

Tiny Homes – *A Tiny solution to a big problem*



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Master thesis: A Tiny solution to a big problem. How Tiny Homes could benefit you, society and how they could play their part in climate change communication.

The Healthy Homes design competition organized by CLIMA 2022 asked for a design of an innovative apartment building. They asked big, but I decided to hand in a proposal with Tiny Homes of 20-40 m² instead.

Why tiny homes?

Humanity has a big problem on their hands: climate change. It is affecting everyone, and it is everyone's responsibility to do their part. Whether that is eating less meat, revolutionizing solar power, or looking at sustainable industry from the perspective of ... a Tiny Home. Exactly what I looked at in my master thesis.

But why choose to look at Tiny Homes? Put simply: I was living in one myself. Considering the struggle, I encountered to live there legally, my original motivation was to legalize my own house using my thesis research. Somewhere along the road the scope changed drastically, and the research focused more and more on how Tiny Homes can help the transitioning to a sustainable society and what role they could help play in climate change communication, preparedness, and mitigation.

The thesis explored many fields in relation to Tiny Homes, through the methodology of research by design. The practical aspect of the design helped keep all elements connected, and focus on a design that is feasible to build today. As we need these homes ... well, now!

While I did not win the CLIMA 2022 competition, I did impress the jury with my proposal, following is how.

Climate preparedness

The brief of the competition asked for a very specific building: An apartment building that will be unaffected by potential flooding. This is not just an interesting



The Tiny Home Design created in master thesis
'A tiny solution to a big problem'.

design point; it is a reality we face today, and will face more frequently in the future: Rotterdam has depleted its land use within protected dikes. In America certain zones are exempt from insurance as the risks for fire hazard due to a changing climate are deemed too high.

Luckily most of the time we are warned for these disasters – in this case a Tiny Home proves to be an elegant solution: In case of disaster, you can drive it away and wait out the storm at a safe location. A Tiny Home does make you a bit slower and we have seen with the floodings in Belgium and Germany that a warning is not always present. But even if you need to leave your home behind in a rush, the financial repercussions and options are less severe than they would be for a conventional home.

Carbon footprint (= climate mitigation)

Preparedness is not the only way Tiny Homes relate to climate change. The Tiny Home designed has a carbon footprint of 15 000 kg CO₂eq. As the thesis focused on Tiny Homes in a suburb/rural environment the comparison was made to the typical house a two-person household will acquire in this environment. The LCA for this home showed that the average house of a two-person household in Danish suburbs is 150 000 kg CO₂eq. The Tiny Home footprint is no less than ten times smaller!

A demographic mismatch

Thus, Tiny Homes are sustainable housing when it comes to climate change, but who will live in them? Looking at the demographics of Denmark – and they are quite similar in most of Europe - shows that 49% of people live alone or as a couple, with the average household being 2.1 people. If we look at the residential buildings being made. However, we see that about 80% of these are aimed at families. Those numbers do not add up on paper. And in reality, they affect the lives of a whole generation, one that cannot afford to buy a home anymore. Tiny Homes are an affordable option for this target market existing of 50% of the population.

Healthy homes

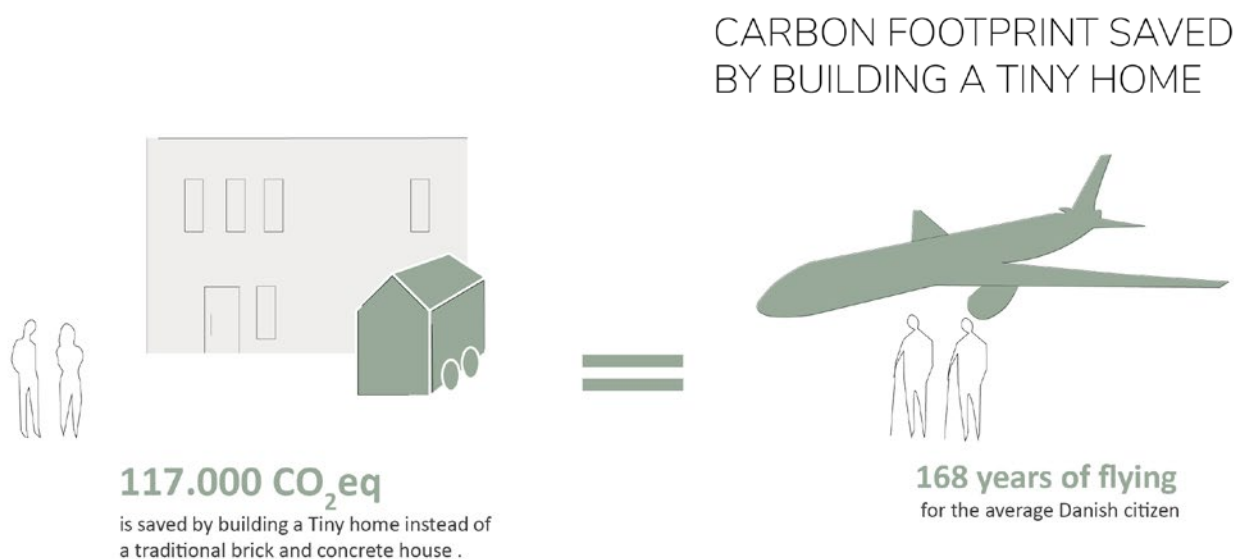
There was a more important reason however, that I chose to submit Tiny Homes into the competition. One that has everything to do with the key word of its title: **Healthy** Homes. The proposed competition

location is near an industrial site. Having been raised in Hoboken in Belgium I have experienced first-hand what that means. An industry scandal 20 years ago showed extreme lead values damaging children's growth and health. Two years back a documentary proved the protection measures taken were actually insufficient. This is not an insulated event. It has been shown on multiple occasions that effects of nearby industrial activity are known too late, and mostly affect children. Thus, an argument is made that the site itself is not suitable for families. Adults however are safe, and the perfect demographic for smaller homes, or Tiny ones.

Zooming in to the level of a building, or a Tiny Home, there are two elements related to Health. The most commonly addressed is the building's influence on the physical health. On the other hand, following the COVID-19 pandemic, a lot of research has been done on buildings' social and mental health.

Buildings' impact on physical health

Tiny Homes provide unique challenges when it comes to Indoor environmental quality, the extremely low volume creates higher pollution levels. Thus, for this article we will focus on air quality. Two factors were considered: materials and ventilation. Volatile organic compounds (VOC's) are so present that, even when we bring clean air into a room, by the time it reaches the occupant it might be polluted again. This is why the first step for the thesis was to design a Tiny Home without VOC's. Again, here I was motivated by own experience of a period with extreme asthma at university. In my Tiny Home that is build VOC free, I had



A carbon footprint comparison, buying the traditional Danish home versus a Tiny Home.

no health problems. But I often had to leave classes early at university, however, as I had no air, despite the ventilation.

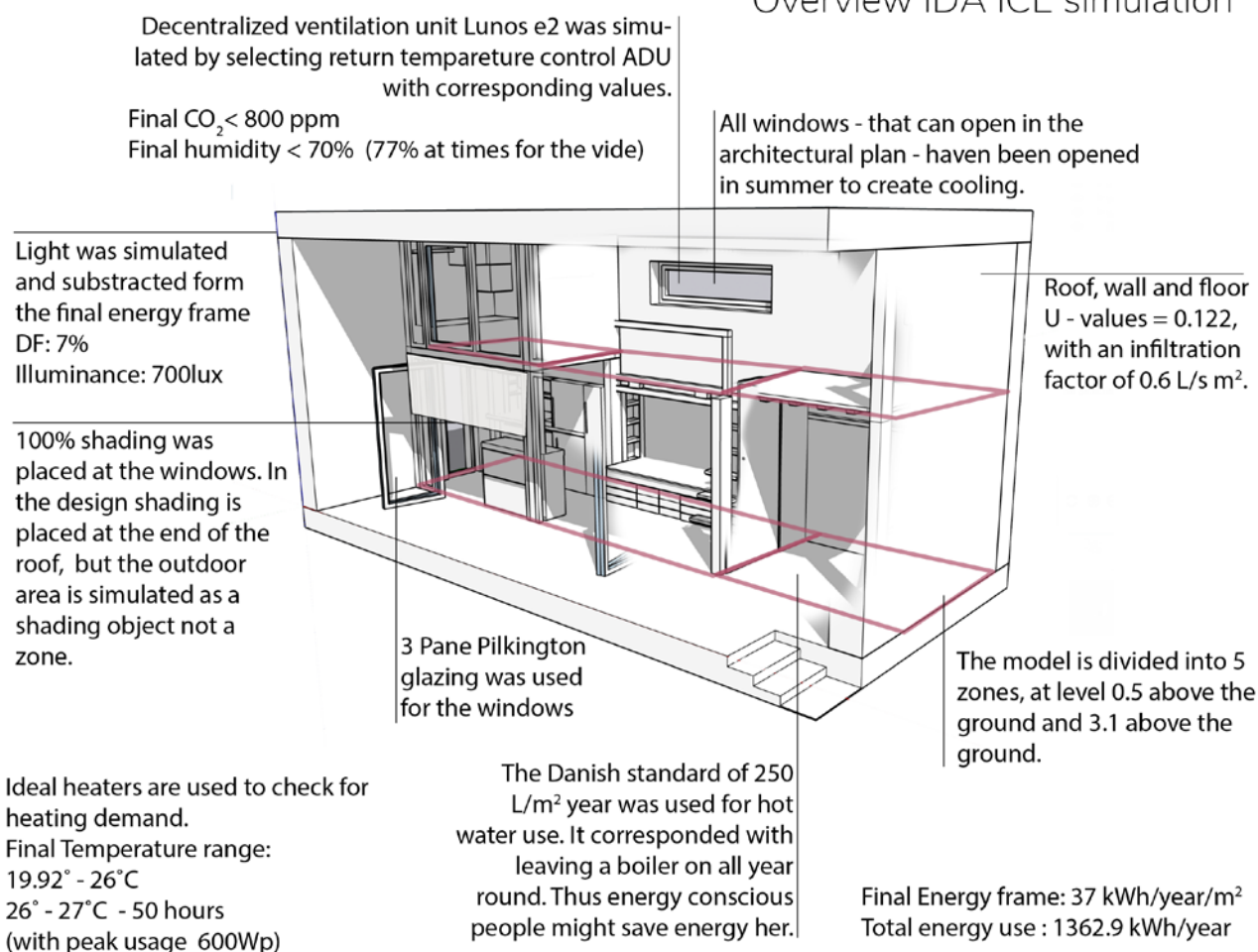
To address the ventilation, bringing in a range of pipes in a Tiny Home is not really feasible, space is in short demand in tiny houses after all. After thorough investigation, I ended up working with decentralized ventilation for the design. This has been widely used in Tiny Homes, specifically the Lunos e2. It was even analysed in a research paper studying two Tiny Homes. One of these homes had perfect air quality and humidity control. The second didn't have the same good results, there several cats were also living in the space though and the owners manually choose to use the lowest mode of the equipment.

Simulating the ventilation in my own design proved to be a challenge. I used IDA ICE and decentralized ventilation is just not included yet. Decentralized heating

also regulates humidity differently than traditional systems. And a third obstacle was the size of the Tiny Home. For example, infiltration is calculated using exposed surface/volume ratio, and the size of a Tiny Home completely skews those results. I did manage to speak to some of the PhD-researchers on this topic and got some help to correctly set up a simulation model.

An argument against decentralized heating I often hear is the noise. It is also a main argument I've heard against centralized ventilation. But in all the research I did I have never seen this argument pop up in relation to Tiny Homes. I think an important difference is the owners' involvement in building the tiny home, and their awareness of how the home functions. This makes people more tolerant towards discomfort. Secondly as the Tiny Homes are in such a small volume that serves all the functions of a home, there might be more obstacles between the actual sleeping resident and the ventilation to limit the sound discomfort.

Overview IDA ICE simulation



IDA ICE simulation summary.

Buildings' impact on mental health

A subject usually not addressed in the building industry: what influence does a building have on our mental health? A number has been floating around for a while now: we spend 90% of our time indoors. The lockdown probably made this number rise to a solid 99% for many people. Different papers were released following lockdown, investigating tangible parameters that can improve our home designs. Tiny Homes faced similar challenges to lockdown apartments. How do you use a small space as a bedroom, office, bathroom, kitchen. The thesis summarized the research done on these subjects and came to a surprising conclusion: the design principles suggested for Tiny Homes and mental health are largely the same.

Guidelines emphasize a flexible use of space. One room should be able to have multiple functions such as kitchen, workspace etc. Flexible furniture can play a big role in this. What was different from Tiny Home living that usually features open lifts was the emphasis on a closed bedrooms for biorhythm. The importance

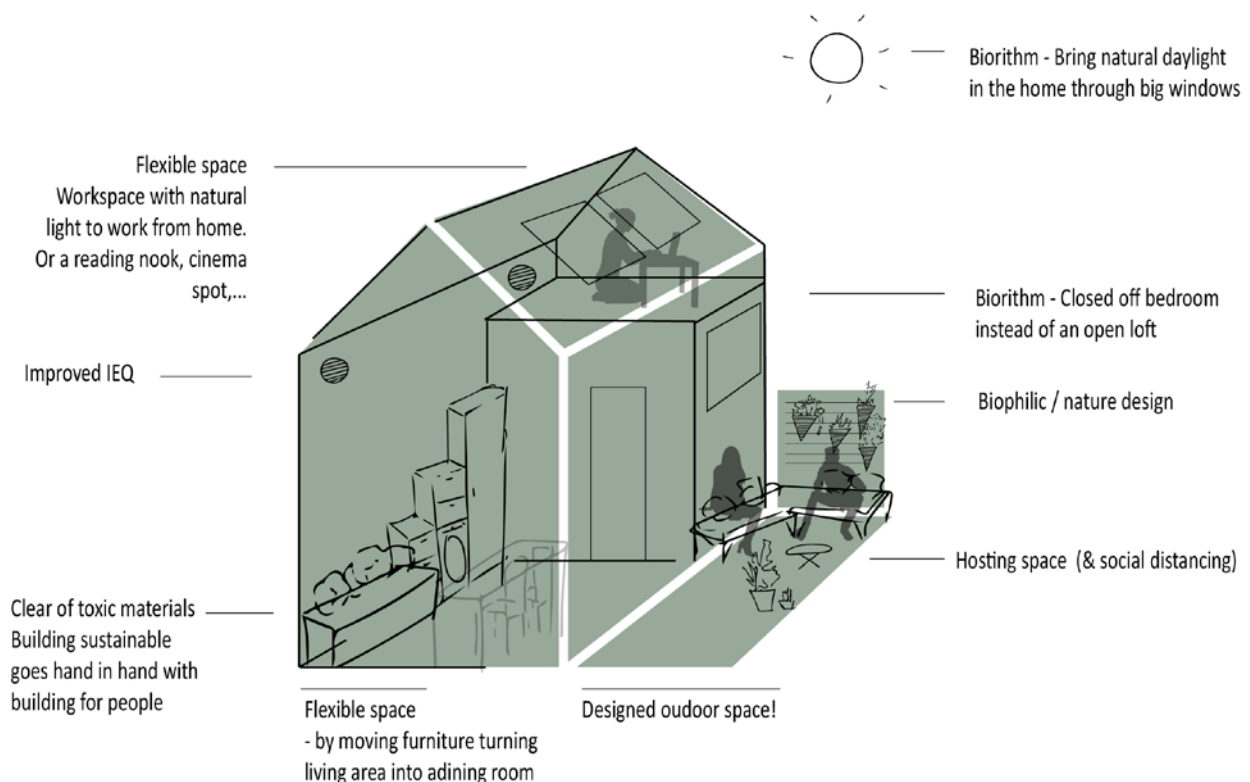
of designed outdoor space and biophilic design was also never mentioned in Tiny Homes. Most of these end up in the countryside however, where nature and outdoor space are plenty.

Back to the original question

Right now, Tiny Homes are largely illegal, or at least not entirely legal. European law however allows a country to implement a different building code for buildings under 50 m². Thus, what if we consider Tiny Homes as a housing typology? They serve 50% of our society and have a carbon footprint that is 10 times lower. They are also fast to build, and cheap compared to large projects. The estimate for the entire building site development of the CLIMA 2022 competition with Tiny Homes was 2.7 million euros compared to the 7.35 million euro's development that the asked for apartment building would cost. Last but not least they have been pioneers in off grid living, and they are the perfect field for optimizing new technologies. ■

SOCIAL HEALTH OF DESIGN

Design principles isolated by post Corona pandemic research



Design guidelines for social/mental health of a home.