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Sufficiency

Sufficiency Analysis on Refshaleøen Village of Copenhagen Village

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Abstract

The Rafshaleøen Village owned by the private corporation Copenhagen Village in the city of Copenhagen was studied generally to look at sufficiency practices in the adaptation of tiny home living for students. By looking at which ways and aspects does the concept of the Rafshaleøen Village contribute to sustainable lifestyles, that enable a good living with a reduced energy demand, while taking into considerations some limitations. Using the Gram-Hanssen 2005 formula (JANTZEN 2010) a basic estimation of the energy consumption that the Rafshaleøen Village could have for example, results in a lesser energy consumption than what a bigger living space would have. However, there were problems to consider, like the non-efficient appliances used by the villagers from observing and communicating this in an in-person site visit to the study area. Furthermore, the lack of some critical evidence and data makes this a more qualitative study and investigation. Regardless, some sufficiency aspects could be connected to the Rafshaleøen Village.

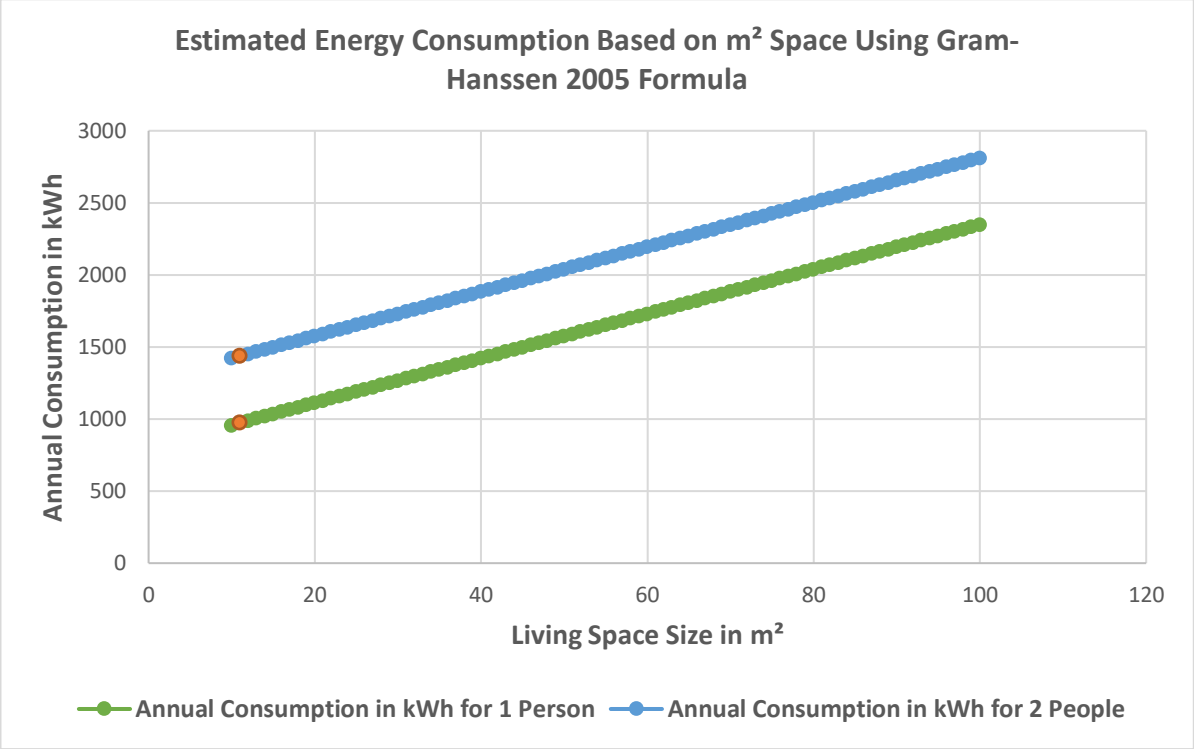

Figure 1: Energy consumption estimation (JANTZEN 2010; Worlddata.info 2020).

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List of abbreviations

CPH……..*Copenhagen Village*
kWh……*kilowatt hours*
kWh/m²…….*energy consumed per square meter*
m²..……...*meters squared*
# of persons……..*Number of people*

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1 Introduction

1.1 Rafshaleøen Village

Rafshaleøen Village is one of the several villages owned by the private company Copenhagen Village. Copenhagen Village is an organization that tries to create more sustainability in three main aspects economically, environmentally, and socially with temporary student housing (CPH Village 2022a). However, rather than focusing on this older and more general approach within "Doughnut Economics", the focus is shifted to how Rafshaleøen Village reduces energy demand in different branches, but mainly through tiny home living and its limitations.

The Rafshaleøen Village, the first village, was completed in the summer of 2018 and is home to 164 students presently (CPH Village 2022a).

Figure 2: Picture taken from site-visit with general information of the number of students dwelling there (CPH Village 2022a).

With permission from the Copenhagen Village team a site visit was made and during this excursion it was possible to communicate with a few villagers in the public community space available to the villagers and the public. From gathering research and gaining in person experience, this small space living concept is seen as the most applicable method to measure sufficiency in two sectors being the energy consumption sector and mobility sector.

Figure 3: Self-taken image of what the village looks like on the outside.

Though the village aims to promote a more substantiable lifestyle, that enables good living with a reduced energy demand based on the reduced space of living affecting these sectors, there are also limits or boundaries, where energy usage might be consumed more in comparison to living in a standard apartment building. This will be looked at, but very generally.

2 Methods

2.1 Initial Sufficiency Aspects Pertaining to the Sustainability Design of Rafshaleøen Village

The villages are temporary housing projects meant to last for about 10 years, “due to the only affordable and vacant land in the city being in former industrial areas and ports which are currently zoned with restriction on permanent development. However, a planning law made these temporary student living spaces available for up to 10 years” (Arcgency // Building Design and Vandkunsten // Urban Planning. 2018). They are constructed entirely of recycled shipment containers that seem to be made from steel from in person observation, meaning that they have good corrosion resistant properties. Normally weathering steel is used for shipping containers and is durable, because of the life they have at sea (Morin 2021). Thus, also reducing the need for corrosion resistant materials. These shipment container style apartments are built for disassembly with the parts lasting for a long life, but after use can be reused or recycled. The private living space size is about 11 m² per person. The room and kitchen are a private space; however, the bathroom is shared in between the two mini shipping container apartments, and this is shown in the diagrams below.

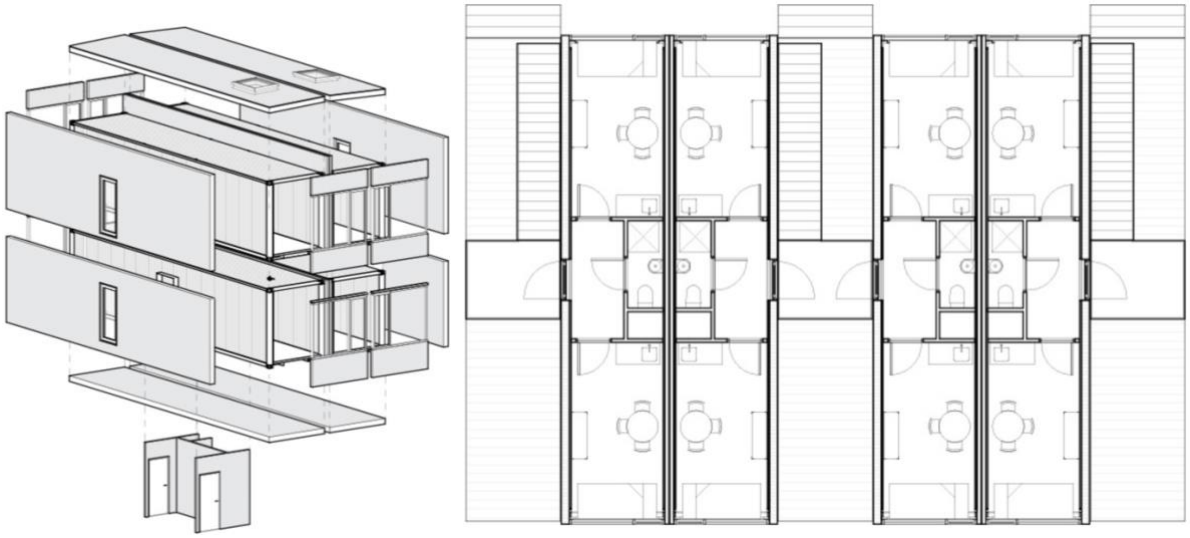

Figure 4: Screenshots of the diagram and plan level 1 are taken from Arcgency's website and the lead architect was Mads Møller (Arcgency // Building Design and Vandkunsten // Urban Planning. 2018).

As shown from the images above, this village’s apartments have no foundation as a base, which already complies with reducing initial energy demand in housing development. This tiny housing living is “one alternative to meet the global demand for sustainable action since less space = less energy consumption

= less material use = less usage of raw material resource = less environmental impact" (Malene Munk Jensen 2020). In this equation it can be applied that the material used is already recycled raw material, along with the bolts and screws that hold the structures in place of the container apartments. The environmental impact is also reduced, because the construction or design being built is on an industrial area.

It can be said that the initial design of the temporary student housing shipment container apartments is made in an attractive manner due to the waterfront environment and many local commercial activities that are attractive to students (CPH Village 2022c). Looking at the prices for living in these temporary homes seems to be affordable being about 690 euros per month. The students also have access to subsidies and can qualify for programs like the Community Creator Fund lowering their rent to about 610 euros or more (CPH Village 2022a), thus invoking a more sustainable lifestyle in giving students the option to create the habits of living smaller.

2.2 Data Being Quantified Based on Assumptions and Research

As explained previously the data researched and observed in person are used to quantify what the annual energy consumption looks like from the tiny home living per student in Rafshaleøen Village based on the size with considering limitations and comparing this to the general consumption of an average student dwelling in Copenhagen (or in Denmark) in a bigger space. The two plots below were used in helping quantify what the energy consumption in Rafshaleøen Village could be. The first graph below shows energy consumption in an average apartment in Denmark made by the Elsparefonden and Dansk Energi (JANTZEN 2010). This was last updated in 2010, so obviously there are other modern technology energy consumers to consider now, however this graph seemed appropriate, due to the Copenhagen Villages wanting to limit consumption to just the basic needs, yet still satisfying the villagers social and community needs and desires.

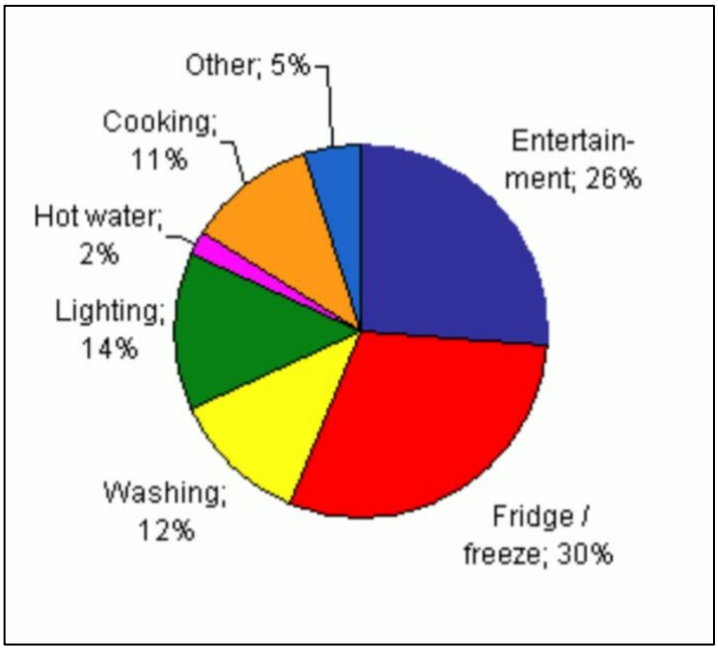

Figure 5: Screenshot of energy consumption of an apartment in Denmark last updated in 2010 (JANTZEN 2010).

The next graph below shows what the average energy consumption looks like annually for apartment size, based on the number of people living there in the legend to the right for Denmark, using the Gram-Hanssen 2005 formula (JANTZEN 2010).

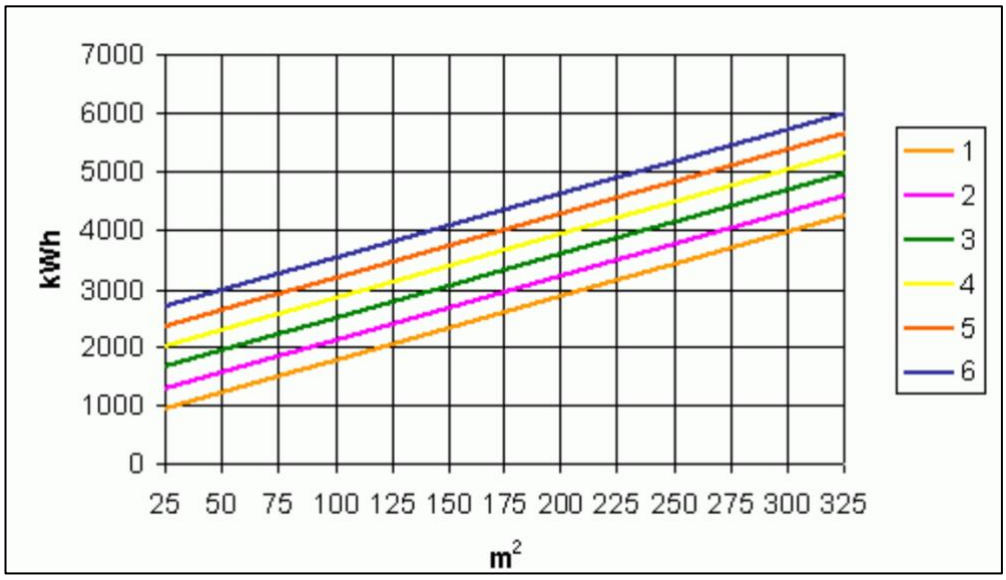

Figure 6: Screenshot of estimated energy consumption for average apartment size based on Gram-Hanssen 2005 formula (JANTZEN 2010).

Using the same example from the Average apartment energy consumption article from the Seacourse Danish website the Gram-Hanssen formula from 2005 is used (JANTZEN 2010), where assumptions and estimates were made based on researching the energy consumption per person in Copenhagen. However, there were difficulties in obtaining the energy consumed in Copenhagen of students as there can be a big variety in how each student lives and so the energy consumption per capita for Denmark was used (Eurostat 2022; Worlddata.info 2020). This can be seen in Figure 7 in the results section with estimated conclusions made for students living in Rafshaleøen Village. Figure 6 was also used to look at the increase since 2010. The Gram-Hanssen 2005 formula is given below:

$$Annual\ Energy\ Consumption\ (kWh) = 340\ kWh + \left(area\ in\ m^2 * 11\frac{kWh}{m^2}\right) + (\#\ of\ persons * 350\frac{kWh}{person})$$

(Gram-Hanssen 2005 formula, (JANTZEN 2010)).

2.3 Data That Is More Qualitative from Site-Based Observations

The data that is explained in terms of quality rather than quantity due to lack of information are given assumptions and a more biased explanation. The data being measured in this case are for example: the appliances used (not all are assumed here just the basic appliances that the apartments came with as stated in the Copenhagen Village website and what was seen from observation during the excursion), the use of water based heat pumps to warm the apartments and how the apartment conditions its air (from speaking to local villagers), other furnishings that students have that may waste more or less energy (based from the observations and communication with villagers), shared washing and/or drying machines, the waste separation and recycling, and the means of transportation. This qualitative data is represented by a few images in the results besides the description.

3 Results

3.1 Energy Consumption Sector

In the first portion of this energy consumption sector the energy consumed in kWh for apartment sizes ranging from 10 to 100 m² is plotted. The energy consumption information per capita in Denmark annually was found to be 5,638 kWh per capita (Worlddata.info 2020). Taking this and dividing it by the number of days in the year and multiplying this by 30 days, yielded in the energy consumption per month being 463 kWh per person as shown in the formula below, thus has increased since 2010. The 340 kWh was kept the same, like in the initial formula, because there was uncertainty for finding an

accurate estimate and so it was assumed to stay as it is, since as previously stated the Rafshaleøen Village tries to reduce the energy demand through small living and trying to influence students to having only basic necessities, when it comes to appliances or other furnishings. The 15 kWh per m² was determined from making a proportion as shown below:

$$\frac{350\left(\frac{kWh}{person}\right)}{11\left(\frac{kWh}{m^2}\right)} = \frac{463\left(\frac{kWh}{person}\right)}{\#\left(\frac{kWh}{m^2}\right)}$$

The energy consumption has increased from 2010 to the present due to more modern technology and so the energy consumption per area in m² has increased to about 15.4 kWh per m². Using the formula shown below a graph was able to be produced for the different apartment sizes with the amount of people within the living space.

$$Annual\ Energy\ Consumption\ (kWh) = 340\ kWh + \left(area\ in\ m^2 * 15\frac{kWh}{m^2}\right) + \left(\#\ of\ persons * 463\frac{kWh}{person}\right)$$

(Gram-Hanssen 2005 formula, (JANTZEN 2010)).

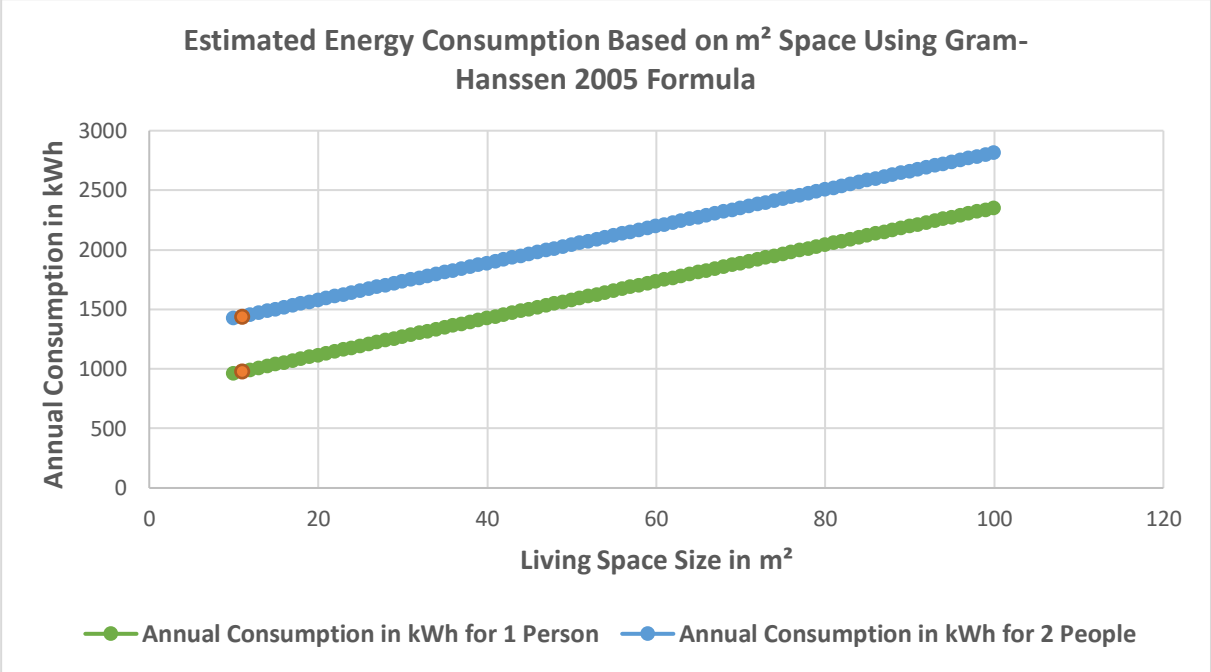

Figure 7: Estimated energy consumption based on Gram-Hanssen 2005 formula and assumptions made for the data (JANTZEN 2010; Worlddata.info 2020) all calculations are in excel spread sheet.

As seen above represented by the orange dot for the 11 m² apartment size for the Rafshaleøen Village the energy consumption could be between 1000-kWh to 1500-kWh. Again, this is a very rough estimate to try to quantify what could be the average or annual energy consumption for the villagers in their apartment. As the living space size increases the energy consumption does as well linearly, however there are many limitations in this analysis and aspects that are not included, such as properly quantifying how much energy is consumed within the shared spaces, like the bathroom, which is why the annual consumption was estimated for 1 person and 2 people. Not having the actual energy consumption data of the villagers of Rafshaleøen Village was another obstacle and though much investigation and contact efforts were made, the energy consumption of the villagers must be assumed to be possibly higher than the 1000-kWh or 1500-kWh. Especially when knowing the 5,638-kWh annual energy consumption per capita (Worlddata.info 2020) in Denmark, meaning that they may consume more energy in their space, especially with not knowing the exact technologies and types of appliances the villagers may have.

3.1.1 More Qualitative Aspects Relating to Energy Consumption and Usage

Continuing with this analysis the appliances and other information are qualitative and based on the observations made from the site visit and researched from the Copenhagen Village webpage. “Each housing unit is built into the about 12-meter size container. The diagrams in Figure 4 can be looked at again to see how the bathroom and entrance is shared. Each room has a large window and kitchen. The kitchen includes a small fridge, freezer, sink, ventilation system, and two portable induction cooking tops. All apartments have electricity, heat from water-based radiators, and water (Arcgency // Building Design and Vandkunsten // Urban Planning. 2018). The apartments are not furnished, and students may have their own microwaves and other appliances. They can also do their laundry in a laundry shared space, but they must pay” (CPH Village 2022a; CPH Village 2022b; CPH Village 2022c). The students must account for their own Wi-Fi, they may have a lot more technologies or other appliances such as laptops, lamps, tablets, TVs, etc., just like other people. The village does have a good trash sorting system for “glass, electronic waste, bins for batteries, paper, and newspapers, hazardous wastes for spray cans, blown bulbs, green bags for food wastes, metals like utensil, plastics, cardboards, and lastly residual wastes like clothing, shoes, broken wood, porcelain, etc.” (CPH Village 2022a; CPH Village 2022b; CPH Village 2022c). In the following images below these can be seen.

Figure 8: Up close picture of apartments.

There also happens to be a sauna and a community garden that the villagers can use to interact with one another. Most of the time their social needs are satisfied with community and public weekend parties as well as the nearby street events.

Figure 9: Picture of different trash bins for villagers to assort and recycle waste.

From speaking to a few villagers, the limitations or hiccups have to do with them not having great insulation in the winter when it is too cold or in the summer when it is too hot. The appliances are not very efficient, of course there is reduced emissions from the apartment size, but this seems like the only appropriate reason. For example, one of the villagers has a mini oven that produces 1,100 watts and is rated with a not good efficiency score. The type of induction stove tops are from IKEA and they may use more energy than a conventional apartment. There is a shared cooking space, however the villagers felt that this is too far from them for grilling or cooking. Despite these limitations the villagers still seemed happy or at least satisfied in their tiny homes and small living-based community.

3.2 Mobility Sector

From the site-tour it could be seen that parking spaces are available to the villagers, not many, but a few spaces were counted 20 to 30 or so, and then of course there is parking on the street. However, from

discussing with a few villagers only one person has a car, the rest either bike or use bus, and there were only 2 or 3 motorcycles seen. It was roughly estimated that there were about 90 bikes by counting from the 164 villagers and so it can be assumed that the rest were not there or use other transportation methods like the bus or metro. One of the villagers mentioned that there is a ferry and in the summer it is nice for them to take get there either by biking or walking, taking the ferry limits them from driving (although obviously most do not use a car) or personally emit carbon themselves.

Figure 10: Picture taken of bikes and boats.

4 Discussion

4.1 Sufficiency Efforts and Limitations in Comparison to Other Dwellings in Copenhagen

Applying the different methods of using the Gram-Hanssen 2005 formula with the world data information for energy consumption per living space size in Denmark may perhaps be a too simplistic approach for measuring the energy consumption in a smaller space to a larger living space in Denmark, but for the purpose of trying to measure the energy consumption of the village and see that it would show a smaller reduction in energy than living in a larger space it can be sufficient for this short analysis.

Looking at the qualitative aspects in regards to the mobility and trash assortment these are good examples of sufficiency practice. The feedback from the villagers in regard to the appliances they use are not very efficient and they do not really tackle any sufficiency practices other than living in a reduced space, however if the opportunity was available to have spoken to other villagers or had a tour this view or observation could perhaps have been different. When looking at the Vesterbro Village that was built after this one, containing 184 student homes, it seems that wood perhaps was used or a more suitable insulating and conventional material (CPH Village 2022a), as a means to improve any issues learned or observed from the Rafshaleøen Village. However, both villages try to establish tiny home living as a target in becoming more sustainable and reducing the carbon footprint, while at the same time satisfying the villagers social wants. One consideration that is very nice is that the Rafshaleøen Village is all recycled shipment container material as shown in Figures 11 and 12 and even though the material and design inside may not be the best insulation or air regulator, the villagers seem to make peace with this type of lifestyle.

Figure 11: Another picture of the shipment container apartments and more bikes can be seen. There is also no foundation as a base to the apartments.

Figure 12: Picture where the shipment container can really be seen in the public space with shared Wi-Fi and other recreational activities.

5 Conclusion

The Rafshaleøen Village was a good place to observe sufficiency aspects and drawbacks to becoming more sustainable. Living in a smaller space is better regarding reducing carbon emissions and energy consumption. In general Copenhagen is trying to work more when it comes to combating climate change and mitigating lifestyles to adapting to more sustainability. Within the village it was found that the sufficiency practice is within the tiny home living. There are other small aspects like the recycling and waste assortment, and within the mobility sector of having less parking spaces and villagers using mostly bikes. It seems that the village and the city of Copenhagen does try to influence ways for students to live greener, but it also depends on the student's personal choices. In general, from this analysis the smaller the space the less consumption there is or at least there should be.

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