HERS score impact of insulation installation quality & what to do about it

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Who is NAIMA?

- NAIMA (North American Insulation Manufacturers Association) is the recognized voice of the insulation industry, bringing together North American manufacturers of fiberglass and mineral wool insulation products.

- Through the Insulation Institute, we leverage the collective insulation expertise of our organization and our members to empower homeowners and professionals to make informed insulation choices.

- Under the Insulation Institute name we deliver tools, training and marketing materials to building professionals, with a particular focus on quality installation.

Outline

- Presentation will have two parts:
  1. Review of the modeling showing HERS score impact of insulation installation quality across the US
  2. Recommended practices to deliver quality insulation installations in a repeatable manner
- Note: all modeling data and associated parameters come from Ekotrope. Any discussion, analysis or recommendations contained in this presentation come from NAIMA only and do not represent the views or opinions of Ekotrope.

Modeling the HERS score impact of insulation installation quality

Background

- It is well understood that insulation installation quality impacts a home's HERS score
- What is less well understood is the actual extent of that impact
- In our experience, people had opinions on this, gut feelings based on their experience modeling homes, but little actual data existed on the subject
- In 2016, NAIMA contracted with Ekotrope, an accredited HERS provider, to try and assess this question in a more meaningful way

Purpose of the project

- There are a lot of ways to model the issue of insulation installation quality, as a given home could have multiple grades throughout
- Our goal was not to model all permutations, or even common permutations of these grades
- Rather, the goal was to understand the *potential magnitude* of the impact installation quality has a home's HERS score
- We also wanted to understand the extent to which installed R-value (of walls only, for simplicity), ACH50 levels and home size impacted the HERS score impact of installation quality

Project Scope

- The permutations used were as follows:
  - 2 homes
  - X 8 climate zones
  - X 2 locations each (to capture climate variances)
  - X 4 insulation R values (R13, R15, R19, R21)
  - X 3 grade levels
  - X 2 ACH50 values (3, 5 ACH)
  - **Total: 768 homes**
- 3 grade levels means a given home was assigned a single grade throughout the home, meaning there was a Grade I home, a Grade II home and a Grade III home
- This was not done to mimic likely real-world grading scenarios but rather to assess the magnitude of the impact of installation quality, which was the project goal

Parameter details

Home 1: Single Story Slab, 2,000 s.f.

- 40ft x 50ft footprint, 9ft ceiling height
- Framed floor over vented crawlspace, R19 cavity insulation (G1 through G3)
- Flat attic, R38 insulation (G1 through G3)
- 15% window to floor area ratio, no overhangs
- 15 SEER Electric AC
- 92 AFUE Forced Air NG Furnace
- .69 EF Gas WH
- 50% CFL Lighting
- .04 CFM25 / 100 s.f. duct leakage to outside

Home 2: 2 Story + bsmt, 4,000 s.f. + 400 s.f. garage

- 40ft x 40ft footprint, 9ft ceiling height
- Conditioned basement, R13 cavity foundation walls (G1 through G3), 8ft height
- 70% Flat attic, insulated to R38 (G1 through G3)
- 30% Vaulted ceiling, 2x12 R38 cavity insulation (G1 through G3)
- 2x10 R30 Framed floor over garage (G1 through G3)
- 20% Window to floor area ratio
- 14 SEER Electric AC
- 80 AFUE Forced Air NG Furnace
- .08 CFM25 / 100 s.f. duct leakage to outside

8 Climate Zones, ~2 Locations Each

- Climate Zone 1
  - Miami, FL
- Climate Zone 2
  - Austin, TX
  - Tallahassee, FL
- Climate Zone 3
  - Charleston, SC
  - Oklahoma City, OK
  - San Diego, CA
- Climate Zone 4
  - Louisville, KY
  - Portland, OR
- Climate Zone 4
  - Louisville, KY
  - Portland, OR
- Climate Zone 5
  - Boston, MA
  - Lincoln, NE
  - Las Vegas, NV
- Climate Zone 6
  - Billings, MT
  - Burlington, VT
- Climate Zone 7
  - Fort Kent, ME
  - Grand Forks, ND
- Climate Zone 8
  - Nome, AK

Additional parameters

4 Wall Insulation Levels:

- 2x4 16” O.C., R13 Cavity Insulation
- 2x4 16” O.C., R15 Cavity Insulation
- 2x6 16” O.C., R19 Cavity Insulation
- 2x6 16” O.C., R21 Cavity Insulation

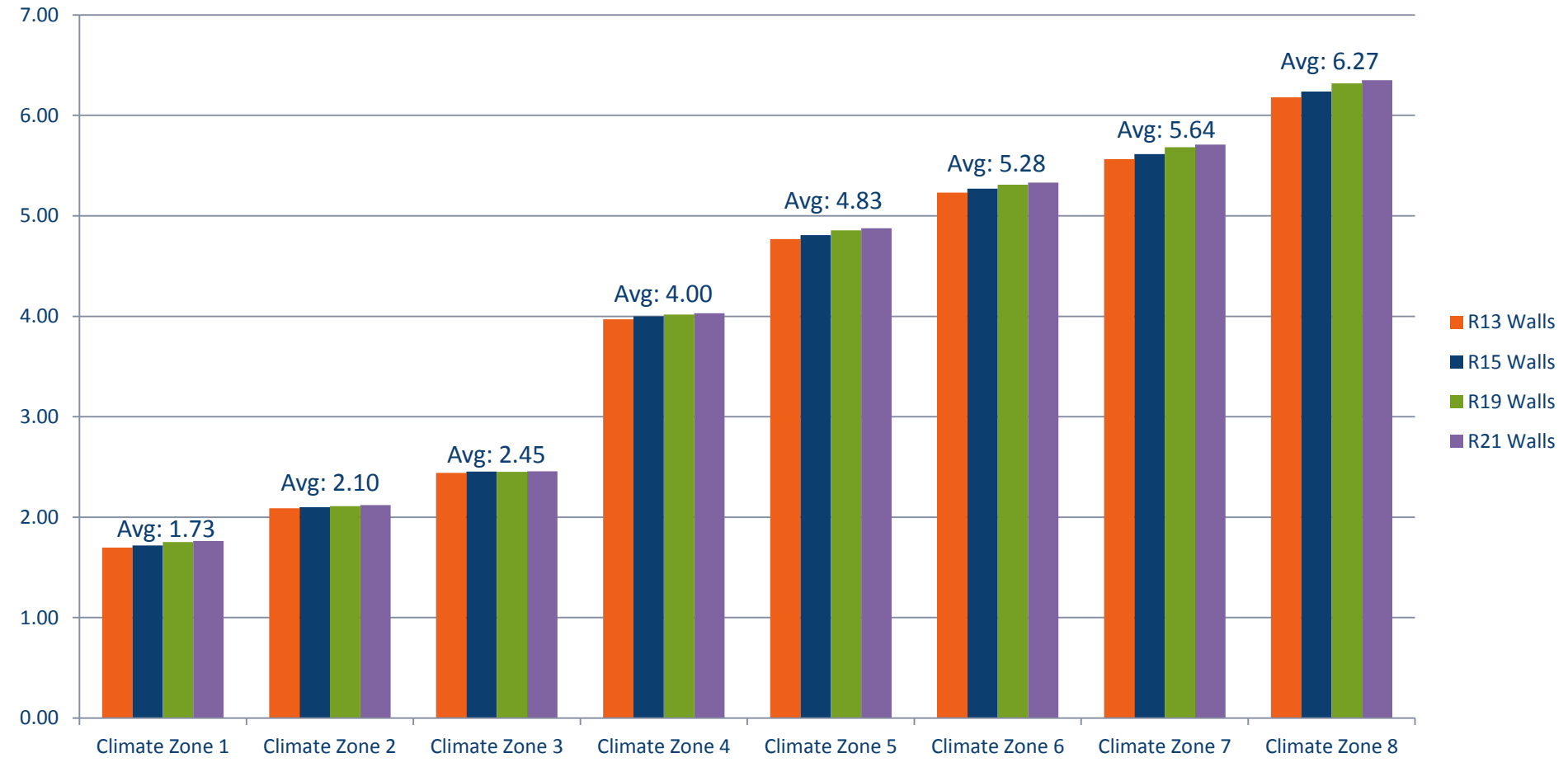
3 Grade Levels for Cavity Insulation (all walls, ceilings, and framed floors):

- Grade I cavity insulation, as defined by RESNET Standards
- Grade II cavity insulation, as defined by RESNET Standards
- Grade III cavity insulation, as defined by RESNET Standards

2 Infiltration Levels:

- 3 ACH50 single-point blower door test
- 5 ACH50 single-point blower door test

Modeling Results



Discussion of results

- ACH50 and installation quality are independent variables
- The impact was greater for the smaller home (4.63 across CZs) than the larger home (3.06)
  - Recall these homes were not identical besides floor area, other variables differed as well (HVAC efficiency, window area etc.)
- The R-value of wall insulation had a negligible impact on the HERS score difference, i.e. the impact of Grade III was not much “worse” for higher R-value walls
- Climate zone is the biggest determinant of how much installation quality impacts HERS scores

Analysis of results

- Installation quality has a meaningful impact on HERS scores in every climate zone, but the impact increases dramatically in colder climates
- These data suggest homes closer to the national media square footage (~2,500 sqft) may see a greater impact from poor installation than larger homes
- While these examples are more illustrative than representative of typical installations grades within a home, the data provide a new input for “Cost Of Poor Quality”, COPQ, for builders and raters to consider
- We hope this spurs builders and raters to consider the cost of getting Grade I as they do other features, on a $/HERS point basis
  - For example, if the incremental cost of getting Grade I with batts, due to extra labor time for both rater and contractor, is $800, and doing so can get you 4 HERS points (CZ4), how does that fare compared to other investments in improving your HERS score?

Recommended practices to deliver quality insulation installations

Background

- Grade I installations are not the norm
  - In a recent field survey, the US Department of Energy found only about half of all homes had Grade I quality (this differed in various parts of the home)
- We hear from raters consistently that getting Grade I is a source of frustration, especially with batts
- Our modeling shows that Grade I should be valued when constructing HERS rated homes
  - Valued is not the same as “I need to check this box”
- We did a lot of research with builders, raters and insulation contractors to try and get at why Grade I proves so hard to achieve on a repeatable basis
- On the basis of this research we have developed a set of recommendations for delivering Grade I, but we first need to abandon some preconceived notions

Things to stop saying about getting Grade I

- "To get Grade I with batts you have to pay installers more"
- "To get Grade I with batts you have to pay installers for quality, not just speed"
- "You need a lot more training for installers"
- "The installer workforce changes over too much, its impossible to keep them all trained sufficiently"

We have to stop saying these things not because any *one* of them is wrong but because *no one*, on its own, entirely right

Why do we know these are not enough?

- During qualitative research with raters on installation quality we heard many variants on these few key themes
- We then asked a key question: “OK. Assume we live in a new world. In this world, every single installer knows exactly what Grade I looks like and how to deliver in. They are also paid to deliver Grade I quality on every single job. In this world, do you think Grade I would become the norm, with most if not all jobs done to that level”?

- What do you think people said?
  - “Well…you see there are still other issues like…”

What are the “other issues”?

- When raters elaborated on the “other” reasons for failure, those not around training and compensation, lots of specific examples were raised
- Unlike the compensation and training comments, each was not just a variant of the other, often they were quite unique
- However, while manifestations differed there were common themes:
  - **Goal setting problems:** Lack of upfront agreement on, and clear articulation of, quality goals among the key parties which include builder, rater and contractor
  - **Communication problems:** A lack of clarity around who needs to say what, to whom, and when was a common theme
  - **Responsibility problems:** It was often unclear who had responsibility for different elements of the process. Who is in charge, who needs to be listened to were common complaints.
- What does this mean?

A Quality Management System is needed

- What is this?
  - "A quality management system (QMS) is a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives. A QMS helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve its effectiveness and efficiency on a continuous basis." – American Society for Quality
- Manufacturer use of QMS is widespread
- The better a job you do with QC, the less problems you have during QA
- Raters that act as quality consultants enhance their value
- A QMS-type approach for batt installation quality is about defining roles and responsibilities for three key parties

Question: Who thinks raters are primarily in the QA business today? Who thinks its QC?

Listen to the leaders for guidance

- Following our exploratory research, we engaged directly with leaders in the space, contractors and raters who find ways to deliver Grade I repeatedly, including with batts
- We also used the expertise of our members to hear about how to address the various failure points
- Our goal was to come up with a set of recommended practices that we believe, if followed, allow Grade I to be a repeatable outcome
- To that end, we have created a “Batt Insulation Quality Management Checklist” for use by builders, raters and contractors (in the flash drives provided to attendees)

Quality Management Checklist: Overview

- Consistent Grade I outcomes are the result of a quality management process that builders, raters and insulation contractors need to collaboratively execute
- Builders need to identify a “quality leader”; this can be either the rater with the contractor in support or the other way around
  - Some leading contractors can do this very well, others may not. We don’t think only one path is viable here.
- This is a team effort no matter what, but there needs to be a defined quality leader
- These recommendations can certainly be adapted to suit specific needs, but we do believe each recommendation is important

None of what follows can happen without a builder buying in first!

Quality Management Checklist: Builder Role

- Make Grade I a written goal. Clear articulation of the goal in the initial statement of work between the builder and the contractor is a must. If the builder doesn't take ownership of the goal and make it clear to the contractor, the odds of delivery are slim.
- The statement of work should be explicit about how delivered quality (whether it's Grades I-III, the Quality Insulation Installation procedures or "per manufacturer specification") impacts payment. Not only does this help ensure you get the desired result, it can also screen out contractors who won't be able to deliver quality.
- *Note: many contracts do stipulate the install will occur "per manufacturer specifications" but this is really just boiler plate. If you are serious about quality, the contract needs to be explicit about the actual expectations and how they impact payment.*

Quality Management Checklist: Builder Role

- Empower the rater to be a guarantor of quality
- This means you have:
  - Made clear to the rater and contractor that they must agree on what quality is. They need a shared understanding of the objective they are striving for.
  - Told your own people, for example your superintendent and your other subcontractors, that the quality leader dictates what proper insulation installation is and how to do it.

Quality Management Checklist: Builder Role

- The superintendent is super critical.
  - Tell your superintendent what the quality goal is.
  - Educate the superintendent in advance. Have the superintendent sit in on the training your rater gives the installers on quality expectations.
  - Have the superintendent remind the crew doing the work what the quality expectation is, even handing out the pictorial guides showing right and wrong ways to install the insulation.
  - Check the install before the rater arrives (and before the crew leaves). Superintendents need to make sure things stay on schedule, and if the rater says the installer needs to come back to fix the work, it throws the schedule off, so this action is typically the superintendent's responsibility.

Quality Management Checklist: Rater Role

- **Quality control processes (cntd.):**
  - Send the contractor instructional materials, pictorial guides, videos etc., on proper installation and encourage him to have his crew review the materials carefully before they arrive to do the work. Make sure you send versions in English and Spanish.
  - Find out if the winning bidder is doing the work or subbing it out. If it's the latter, you may want to double check the actual installation crew is trained and able to deliver Grade I and get them the instructional materials.

Quality Management Checklist: Rater Role

- **Quality assurance processes.** For this step the rater should:
  - Review the completed work, or as it is being completed, to ensure it can get Grade I when grading occurs.
  - Require immediate remediation for any work that is not Grade I. This can save the builder money by not sending the crew back to the job, not to mention preventing interruptions or delays for the other trades.
  - Work with the quality leader to share results of the install process with the builder and contractor to see what went well, what didn't and what could be improved for the next job.

Quality Management Checklist: Rater Role

- Show the builder the benefits
- After the work is complete, take the time to show what the builder got by employing this process. This could include HERS point benefits, qualification for incentives or certifications, cost savings by using batts instead of other products or all of the above. This will reinforce not just the value the builder got from the quality installation but also the value you delivered.

Quality Management Checklist: Contractor Role

- Ensure the crew knows the requirement. The contractor must ensure that the crew assigned to the job knows what the expectation is and can deliver on it.
  - This can be tricky if the contractor that won the bid and signs the contract is subbing out some or all of the actual installation work. In these cases, it's especially important to double check that the party doing the install knows the expectation, not just the party that signed the contract.
- Motivate the crew for delivery of Grade I. Ask the contractor how he will get the crew to deliver Grade I. How a contractor motivates is up to him, it can be carrots, sticks or both, but make sure there is some direct motivation for the crew to deliver Grade I for the job.

Quality Management Checklist: Contractor Role

- **Ensure there is a responsible party for onsite Quality Assurance**
  - A contractor should ensure there is a responsible party in his organization to confirm Grade I is delivered. This means a designated person who confirms Grade I was delivered before considering the job complete. If it was not, this party should be sure remediation occurs before the installing crew leaves the job. This should likely be the crew supervisor.
- **Make sure the crew has the technical competency to deliver Grade I**
  - It can be hard to keep every worker trained appropriately, but be sure the team for the job is prepared to do it right. If the rater is doing his job, he should have provided helpful instructional materials to the contractor. It's then up to the contractor to make sure the appropriate people in his organization get them and actually review them.

Quality Management Checklist: Team Role

- **“One and done” is “one and dumb”**
  - Doing something right once and assuming you’ll get it right again is how processes break down. It is about implementing this process every time. For larger production builds where the installs are staged, that means repeating some parts of this even for the same project, as crews can change and significant time can elapse between installations. This is about putting in place a repeatable system that results in quality. Committing to it will make it easier for everyone involved. Doing it sporadically will mean more missteps, more failures and more headaches.

Yeah but…the money

- Yes, employing some elements of this will cost a builder incremental money over getting Grade II or Grade III work
- That is not the whole story though
- An example can make this more clear

Option 1: Blown Cellulose

- Get GI on first pass
- Total cost = $4,700

Option 2: batts w/out QMS

- Get GI on 3rd pass
- Total cost: $3,800
  - $2,600 for material/labor
  - $300 for additional contractor trips
  - $300 for additional rater time
  - $600 due to lost time

Option 3: batts w/QMS

- Get GI on 1st pass
- Total cost: $3,400
  - $2,600 for material/labor
  - $500 for incremental contractor labor time
  - $300 for additional rater labor time

On a total cost basis, what is the cheapest approach to getting Grade I?

Ex. is 2,000 sqft. home, 2x6 framing R-20 walls, R-38 attic

See endnotes for cost estimate citations

Closing Thoughts

- The data is clear, insulation installation quality matters for HERS scores
- Installation quality, and its costs, should be a consideration for builders and raters as they look to cost optimize for various HERS score targets
- Grade I is achievable with batts if you employ a quality management system that addresses typical failure points
- On a total cost basis, the batts + incremental costs for quality compare favorably to other approaches

Questions and Discussion

Endnotes

- Insulation material and labor cost estimates from Ekotrope. Cost data from Ekotrope is based on aggregated costs from its database as well as market research.
- Lost time estimate assumes delay of two days due to re-work needed to achieve QII before drywall. According to NAHB data, one day of lost time costs the average builder $291. We rounded up to $300 for illustrative purposes.
- Estimates on additional incremental contractor labor costs are based on reports from knowledgeable people in the field working in CA. Estimate is also informed by EPA Energy Star analysis.
- Estimate on cost of coming back to jobsite based on general industry knowledge, there is no specific source