A New Design Method to Impact the Development and Sustainability of Affordable Housing

Honors Thesis City and Regional Planning

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ABSTRACT

This research paper aims to determine a potentially new method of design for affordable housing. Conventional buildings materials and design techniques often leave residents of affordable housing paying a high price for utilities. In this research, Passive House design, an extremely sustainable approach to architecture and design, was examined as a possible tactic to designing affordable housing. This examination took place through a series of interviews, some via Zoom and others via email. A total of nine interviews were conducted, three of which were with affordable housing developers in or around the Columbus area. The other six were with Passive House developers and architects located across the country. It is often perceived for any sort of sustainable architecture to be extremely expensive initially, thus many avoid it for affordable housing. Based on the interviews, it was proven that Passive House design can be designed and built for the same cost, or lower, than conventional, code-minimum buildings. Aside from initial costs, Passive House design has much more long-term benefits because of its energy efficiency. Through a series of design strategies, Passive House buildings and dwellings help to lower the use of utilities, in turn lowering utility bills. Even compared to other sustainable approaches, such as green building, Passive House design tends to be the most beneficial design strategy.

INTRODUCTION

Designing and developing affordable housing is, and remains, a problem in cities across our country since the beginning of housing programs. Not only that but creating affordable housing with a positive aesthetic appeal has not been a priority to the government and the subsidies they have created, often due to financial restrictions. Whether the problem is a lack of funding, a lack of knowledge of new and progressive techniques, or a lack of motivation to develop this affordable housing, this project will introduce a new design strategy in the building of affordable housing. Passive House design, a hyper-sustainable approach to design, will be introduced and examined as a new potential design technique. This examination will take place through a series of interviews that will be split into two categories: one where I will interview affordable housing developers and architects, and the second, Passive House developers and architects.

In this thesis, I aim to answer the following research questions, the first being are government subsidies such as the Low Income Housing Tax Credit offering any incentives for sustainable architecture approaches to design, specifically Passive House design? Currently, it's understood that funding for affordable housing focuses primarily on development and not on lowering energy costs for those living in these affordable housing developments, therefore leading to lower rent, but market-rate utility bills. This leads to the next research question of is Passive House design a feasible technique for developing affordable housing? Breaking down this question, is a Passive House certified structure more expensive than designing and building a simple, to-code structure? Also, does a Passive House certified structure require more skilled labor or a more intense design process?

LITERATURE REVIEW

Countless cities within the United States do not have enough affordable and available housing. With affordable housing being such a broad term and problem within our country, there are two ways

to consider it for our purpose: one as a definition and the other as a goal. The first definition is simply housing that is developed outside the purely market-rate private system. The second, which I have defined as a goal, is housing that, "considers the social effects of long-term habitation," (Wallbaum et al. 354). The U.S. Department of Housing and Urban Development (HUD) requires that housing be "no more than 30 percent of [the] household income" (Wallace 786). However, it may not be the best standard to follow as many U.S. citizens are barely able to afford even that. When speaking of affordable housing, the cost of this housing typically only takes rent into consideration, when in all actuality, a person or family also has to pay for utilities, groceries, transportation, appropriate clothing for work, possibly childcare, and much more.

Here in the United States, Williamson states that Low Income Housing Tax Credits (LIHTCs) are often used to fund the development of housing for low-income families (776). According to Williamson, "the program offers a financial incentive for the new construction or substantial rehabilitation of housing affordable to low-income tenants" (778). Different states' housing agencies are generally in charge of administering LIHTCs even though the overall monetary component is the responsibility of the Internal Revenue Service when looking at the program from a federal viewpoint. And beyond that, various developers across all the states in the U.S. are responsible for contending for the tax credits (Williamson 778). When applying for LIHTCs, "developers make decisions about where to site properties, architectural design, amenities to be provided, and the tenants to be served (e.g., seniors, families, special needs groups)" which allows the housing credit agencies to make their decisions based off of what fits their city's needs the most (Williamson 779).

When taking Low Income Housing Tax Credits (LIHTC) into consideration for affordable housing, it is imperative to know how they are distributed, what's required of those qualified to live in these developments, and also if or how Housing Choice Vouchers (HVC) factor into these residents and developments. "LIHTC developments provide a source of housing opportunity for those with vouchers,

and extremely low income (ELI) households have been able to use the HCV to occupy units they otherwise could not afford," (Williamson 783). In Williamson's journal, she stated that "Climaco et al. (2006) found that nearly one-half of all LIHTC developments have at least one resident with a voucher," (782-783). Other than the general requirements of a background check and credit history, "… the Quality Housing and Work Responsibility Act of 1998 requires that 75% of newly issued vouchers serve households at or below 30% AMI…" which is 30% the area median income, requiring a tremendously low income (Williamson 779). The percentage of the income is only calculated based off of what each household will pay for rent. This does not address those with incomes anywhere above that 30%, nor does it address the cost or payment of utility bills or other everyday necessities.

Occasionally it is beneficial to look outside of the United States for solutions to problems, such as a lack of affordable housing, in order to gain an understanding of methods or even solutions that we find unconventional in the United States. For example, in Russia, they are experiencing an obscene lack of affordable housing, so the governments are looking at both theoretical and practical ways to increase energy efficiency, which will in turn decrease long-term housing costs such as utility bills (Baronin and Kulakov 291). To put it plainly, Russian governments are looking at sustainable architecture to decrease construction costs, therefore, creating a potential solution to their lack of affordable housing. So, can we in the United States also use sustainable architecture, or specifically Passive House design, to decrease construction costs or will sustainable architecture be more expensive like commonly thought? Another example exists in Yemen where researchers have looked into new design methodologies for affordable housing based on two surveys they conducted. The first survey asked low-income people and families their requirements and needs for affordable housing. The second survey, on the other hand, evaluated the feedback of housing authority officials, gathering their opinions on what is required and necessary of affordable housing (Alagbhari et al. 84). They found that:

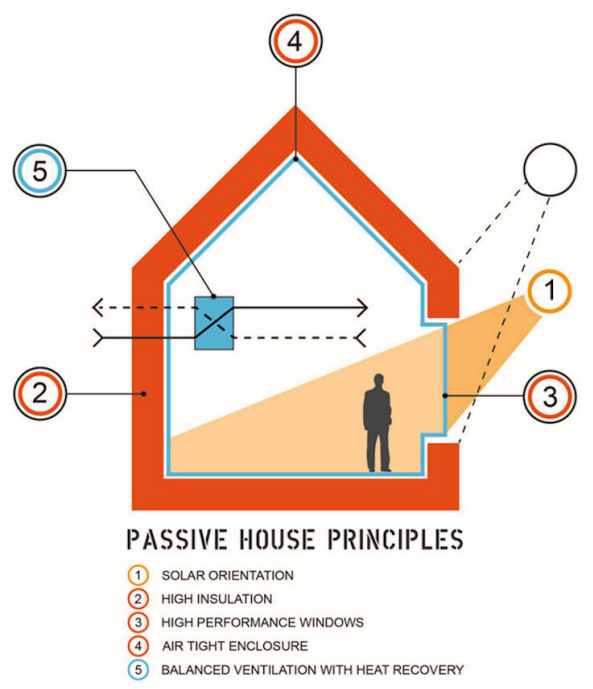
> the low-income group can afford new houses in Sana'a in consideration of the following: constructing multi-story housing units such as apartment system through using the concrete frame structure and building the internal and external walls with concrete blocks with limited areas… (Alagbhari et al. 84).

Moving this conversation back to the United States, an article stated that LIHTC funding was used to fund the design and development of Belfield Townhomes (pictured to the right) in Pennsylvania, a cluster of apartment units designed to Passive House standards yet utilized as affordable housing (Hanley Wood Media, Inc, 2020). Knowing that this Passive House development was built to within a LIHTC budget, it begins to prove Russia's theory that we can begin to generate more affordable housing through the use of sustainable architecture. It also addresses the study in Yemen whereas the low-income groups can afford multi-family housing as opposed to single-family housing made of materials easily accessible to the area.

http://www.onionflats.com/projects/affordable/belfield-townhomes.php

Passive House design is a technique that utilizes solar heat gain and other natural elements based on the climate, along with accentuating principles such as a continuous and airtight building envelope, high-performance glazing, "some form of balanced heat- and moisture-recovery ventilation," and "a minimal space conditioning system," (Passive House Alliance, 2020). To expand on some of these components, an airtight building envelope is essentially the insulation of a structure without any gaps that specifically happen around doors and windows. Solar orientation simply means designing a structure so that there is a lot of glass, doors and windows for example, where the sun sits in the sky the longest. It is most common for the sun to sit in the south for the majority of the day, therefore alluding

to south-facing glazing systems. Having high-performance windows, typically double- or triple-paned, on south-facing façades increases this energy efficiency even more. All of these components are illustrated in the image to the right. Passive House design is a sustainable approach to architecture that immensely decreases the energy consumption. For example, "In temperate climates… roughly 50% of total energy use for a typical building is used for indoor air conditioning, in terms of heating and cooling" (Morrissey et al. 2010). Therefore, increasing solar heat gain and optimizing building and glazing orientation will reduce energy usage. Solar orientation is an attainable attribute, especially when the thought or idea is conceived early in the design process.



Passive house principles via Richard Pedranti Architect (RPA), a Pennsylvania-based firm specializing in passive house design, https://www.remodelista.com/posts/what-is-a-passive-house/

For example, facing the glazing towards the sun (typically south-facing in the United States) is much easier if the largest façade is also south-facing. This glazing placement is important because it allows sunlight to penetrate the glass, allowing the space behind the glass to be naturally heated. This is not only easier, but also inexpensive both in the short-term (design costs) and the long-term (a decreased utility bill). Passive House design also tends to require acute attention to detail, often creating a more aesthetically pleasing structure therefore allowing the second definition of affordable housing to be addressed. That definition being housing that, "considers the social effects of long-term habitation," (Wallbaum et al. 354).

RESEARCH DESIGN

In my research project I have chosen to explore affordable housing, mainly within the parameters of the Low-Income Housing Tax Credit, and Passive House design. I have investigated the development of both affordable housing and Passive House structures while also exploring the familiarity of Passive House design to affordable housing professionals and vice versa. Through this investigation, I have begun to understand the potentials of using Passive House design to generate affordable housing at a similar or lower cost than a normal to-code building. I will begin discussing the Passive House questions first, followed by the affordable housing questions, then I will begin to correlate the two subjects.

In this project, I conducted exploratory research based on a series of interviews. My sample began purposive by interviewing a specific Passive House certified architect and developer. This architect has designed and developed both Passive House certified structures along with affordable housing and has even begun to combine these approaches. I aimed to interview five architects and/or developers in order to find a pattern and get a sufficient amount of data but was able to conduct six interviews via email. Email interviews came into practice instead of Zoom interviews due to time constraints. Ending the first interview, I attempted to begin a snowball sample by asking for recommendations for future interviewees that work in the same realm. I lost contact with the first architect interviewed, so I had to make a random selection from the Passive House database that names all Passive House certified professional builders. This list, however, does not show those who utilize Passive House techniques to develop affordable housing. Therefore, this has altered the research in the sense that I now have more of an understanding of how common it is to utilize Passive House design for affordable housing. I was able to gain contact with professionals of different positions who also come from different backgrounds in the Passive House field: architects, developers, and contractors from small, rural areas to large urban areas. This generated a variety of answers and knowledge offered.

Some work strictly with design, some played into the policy side of things, but they all were client-based – designing or developing for a specific person or group of people.

Below I have listed the questions that I sent for the Passive House interviews:

1. What does a typical day as a Passive House developer look like for you?
2. Have you looked at using Passive House to develop affordable housing? Why or why not?
3. Do you need to be commissioned to design affordable housing or are you also able to design and develop it on your own?
4. If you are aware of Low-Income Housing Tax Credits, do you know if there are points for Passive House design standards in these applications in your city?
5. (This question will be asked dependent upon the answer to the previous question.) How attainable is it to get approved for a LIHTC? Or, how attainable is it to meet the Passive House requirements to get the points for the application?
6. What are the incentives for Passive House development in the context of LIHTCs or affordable housing in general?
7. Speaking generally as opposed to a case-by-case basis, is the cost of labor and materials more expensive when designing to Passive House standards as opposed to traditional ones?
8. What is the incentive to an architect to design to Passive House standards?

After interviewing Passive House developers and architects, I changed my focus to interviewing affordable housing developers and professionals. Again, my sample began purposive and became a snowball sample from there. Unlike the Passive House interviews, I was able to fit in two interviews via Zoom, along with one via email similar to the majority of the Passive House interviews. I began by interviewing someone at a low-income housing agency located in Columbus, Ohio, asking questions about what his or her day-to-day work life looks like and how he or she determines what to develop.

Below are the questions that were asked in these interviews:

9. What does a typical day as an affordable housing developer look like for you?
10. How do you determine what and where to develop?
11. What is the average cost of an affordable housing project?
12. As an affordable housing developer, are you aware of Passive House design as a technique and/or method to design and develop affordable housing?
13. If so, is it being used in your city? If not, what is your speculation as to why not?
14. If not, what is your speculation as to why not?

Concluding the first interview on the affordable housing side, I asked this person for recommendations to any other affordable housing developers, and this person provided me with multiple sources for future interviews. My plan in the case that he or she did not have four names to offer me, or if all four developers are unavailable for an interview, I planned on getting more contacts through the Ohio Housing Finance Agency's website when looking at the section labeled "Office of Housing Policy Staff," or even through professors with contacts here at Ohio State.

The interviews focusing on Passive House development differed from those focusing on affordable housing development in the sense of geographic boundaries. For example, affordable housing is a well-known problem across the United States, so people and data around this topic are quite expansive. Passive House design on the other hand is not as well known, as a design technique as it originated in Germany. In noting this, it is assumed that there are not as many Passive House professionals in one area as there are affordable housing developers. Along with this, Passive House relies heavily on the climate in which its being built because of sun orientation and materiality availability, causing it to be utilized in different ways depending where you are in the country, or even the world for that matter. Therefore, when considering Passive House developers and architects, the parameters will be more expansive, potentially ranging across the United States to gauge how different

climates, cultures, and communities are utilizing this technique. On the contrary, because of the expanse of affordable housing, I started by setting the boundary to be the central Ohio which included, the suburbs of Worthington, Westerville, Gahanna, Reynoldsburg, Grove City, Upper Arlington, and Hilliard. After comparing the populations of these suburbs, the only outlier was Worthington, so I decided to cut it from the list. I did another comparison of the median household income with Upper Arlington being the outlier, so I also cut Upper Arlington from the list. Once comparing the median gross rent, there was no longer an outlier, so the final list is Hilliard, Westerville, Gahanna, Reynoldsburg, and Grove City.

Because I chose to conduct interviews, there were many ethical considerations to account for, especially considering our world's current situation with the Coronavirus. The interviews will be offered via Zoom in order to offer a version of face-to-face interviews without putting myself or anyone else at risk of exposure to the virus. But on the other hand, they were also offered as simple exchanges of email in the interest of time. Beyond physical matters, I also had to take into account anonymity and confidentiality. Therefore, I have not named any of the individuals that agreed to be interviewed. Furthermore, for any questions that any interviewees were not comfortable with answering, I made it clear that no question was mandatory to be answered. Finally, I asked for each interviewee's permission to record the interview, both audio and video, through Zoom. This was all made clear in the email that I sent out. Because of the human interaction through these interviews, human subject approval is necessary. Therefore, I have submitted an application to the Institutional Review Board under the advisement of Dr. Bernadette Hanlon, and our project was approved.

DATA ANALYSIS DESCRIPTION

I have started with the hypothesis that Passive House design can be utilized to propel the development of affordable housing. In essence, I believe that a Passive House structure can be designed

and built for the same amount of money, if not less money, than a normal, to-code structure. My research project has consisted of a series of in-depth interviews generating a mixture of a descriptive and an explanatory case study. Because a descriptive case study asks “what” and “how” questions, I have asked Passive House developers and architects what Passive House design is and how it is beneficial in general. Then, because an explanatory case study essentially asks why “A” relates to “B,” my questions will began to correlate Passive House design with affordable housing: “How can we allow Passive House design to influence and propel the affordable housing sector?”

My second set of interviews, where I talked to affordable housing developers, continued on with the same theme. I asked about the process of developing and constructing affordable housing and what that looks like, along with how that process is attainable, specifically financially. I then moved to ask the same question asked of the Passive House developers: “How can we allow Passive House design to influence and propel the affordable housing sector?”

As stated in the Research Design, none of the interviews were conducted face- to-face, they were a mixture of Zoom interviews and email interviews. With permission, I recorded all of the Zoom interviews, allowing me to really delve into understanding the concepts on both sides. I took my own notes, documenting anything that was relevant to the research questions. Beyond my own memos, however, I was able to rely on the transcription to fill in the portions that I may have missed. The email interviews were very helpful in this regard because I was able to have their exact answers in writing from the beginning. From here, I have taken each set notes from the Passive House interviews and compared the answers to each question across each separate interview. Again, I will begin by discussing the questions and answers related to the Passive House interviews first, followed by the questions and answers related to affordable housing.

Below I have restated the questions but added my analyses of the answers from each Passive House professional:

1. What does a typical day as a Passive House developer look like for you?

Of the six Passive House professionals that I interviewed, two were developers meaning they focus on hiring architects, they manage projects, sales, and marketing, and they are constantly finding the best ways to be time-efficient to mitigate costs for clients. Three professionals were designers or architects whose responsibilities range from working directly under Passive House developers creating designs to advocating on behalf of the Passive House community. These professionals meet with both policymakers and clients to ensure that all needs are met when it comes to codes, certifications, policy, and desires of the clients. The final professional was a contractor meaning that he only builds when commissioned and does not have much flexibility in what he builds as it is completely up to the client's discretion. He lives in a small, rural community that has remained resistant upon new methods of design and construction, constraining him to conventional design and construction.

Despite the differences in positions, geographic location was also a strong factor into the daily lives of these professionals. Of those interviewed, only half deal with Passive House design or development on a daily basis. For instance, the two architects and one developer who work with Passive House every day are from large cities, whereas the other developer, the designer, and the contractor all live in smaller, more rural areas and only work with Passive House on occasion.

2. Have you looked at using Passive House to develop affordable housing? Why or why not?

   All but one of the professionals interviewed has at least heard of Passive House design being used as a strategy to design and develop affordable housing. However, only two have actually designed affordable housing to Passive House standards. The ways in which they made it possible was through city funding such as the Low-Income Housing Tax Credit. The other three that have heard of it as a possibility either have not yet found out how to make it financially feasible, or their clients have not yet requested a Passive House structure. One thing to note here is that again, the geographic location plays a role into who is more aware of this possibility: those that live in large, urban areas have heard of it while those living in small, rural environments simply are not as aware.

3. Do you need to be commissioned to design affordable housing or are you also able to design and develop it on your own?

   Technically speaking, none of these professionals need to be commissioned to design affordable housing, however, only one of those that I interviewed has sufficient capital to develop it without a commission. But even in this case, challenges have still arisen. For example, this professional is struggling to find a property that has high potential for future resale or rent. One of the architects interviewed stated that he can always apply for a Low-Income Housing Tax Credit because in this case, the city funds the development. However, the biggest drawback in this case is a matter of his project getting chosen and built. The Low-Income Housing Tax Credit is something an architect or developer must apply for, and it is competitive as many architects and developers

within the city are applying for it. Noting the competition, you can make the assumption that your building may not always get chosen for this application.

4. If you are aware of Low-Income Housing Tax Credits, do you know if there are points for Passive House design standards in these applications in your city?

   Of these six professionals, all of which are from six different states, only one is aware of the LIHTC application including points for a Passive House design. This state offers ten optional points for Passive House design meaning that anyone applying for the Low-Income Housing Tax Credit has the opportunity to design to Passive House standards but is not required to do so. The other architect that I interviewed informed me that her state once allocated funds towards projects aimed at Passive House design, but has just recently removed all "green building" from tax credits. This is not to say that the other cities represented here do not offer points for Passive House design in their applications, but to say that these particular professionals are unaware of it if the points are in fact offered.

5. (This question will be asked dependent upon the answer to the previous question.) How attainable is it to get approved for a LIHTC? Or, how attainable is it to meet the Passive House requirements to get the points for the application?

   The architect that was certain of his state's tax credit including Passive House design informed me that the LIHTC application includes a total of 120 points but that it is very unlikely to obtain all of those points. Again, designing to Passive House standards awards you ten points and so long as your design meets those standards, you will be

awarded all ten points, there is no way to obtain only a portion of the Passive House points. Three of the professionals that either are not educated about the Low-Income Housing Tax Credit within his or her state, or do not know if it includes Passive House design incentives, were still able to contribute to the conversation. For instance, informing me that there are at least some government incentives that help to offset some initial costs of a Passive House structure. However, these incentives are not related to affordable housing. I was also informed about Passive House 2021+ creating a simpler process towards Passive House certification for both designers and builders.

6. What are the incentives for Passive House development in the context of LIHTCs or affordable housing in general?

   The biggest incentive in developing affordable housing to Passive House standards in the context of a Low-Income Housing Tax Credit, according to my interviews, is those extra ten points. One architect described it as, “If you don’t get those ten points, somebody else will.” Because the Passive House points are optional, not every application that gets submitted will address those points and standards, so if you do, those are ten points that another application might not get. All of the professionals could agree that another common incentive for Passive House design in general, but especially within affordable housing, is that Passive House structures generally “pay for themselves” within roughly seven years because of the energy savings. Because of the intricacy of Passive House design, the climate it is built within is utilized to naturally heat and cool, along with preventing the generated heat and air conditioning from escaping the structure, lowering energy usage, thus lowering the cost of utilities.

7. Speaking generally as opposed to a case-by-case basis, is the cost of labor and materials more expensive when designing to Passive House standards as opposed to traditional ones?

   Put plainly, three of our professionals agree that designing and building to Passive House standards is more expensive than a structure that is simply built to code, at least in the context of upfront costs like construction costs. One professional is not yet experienced enough to address this question accurately. But the remaining two whole-heartedly believe that with smart design decisions early on in the process, it is more than possible to design to Passive House standards at the same cost as a code-minimum building, if not at a lower cost. The need for experienced labor was also stated as a potential cost increase due to the intricacies of Passive House design, and it not being very widespread yet. It was mentioned again that a Passive House structure will essentially pay for itself within roughly seven years, but debated with the question of, "Are the initial costs worth those long-term costs?"

8. What is the incentive to an architect to design to Passive House standards?

   The one thing that all six professionals agreed on was that the biggest incentive to designing and building to Passive House standards is planetary benefits such as utilizing natural and unconventional methods to heating, cooling, and daylighting. This has led them to moral incentives as well. Multiple answers stated that structures built to Passive House standards include a lack of drafts and cold spots, fresh air from the heat recovery ventilation, and a noise reduction from the outside due to the thick walls and insulation. In other words, it creates an extremely comfortable environment for the clients. And finally, the topic of competition comes up again when one architect said,

"There is certainly someone else designing to Passive House standards, making their design 75% more energy efficient, so why don't I do that too and compete with them?"

Below, I have followed the same arrangement with the affordable housing professionals as I did the Passive House professionals:

9. What does a typical day as an affordable housing developer look like for you?

Similar to the Passive House professionals, the affordable housing professionals also come from different positions, however they all focus on development in Columbus, Ohio. Of the three professionals interviewed, there is an architect, a research analyst, and a developer. All three professionals work with clients and/or residents on a daily basis ranging from creating a design to meet their needs or sending surveys to residents to determine the specific needs of the residents within affordable housing. The architect and developer also have a daily focus on the design, construction, and financing of these affordable housing projects and developments.

10. How do you determine what and where to develop?

As mentioned above, all three professionals' organizations are based out of Columbus, so that is where the focus of development lies. The developer's organization spans to Ohio's surrounding states as well, offering the opportunity to develop in Columbus along with these other states. When determining what to develop, it depends on the city or state's specific need for development and the funding available, as both fluctuate on a yearly basis. The most common development-need is medium-sized housing which typically ranges from 28 to 30 units, but occasionally large complexes of approximately

200 units is a need that year. The Low-Income Housing Tax Credit and other subsidized bonds and credits generally set the standards and boundaries of what needs to be developed and also where it needs developed.

11. What is the average cost of an affordable housing project?

    Similar to the previous question of what and where to develop, the cost of an affordable housing project will vary year to year. Typically, when developing affordable housing, it is through a tax credit or a subsidized bond. The Low-Income Housing Tax Credit specifically has a cap on the price per square footage, along with a cap on the price per unit, thus generating a budget for an architect and developer to work within when designing affordable housing.

12. As an affordable housing developer, are you aware of Passive House design as a technique and/or method to design and develop affordable housing?

    All three affordable housing professionals were aware of Passive House design prior to the interview, however only one was aware of it being used as a strategy for designing and developing affordable housing. This particular professional realizes that other states are beginning to utilize it in ways like awarding points on the Low-Income Housing Tax Credit application. However, the other two professionals view Passive House design as being “too expensive up front.”

13. If so, is it being used in your city?

According to all three professionals, Passive House design is not being exploited to develop affordable housing in Columbus, Ohio.

14. If not, what is your speculation as to why not?

Again, there was a general consensus among all three professionals as to why Passive House design is not being used to develop affordable housing: there is already points on the Low-Income Housing Tax Credit application going towards a building being "green," or LEED (Leadership in Energy and Environmental Design)-certified. The challenge of high up-front costs was also referred to again.

DISCUSSION

Continuing with the same format as in the Research Design and the Data Analysis Description sections, I will begin by discussing the Passive House questions and answers first, followed by the affordable housing questions and answers, then I will begin to correlate the two subjects.

When asked about using Passive House to develop affordable housing, all six participants have at least heard of it, whether or not they have made this a practice themselves. Two participants, specifically, have actually done this and they have both used city funds and subsidies to make it possible. Three others have it as a goal in mind but have not yet found the best financial strategy for making it a reality. And the final participant has found resistance within the community because Passive House is a rather new technique, and those within that community are not completely open to changing the way things have been done. In essence, many do in fact see Passive House design as a potential method for

developing affordable housing, but the biggest factor fighting against this technique is up-front costs (i.e., construction costs, labor costs, material costs, etc.).

When designing affordable housing, it is not necessary to be commissioned when speaking in terms of policy or zoning codes. The necessity comes factors in again when we speak of finances. For example, if one of these architects, developers, or contactors has the financial means to design and develop affordable housing, then he or she has every right to do so. However, most of the participants that were interviewed do not have sufficient capital, therefore needing to be commissioned, or to put it plainly, the client needs to pay for it. Another option, however, is the Low-Income Housing Tax Credit in which an architect or developer completes an application and that state's housing finance agency goes through and selects certain projects to go through with development. That being said, just because one of these participants finished a design and completed this application, does not mean that his or her project will be chosen and built.

Of the six interviews I conducted, all of which represent six different states, only one is certain that there are points for a Passive House design in the LIHTC application, that state being Pennsylvania. California on the other hand has recently removed any sort of "green building certification" from their applications according to the participant. This means one of two things: 1) These five states just simply do not incorporate Passive House in the LIHTC application, or 2) These five states do not advertise the allotted points in the application. For those that were aware of Passive House within the LIHTC application, they stated that it was easily attainable. For example, it was worth ten points and so long as the project met Passive House standards then it received all ten points. For those that were not aware still had some thoughts to offer. In Massachusetts, a government agency has begun to help offset the soft costs of Passive House design, but it is unrelated to affordable housing. A Chicago Passive House architect has begun to hear about multifamily dwellings getting built in New York, and another participant is aware of a much simpler approach, for both the designer and the builder, to Passive House

certification. All this means to say that Passive House is beginning to make a name for itself and even a few architects interweaving it with affordable housing can and will shift the narrative. The biggest incentive for Passive House design in terms of LIHTC is simply competition. If you do not get the ten points offered in the application, somebody else will; those ten points could be the reason your project is not chosen.

According to one of the Passive House professionals that I interviewed, a common concern in using Passive House design, or even sustainable architecture in general, whether for affordable housing or not, is the cost of labor and materials. For instance, it is often perceived that the high-performance building materials such as triple-glazed windows or airtight weather barriers cost more than a simple to-code window or insulating system might. This concern was also raised by an affordable housing professional. According to one architect that was interviewed, many of these cost increases can be avoided with smart design decisions early on in the process, i.e. placing windows in certain spots that would not require a break in the air barrier. Another architect actually gave price comparisons of actual LIHTC application projects. A non-Passive House application was slated to cost approximately $171/square foot and it actually cost $176/square foot, with a 3% cost increase. On the other hand, a Passive House application was slated to cost approximately $161/square foot and actually cost $168/square foot, with a 4% cost increase, thus proving that it is in fact possible to design a Passive House project for less than what it would cost to only build to code. The other four professionals, however, have either had personal experience, or at least experience by association, of Passive House design costing anywhere from 5-15% more than a to-code project. Despite these discrepancies, all six architects and developers could agree that the energy efficiency of Passive House design pays for itself within five to seven years of being built and operable.

The final question that I asked these architects and developers was a simple one that gained a fairly general consensus: What is the incentive to an architect to design to Passive House standards?

Overall, the incentives are moral and planetary. Once you've started designing this way, a way that is better for both the planet and the occupants, what reason do you have to stop, or as one participant said, "Why would any architect want to go backwards?" Homes built to this standard will last ages according to one of the participants, and once again, why would any architect want to move away from a strategy like that.

Following the Passive House discussion is the affordable housing interview discussions which will continue in the same format. I have begun with the same question for both sets of interviews and was also rewarded the difference in positions among the three participants interviewed. For example, the average day looks different for all three participants in that the research analyst mainly looks at the policy side of things, focusing in on examining LIHTC applications and sending surveys to residents of affordable housing. The architect and developer on the other hand look at the design of affordable housing from start to finish of the project, even looking at financing and marketing. Despite these incongruities, all three professionals concentrate on working to create a comfortable environment for residents in affordable housing.

For the architect and developer, they choose the develop where they are located, i.e. Columbus. The developer, however, also has properties in surrounding states, so he has the flexibility of choosing to develop outside of Columbus and the opportunity to see how other cities and states manage their LIHTC applications. On the policy side of things though, funds vary year to year therefore altering the need of development. For example, one year there may be a need for a medium housing development (around 28-30 units) and then the next year a large housing development of roughly 200 units. The city and state's need will ultimately modify when and where development takes place, along with determining the budget that the architects and developers must work within.

Since each state has its own LIHTC applications and standards, the cost of affordable housing will vary state to state. That being said, each state's housing finance agency generates a monetary cap per square foot and per unit costs, so anyone applying for a LIHTC must remain within that price cap. There's roughly a 30-40% success rate for those who complete the LIHTC application – a lower percentage due to a rather complicated application.

Just as was asked of the Passive House designers and developers, the affordable housing participants were asked of their awareness of Passive House design and its potential to be used in affordable housing. All three were generally familiar with the technique but have not necessarily considered it for the development of affordable housing. Again, the concern for higher initial costs was raised. The research analyst recognized that some states offer it in the LIHTC application, but that Ohio does not. Instead, Ohio offers points for green building and LEED certification. All three affordable housing participants speculate that these current sustainable approaches are enough and there is no reason to add Passive House to the application with those already in place.

With this conclusion, the question was posed: is green building/LEED certification just as good as Passive House design? According to an article, the average green building is 28% more energy efficient than a conventional, to-code building (Kats 4). A Passive House on the other hand uses 64% less energy than a conventional building within the same city (Truong 221). So, speaking solely in terms of energy efficiency, Passive House design is more effective than green building. That this is not to say that green building is bad or ineffective, it just does not have as effective benefits as Passive House design. Kats exclaims that it is a common belief for people to think that green buildings cost more than conventional buildings. This belief was backed by six of the nine total professionals interviewed. However, "the majority of this cost is due to the increased architectural and engineering (A&E) design time, modeling costs and time necessary to integrate sustainable building practices into projects," (Kats 3). Based on answers from the interviews, it is possible to design to Passive House standards at the same cost, or

even lower, as a conventional building so long as smart and efficient design decisions are made early on in the design process.

According to a lecture given by a Passive House professional in 2019, fifteen states have begun to build Passive House structures and introduce Passive House in their QAPs (Quality Allocation Plans) and another fifteen were building Passive House structures without it being built into the QAP. The fifteen states that had Passive House built into their QAPs were California, Idaho, Montana, South Dakota, Illinois, Ohio, Pennsylvania, New York, New Hampshire, Vermont, Delaware, New Jersey, Connecticut, Rhode Island, and Massachusetts. According to the interviews California, Illinois, Ohio, and Massachusetts have removed Passive House from their QAPs within the last two years. The other fifteen states that are building Passive House structures without it being in the QAP are Washington, Oregon, Nevada, Utah, Oklahoma, Minnesota, Iowa, Missouri, Wisconsin, Michigan, Indiana, Kentucky, Maryland, Maine, and Alaska.

Taking this information into consideration, it is safe to claim that Passive House design and green building are both attainable techniques to begin to implement in the affordable housing sector. Passive House design has a stronger long-term benefit of being roughly 64% more energy efficient than a conventional building. The next step requires more advertisement of Passive House design and its benefits to the planet and to the residents living in these dwellings, and the biggest question to ask is why was it removed from the QAP of these various states? If this were a recommended technique and strategy across more states, allowing more points in the LIHTC application, more architects and developers would be more apt to utilizing it, if anything, out of competition for more LIHTC points.

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