiltrating at the connection of these two boxes which indicates a lack of proper sealing between units. (L)

Air Leakage Potential

•Fiberglass insulation is not enough to properly seal

•Air seal the perimeter between floors before siding is installed.

•Seal all gaps on the marriage wall at archways and door openings before installing trim.

Site Case Study – Energy Star Home Certification

- Communications established between HERS rater and Manufacturer
- Manufacturer hands off project coordination for final testing to Rater and Builder
- HERS Rater sets up date for field testing; explains to builder how it will be done and required conditions
- Builder calls 1 week before testing and moves scheduled performance testing out an additional 3 weeks
- HERS Rater arrives on site on new date, but house not ready for testing and Rater finds deficiencies in site work that will challenge the ability to pass ES testing

House Ready for Verification Test?

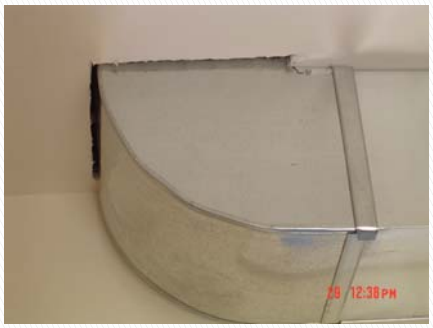
Arrive at jobsite…notice apartment unit in basement…NOT ON PLANS!

Subcontractors through-out the home…

Unfinished Fireplace

HVAC Applications – IAQ Isues

Connection between basement, apartment, bonus room, and attic…



Unsealed duct chase into living space from garage…

HVAC Relative to Thermal Envelope

Air handler located in unconditioned attic…disconnected ductwork

At Least the Ductwork is Inside the Roof Cavity !

Energy Star in Modular

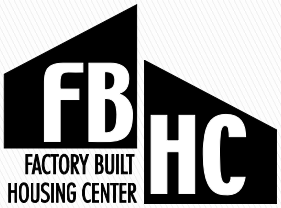
- Standard EPA New Home Protocol
  - Plan Review/Consultation
  - Thermal Bypass Checklist (In-plant Inspection)
  - Final Performance Testing
    - Blower Door
    - Ductblaster
- MHRA Protocol
  - Plant Certification
  - 3rd Party QA of In-house QC
  - Energy Star Ready
  - On Site Sampling Protocol for Builders; 1 in 7 per HERS Rater Acceptance

Challenges to Green with Modulars

- Lack of contact between customer/builder and manufacturer at beginning of sales process
- Manufacturers not involved in site aspect of planning and design
- Lack of education/training with all stakeholders
- Lack of enthusiasm with sales staffs and builders; results in a lack of confidence to sell Green and Energy Star programs
- Fear of additional costs by consumers, builders, manufacturers

Overview Summary

- Continue to educate and train industry staff and builders
- Breakdown certification process and develop training that integrates into existing process
- Utilize grants and incentives to entice entry into **Green** market and philosophy
- Constantly reinforce benefits and true cost "savings" by going **Green** (with emphasis on Energy and Quality)
- Establish Partnerships to spread message and opportunities with like minded organizations!



Factory Built Housing Center
Pennsylvania College of Technology
DIF#153, 1 College Ave.
Williamsport, PA 17701
570-327-4768
fterry@pct.edu & larmanda@pct.edu
http://www.pct.edu/wdce/fbhc