E3T Multifamily Technical Advisory Group
Scoring Results – Passive House, Net Zero Energy, Airtightness
Technologies presented at the 8/18/2016 webinar

Ranking per criteria	Passive House	Net Zero Energy Ready	Airtightness
Energy Savings	**1**	3	2
Non-energy benefits	**1**	3	2
Tech readiness	3	2	**1**
Adoption Ease	3	**1**	2
Value	3	2	**1**
TOTAL RANKING	**3**	**2**	**1**

SCORES (average ratings)	Passive House	Net Zero Energy Ready	Airtightness
Energy Savings	3.95	3.33	3.50
Non-energy benefits	3.78	3.22	3.50
Tech readiness	2.88	3.50	3.84
Adoption Ease	2.67	3.33	3.00
Value	3.17	3.35	3.79
TOTAL AVERAGE	**3.29**	**3.35**	**3.53**

PASSIVE HOUSE

Summary	
Energy savings	3.95
Non-energy benefits	3.78
Tech readiness	2.88
Ease of adoption	2.67
Value	3.17
AVERAGE	**3.29**

How significant and reliable are the energy savings per unit?

- I think it is important to at least acknowledge the differences between the two passive house programs. The reliability of the energy savings may not be exactly equivalent; in some cases, it might not even be close.
- This is now well documented.
- The whole building approach is good for new construction. In commercial/industrial programs, various levels of % reductions relative to code are incentivized. I like the quality control a standard will provide, but would be cautious about limiting the field to a specific design and construction standard which may suppress other approaches to implementation.
- Measured performance of single and multi-family projects in the PNW reliably show a reduction of approx. 60+% compared to energy code baseline.
- Depending on what code it being built under/to.
- There's a contradiction in the description here. I have yet to see any compelling data that shows investing in the building envelope of a MF building will have significant impacts on the heating/cooling load. However, we do have data suggesting that this isn't the case. The Passivehaus crowd has also not provided any evidence that their calculated EUIs for code or baseline buildings reflect actual EUI of NW Multifamily building stock. As of now, the "savings" for these buildings is completely cooked up.
- Depends on the type of building. In high density mid-rise the heating energy is only about 1/8 of the energy use of the building. So saving 90% of the heating energy represents only about a 10% decrease in the energy use of the building. Passive House approach has a better impact on townhouses and "woody walk-up" type construction where there is a larger envelope-to-floor area ratio.

How great are the non-energy advantages for the end user adopting this technology?

- See the research reported by the Green and Healthy Homes Initiative.
- I suspect the non-energy benefit to be comfort.
- Resilience – temps will not fall below 45+ degrees in the PNW, not rise above 90 during power outages in case of extreme weather periods. Thermal comfort and indoor air quality is excellent. Wall assemblies are more durable, of higher quality. Maintenance footprint of projects is much lower.
- Don't see the average developer going this route on their own.
- The occupants get some benefits. (Again, yet to be verified by actual data, with the exception of improved ventilation systems.) The owner/builder doesn't get anything they couldn't get for a much lower cost by investing in better ventilation, hot water, and lighting systems equipment and design.
- Low bills, quiet, probably marketable

How ready are the product(s) and providers to scale up for widespread use in the Pacific Northwest?

- First time for any team may be rough and add significant labor costs. But experience is a great teacher, so incentivizing the first (and maybe, second) PH project for a team could go a long way to overcoming industry resistance.
- All technologies are mature and available (triple pane windows, HRVs, exterior continuous insulation products).
- Unknown, probably will take some time and be rough at first
- All components necessary are available on the US market and American made options are available. Not rocket science, but requires some different and additional skills. Scaling up professional training will be necessary.
- Since this is a third party program there are barriers to entry. You have to be certified and trained by them

How easy is it for the end user to change to the proposed technology?

- It is not really hard. It just takes a lot of attention to details.
- Some work is necessary in training design professionals and code officials to better understand hygrothermal basics.... i.e. when a vapor retarder is or is not necessary.
- Can by challenging and costly.
- Passive house uses typical construction techniques and equipment. Typical details need to be further developed and changed some, but once that transfer has been successfully performed by builders and designers, the general feedback is that it was much easier than people at first had anticipated.
- The missing link in all this super energy efficient construction is the skill and knowledge of the tradesmen. In my experience, it is sorely lacking. The higher ups in the company may be on board and know how to perform the work, but rarely do the guys on the crew get the detailed training to perform the work. I have had to train many guys in the field even though I was only QC/PM.
- This was really designed around single family. Not sure it translates well into larger multi-unit buildings.
- New construction only - easy for a few builders and difficult for most builders

Considering all costs and all benefits, how good of a buy is this technology for the owner?

- It is an excellent thing for the occupants, and to the extent that occupant satisfaction and reliably low energy bills reduce turnover, it is also an excellent 'buy' for the owner.
- Especially true considering lifecycle costs.
- It depends on baseline. It’s a great value for some; out of reach for others.
- The value to the owner is at tenant turnover.
- Focus is on nearly eliminating heating load. With current standard practice and energy codes the heating load has already been significantly reduced. Combination of required construction techniques, insulation, airtightness, ERVs, and program costs are far from cost effective in multifamily.
- Fairly high costs and high benefits.

NET ZERO ENERGY READY

Summary	
Energy savings	3.33
Non-energy benefits	3.22
Tech readiness	3.50
Ease of adoption	3.33
Value	3.35
AVERAGE	**3.35**

How significant and reliable are the energy savings per unit?

- This is largely the same as passive house.
- The answer to this question is highly dependent upon the metrics, and whether all energy is accounted for, and whether we are talking about "on average" or in regards to specific buildings (the behavior issue, as well as required assumptions).
- ZNE means different things for different building types therefore the energy savings per unit will vary.
- ZNE may not actually be the best goal for some buildings, especially as net metering alternatives come into play. It will be more important for buildings to be "grid-friendly". Maybe the appropriate paradigm is zero net energy communities or regions. However, I see that ZNE can be a great motivator for homeowners/occupants/developers.
- Assuming that Zero Net Energy Ready means ZERH (Zero Energy Ready Home) envelope as per the DOE program. I would rate Zero Net Energy Ready based on passive building standards envelope. I would rate excellent.
- Are we evaluating the concept, or the proposed means of achieving net zero? My answer varies significantly depending on the answer to that question. Also, this poses some serious challenges, not the least of which is agreeing on what makes a building zero net energy ready. It will depend on the building type and it will depend even more on the cost metrics used. The Passivehaus crowd would have us use cashflow, despite the fact that the RTF and most utilities use societal cost testing that is quite different and arrives at a much different answer.
- Not sure how this is an emerging technology. This is a design approach that I support. California is putting it into code. The question is not whether we should be building houses so that solar panels on the roof can cover the annual energy use. The question for this TAG should be WHAT MEASURES/TECHNOLOGIES are the best ones to include to get the building to that level of energy efficiency.
- Reliable if a version of DOE Zero Energy Ready Homes is used.

How great are the non-energy advantages for the end user adopting this technology?

- This is largely the same as passive house.
- Lower costs, lower GHG, more comfort, better IAQ, less maintenance.
- Does not necessarily deliver the health and comfort benefits of Passive House because the standard is not consistent between buildings. Or depending on how the ZNE standard is written if a lot of PV can be used to offset energy use of a typical building then there are no non-energy benefits to speak of.
- ZNE may not actually be the best goal for some buildings, especially as net metering alternatives come into play. It will be more important for buildings to be "grid-friendly". Maybe the appropriate

paradigm is zero net energy communities or regions. However, I see that ZNE can be a great motivator for homeowners/occupants/developers.
- If it is a ZERH envelope, then the home is not low load enough to provide resilience during power outages (temps will drop below approx. 45, will rise above 90 during extreme weather periods. Thermal comfort and indoor air quality not assured (window specs typically not good enough, no required balanced ventilation systems).
- Low energy bill and high comfort levels
- It completely depends on where you set the threshold for "zero net energy ready". There may not be any significant non-energy benefits, aside from the good feeling the developer gets from saying they met an arbitrary metric. Some entities will have funding opportunities that hinge on getting such a stamp of approval. For those folks, the benefits can be pretty big. But benefits to the end user don't always translate into benefits for the region, BPA, the ratepayers, or our power infrastructure.
- Resilience, low or zero energy bills.
- Great if a version of DOE Zero Energy Ready Homes is used, could be very bad if the wrong practices are used.

How ready are the product(s) and providers to scale up for widespread use in the Pacific Northwest?
- This is largely the same as passive house.
- It can be done with off-the-shelf technologies, but will require training and feedback for practitioners. But as was shown in the webinar, the second time a team does this, the costs are lower, partly because the team now has experience.
- The passive house approach is common in Europe and when ZNE is the goal is the key to the best-practice solution
- There are no major barriers to this technology
- Existing specs/programs severely lacking in science. We need a good spec before arriving at answers to these questions.
- This can be done readily for 3-story buildings with existing technologies. But again, Net Zero Ready is not an emerging technology the question is which emerging technologies do we need to include to get our buildings to Net Zero Ready?

How easy is it for the end user to change to the proposed technology?
- This is largely the same as passive house.
- For new construction, it’s excellent.
- For retrofit many products are good to excellent"
- New construction: easy. Retrofits: more difficult.
- If they were already planning on a centralized water system requiring pumping.
- Some aspects are easier than others. Since MF projects have a pretty structured design and bidding process, it should be an ideal environment for implementing something like this.
- I am not at all convinced that central hot and chilled water plants are the way to go for HVAC in multifamily in the Northwest. If you do end up with central hydronic HVAC pumping then this is probably a great technology for those pumps. However, the energy impact of the pumps is very small in comparison with the impact of the technology that you use to make the hot and cold water and the insulation of the distribution piping throughout the building.
- Depends if a program is used or not. Hard for most builders to come up with a reliable, durable, cost effective package on their own. See https://basc.pnnl.gov/optimized-climate-solutions/marine for some ideas.

Considering all costs and all benefits, how good of a buy is this technology for the owner?

- This is largely the same as passive house.
- Though I rated it "excellent," there is a caveat. ZNE is an excellent deal for the occupant and a very good deal for the MF owner. By providing a significant improvement in tenants' utility cost security, household budgets are more certain, resulting in fewer vacancies. I have heard from several owners that vacancies and make-ready costs are among their highest costs - taking the biggest chunk out of their net monthly income.
- The best long term investment.
- Depends on building type.
- ZNE may not actually be the best goal for some buildings, especially as net metering alternatives come into play. It will be more important for buildings to be "grid-friendly". Maybe the appropriate paradigm is zero net energy communities or regions. However, I see that ZNE can be a great motivator for homeowners/occupants/developers.
- Adding renewables may increase the costs considerably.
- IF you need central HVAC pumps then yes.
- If the right package is used and implemented correctly. \

AIRTIGHTNESS

Summary	
Energy savings	3.50
Non-energy benefits	3.50
Tech readiness	3.84
Ease of adoption	3.00
Value	3.79
AVERAGE	**3.53**

How significant and reliable are the energy savings per unit?

- This is the next big ECM in the evolution of existing buildings. It is best addressed at the time of window and cladding replacement, and/or balcony repair.
- It really depends upon climate, occupant and other factors. Air tightness is important for many reasons, but energy savings in mild climates (e.g., along the coast of OR and WA) will not be significant (according the ASHRAE 62.2 Committee). Further, it is not clear how much of the benefit is due to the air tightness MEASUREMENT (per the question).
- There may be issues after the units are leased with how the residents use the windows, doors, vents, etc. Regardless though energy savings should be significant.
- The taller the building the more important to reduce stack effect
- Sealing R-0 penetrations always makes sense.
- Ventilation must be done correctly.
- Depends on building size and climate. Has to be combined properly with heat recovery ventilation.
- Excellent if air-tightness materials/measures are installed in a long lasting manner.
- Air tightness affects most every other envelope measure. Tighter equals better performance overall.
- Trust but verify

- Research data tells us that this measure will have reliable and predictable impacts, but that those impacts change depending on the nature and size of the building. Buildings with significant corridor or common areas will see much less benefit since they experience constant infiltration through the core of the building.
- This is a relatively small effect. It also greatly depends on what the ventilation system is. If you are assuming continuous exhaust-only ventilation then the impact of significant airtightness measures is minimal. There is a greater impact if you are assuming continuous heat recovery ventilation, but now you are spending a lot of energy on fans to push air around.

How great are the non-energy advantages for the end user adopting this technology?

- Comfort, acoustics, energy cost reduction, indoor air quality (assuming appropriate ventilation system).
- I'd have said "excellent" except that the advantages are dependent upon also having good ventilation. A very air-tight building with only "standard" ventilation is not necessarily a plus for the occupants. ...but it is important to measure and know it.
- Poor if no HRV and excellent with HRV.
- Compartmentalization is key for good IAQ.
- In the case of changes to the home or in the maintenance of the home, the owner may actually have non-energy costs if they do not understand the need to maintain ERV's and such.
- No drafts.
- Very quiet, plus the houses stay very clean because of the low infiltration/ exfiltration.
- Need tenant education on system operation.
- Reducing air leakage between apartment dwellings is a great thing to do. It has health and safety benefits, occupant comfort benefits, building durability benefits. In order for the benefits to be realized, though, the ventilation system has to be well designed and commissioned.
- Accoustical improvements from airtightness. Air quality may suffer depending on how the rest of the ventilation system design is addressed.

How ready are the product(s) and providers to scale up for widespread use in the Pacific Northwest?

- Thanks to Seattle and WA-State Code requirements for whole-building airtightness testing.
- Again, the main issue will be training of practitioners, and then repeated verification that they are measuring correctly. The debate is still active as to the 'right' way to do air leakage testing in MF.
- High Performance Building Materials has some unique and cost effective products and so do others.
- I don't know the extent of the industry in the NW.
- Not really sure because I haven't worked there in a very long time. But since the area has lead the way since the '80's, I am guessing they are ready!
- Thinking the products and some providers are here, but lacking training and oversight.
- Oregon is the only state in which the code doesn't specify infiltration testing targets for both residential and commercial buildings.

How easy is it for the end user to change to the proposed technology?

- Needs to be scheduled at time of renewal.
- Until there is wider consensus on how to measure air leakage in MF units, building owners may find it difficult to embrace ONE of the protocols.
- Very easy for new construction and some limited products for retrofit
- Will slow down construction at first.

- Unless they leave the window open.
- It can certainly be done. Multifamily can be built airtight.

Considering all costs and all benefits, how good of a buy is this technology for the owner?

- Outstanding economics.
- Long term these airtight - HRVs and Heat pumps are the lowest LLC
- This is the only way to guarantee performance. visual airtightness inspections do not work.
- The biggest bang for the buck is air sealing the building.
- The value for the owner is tenant retention.
- I'm not sure I understand the term "how good of a buy". This is something owners should do to save energy and improve their buildings. If the cost of doing it isn't substantially recouped in incentives and increased revenue, though, it's probably not a "good buy" based on business principles, so they'll need a different driver. Experience has shown that expecting a business to make such a decision based on altruism is not a reasonable expectation.
- There are much better places to put the money. Most new construction in the NW is already relatively tight and appropriate for exhaust-only ventilation.
- For new construction especially.