# Residential Unit for Densification of the Urban Environment in Trondheim

Preparation for Master thesis, spring 2016,

Håvard Eide

**Content:**

**1. Abstract:**

Trondheim is experiencing a really fast population growth, with more than 2000 people every year. This is the first premise of this project. How does this growth affect Trondheim, the urban environment and the life of the urban dweller? And what would be the most beneficial way to expand the city both for the city and the dweller? I will try to draw closer to the answer and the end result of this project will be to project a residential unit that can be used to densify the urban environment of Trondheim.

The second premise of the project is global warming, the 'number one cause' of climate change (Booth C. et al.), and the need to reduce $C0_2$ emissions and energy use. And I will look at how these two premises are connected.

This preparation paper is built up with first an *Introduction*, describing the key concepts of the project, then follows my *Research Question*, followed by *Visions and Framework*, then *Methodology* and lastly *References* and *Sources.*

In the introduction I am looking at the city growth in Trondheim and the development in the last 15 years. The aim is to find out the direction the city is heading towards, and to analyse the current densities here. This will then again be made as a foundation for the density goals that I will set for myself and the standard that one should seek to achieve in future projects in the city.

By studying the population growth, we notice that the city has grown fastest in Rosten and in Ranheim, quite far from the city center. Such a sprawled city expansion would then lead to many negative consequences for the environment, and for the individuals living here. There would be higher dependency on means of transportation and more traffic and noise to mention a few.

Another challenge ahead is the climate change and the $C0_2$ emissions derived from housing. Almost half of the total emissions comes from building related activity in the UK (Booth C. et al.). And the number should not be very different in Norway, even if I have not been able to find it. We can also notice how square meters per person in Norwegian houses have changed in 35 years, from 36 $m^2$ in 1980 to 58 $m^2$ in 2015. Further we see how large percentage of total energy use is used for heating of rooms.

All this analysis suggest the need for a different kind of architecture in the future, based on dense forms, but that will also consider the quality of the dwellings, the social environments and secure healthy and environmental friendly neighbourhoods. My research question is then:

*How can we design socially inclusive and energy efficient residential units for densification close to the city center of Trondheim and reduce the environmental footprint of the built environment on a life cycle perspective?*

The plot I have chosen is at Tempe in Trondheim, an area of about 7500 $m^2$, just besides one of the buildings of Sintef. This plot is today used for parking of buses by AtB and for filling up natural gas. Tempe is an area that is relatively close to the city center (about 2,5 km), but the density is really underdeveloped and it is an urban void in the city. Actually the municipality has a regulation plan for this area where they are planning to build very dense. So things are happening. The area is very open and flat and around there are many different typologies. The main road, Holtermanns vei, functions as a barrier between the east and the north. There are some bus stops nearby and it is very well connected to most of the city by bus.

Later I mention three key aspects that I will work with, social integration, yearly energy budget and environmental footprint a life cycle. I describe the methodology that I am going to use to try to solve the project. I also show a section that has information about the density and how I want to increase it.

Lastly I have listed two reference projects, namely Brøseth and Hurdal Eco Village, which will help me to understand some of the dimensions and concepts that are important in new and modern projects

## 2. Introduction:

*Population growth:*

Trondheim is growing fast. Some estimates (TR2015M) predicts that Trondheim will have almost 70 000 more people in 2050, that is an average growth of about 2000 people each year. Last year (2015-2016), Trondheim's population increased with 2393 people (1,3%, Adresseavisa). What will this high popluation growth mean for the city and the urban environment in Trondheim? How will this affect the way we live in this city?

*Urban environment:*

What does the urban environment in Trondheim look like today? Trondheim as a municipality is spread across an area of about 340 km$^2$ (Trondheim kommune). And the overall density of the municipality is only 540 people/m2. The municipality office have divided Trondheim into 42 Elementary school zones (ESZ) and 432 basic zones (BZ). The average density of the ESZs is 1760 people/km$^2$ and of the BZs is 3020 people/km2. The highest density of a ESZ is found in Bispehaugen, with 7820 people/km2. The BZ with the highest density is Rosenborg 15 with a density of 18700 people/km$^2$.

*City growth:*

How has Trondheim grown in the last 15 years? I have taken a look at where Trondheim has grown most, according to percentage and also to numbers. Trondheim has grown fastest at Ranheim with over 3000 new inhabitants. Second follows Bispehaugen with 2500 inhabitants. Trondheim grows fastest at Rosten, with an increase in population of 290 % since 2001.

Looking at where Trondheim has grown according to the distance to the city center (Trondheim Torg) we can find that only almost 30 % of the population growth have come inside a circle with radius 2,5 km. While more than 50 % of the growth of Trondheim have come outside a circle with radius of 7 km from the city center. (Figure 1.5). This shows that Trondheim is growing in a very sprawled way.

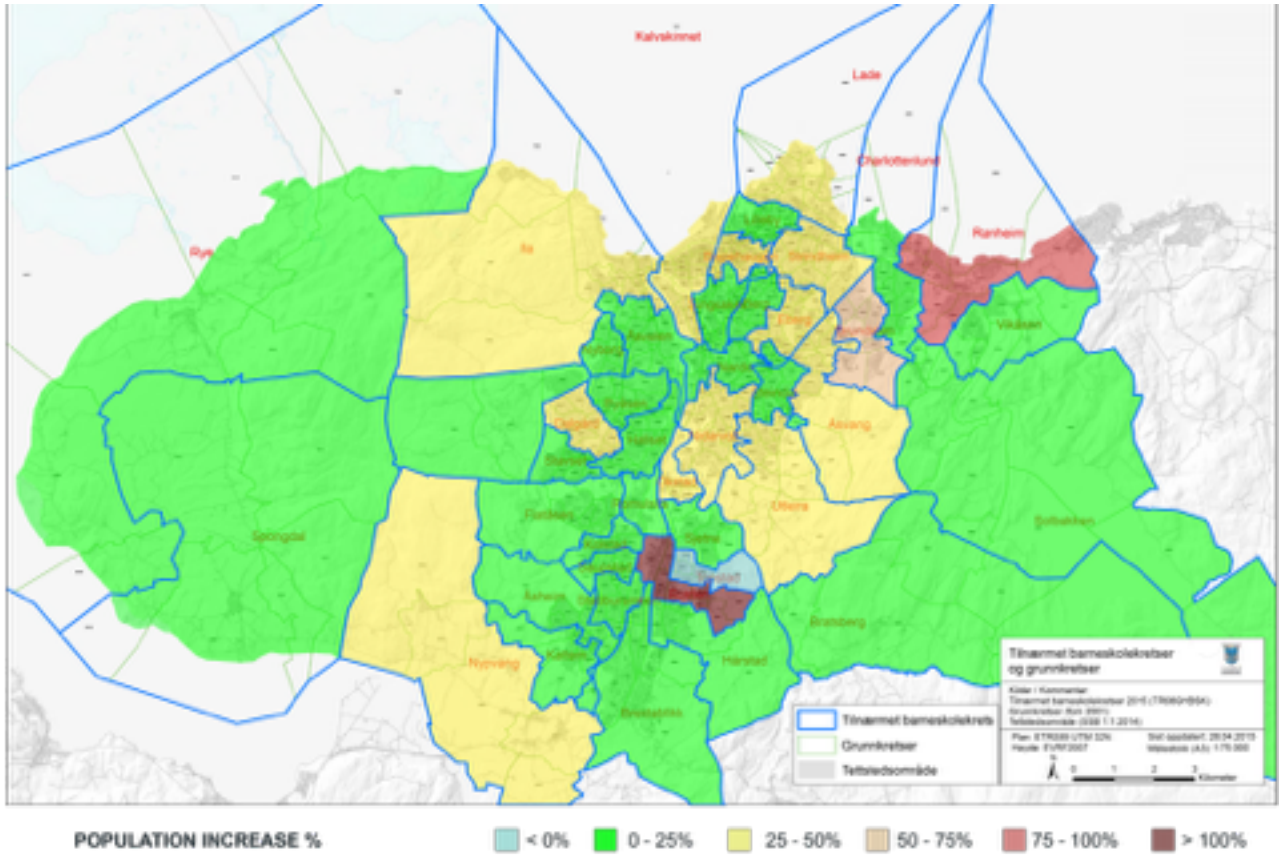



Figure 1.1: Population growth in Trondheim, %

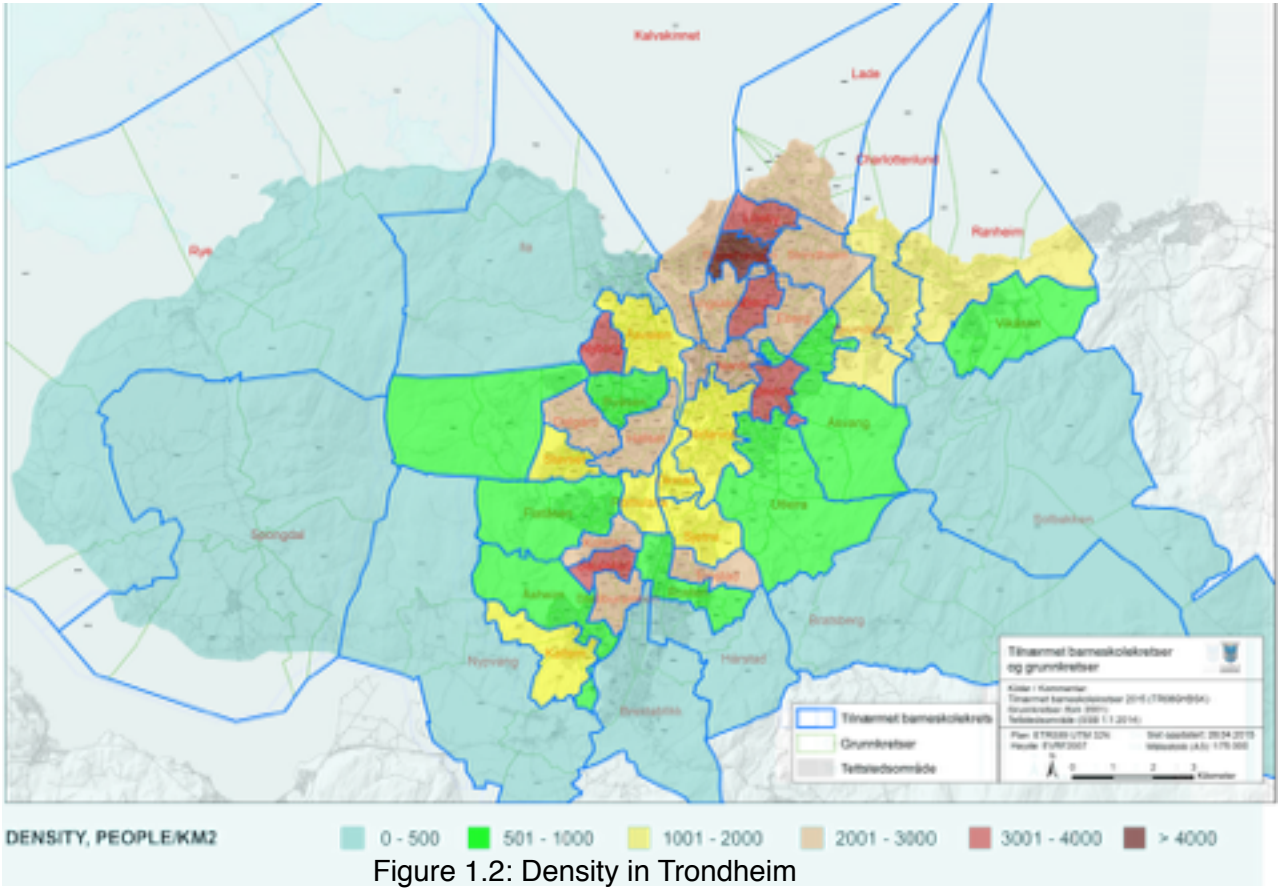



Figure 1.2: Density in Trondheim

*Consequences of sprawl:*

There are various consequences that comes with a sprawled city. It will lead to a higher dependency on means of transportation, more traffic and less efficient area usage. This will again lead to more noise and pollution, $C0_2$ - emissions, energy consumption and area shortage.

*Climate change:*

''The built environment is crucial in the climate change and global warming dialogue. It is estimated that nearly half of (UK) $C0_2$ emissions are buildings related, and 27 % of (UK) $C0_2$ emissions come from housing.'' (Booth C. A., et. Al, 2012)

It is obvious that there is a clear connection between climate change and $C0_2$ emissions. And a big part of the $C0_2$ comes from building houses. How can this be reduced by building in a denser and more efficent way?

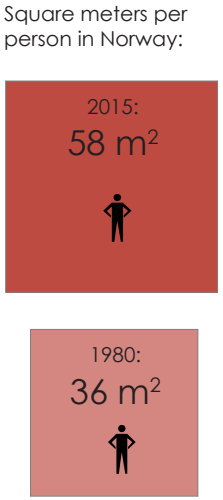



Figure 1.3

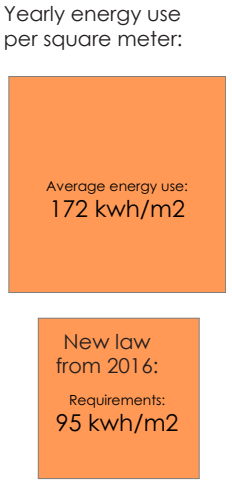



Figure 1.4

Figure 1.5: In Norway, heated area per person is 58 m² in 2015. In 1980 it was 36 m² per person. (*Source:* SSB.no*)*

Figure 1.6: Average energy use per m² in Norwegian households. The requirements under are for apartment buidling type. (*Sources: Energibruksrapporten 2012/ Plan- og bygningsloven.)*

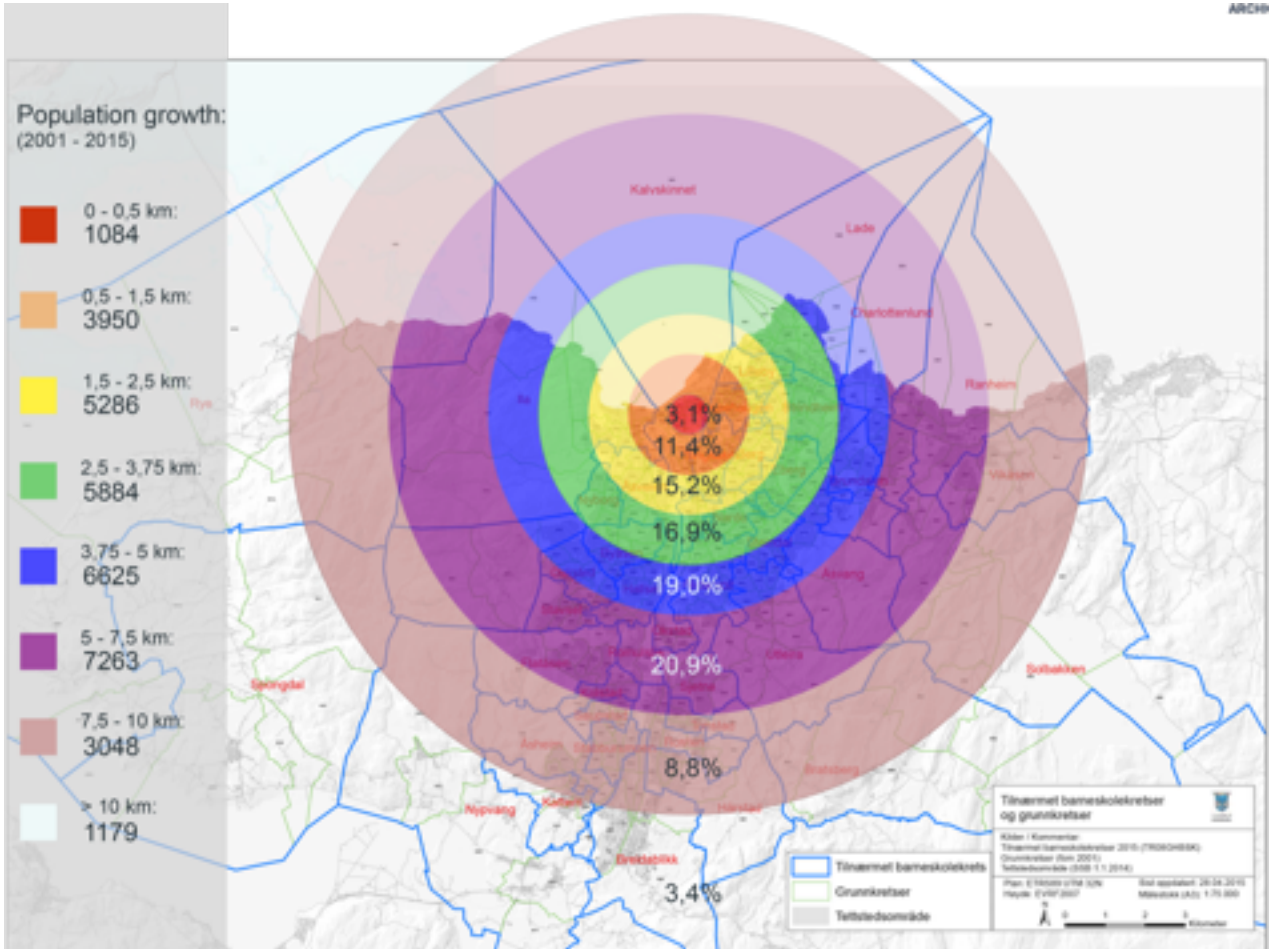



Figure 1.5: Population growth % in Trondheim according to distance to city center (Trondheim Torg)

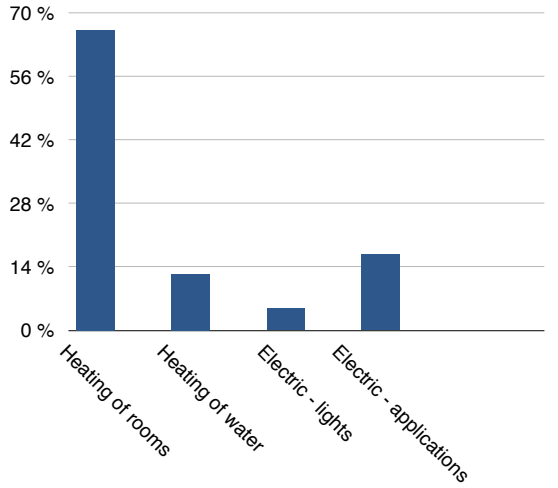



Figure 1.6: Energy distribution in an average Norwegian household: We use almost 70 % of the total energy on heating of rooms.
*Source: Energibruksrapporten 2012*

*Potential of densification:*

Should Trondheim continue to grow as a sprawled city, or is it necessary to build denser? It is important that the growth will contribute to a good environment in the city and for each citizen. With a denser model, much less area would be required and this would be very important for Trondheim in the future, especially because they have decided to preserve agricultural areas close to the city by a green line. How can we build denser in this city, and closer to the city center? How can we increase the walkability for people? This project is about sustainable densification in Trondheim, and my focus will a new type of housing, a prototype of apartments close to the city center in Trondheim. My focus will also be on materiality and area efficiency. It is not only important to build dense forms, but that the new typology creates a dense city and city block optimization.

## 3. Research question:

*How can we design socially inclusive and energy efficient residential units for densification close to the city center of Trondheim and reduce the environmental footprint of the built environment on a life cycle perspective?*

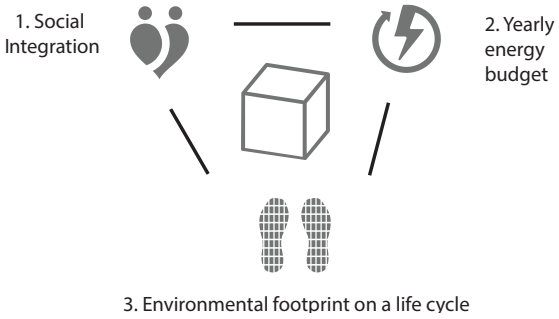



Figure 2.1:
My research question consists of three parts. First it is how to design residential unit that is supposed to be socially inclusive. Later it should also be energy efficient And finally it should leave a minimal environmental footprint on a life cycle perspective of the bulding. I have then divided those three parts as shown in the diagram, but they are also connected between them.

## 4. Visions and Framework:

I have chosen a plot at Tempe. This is an area close to the city center, in a reasonable walkable distance, at least in a distance good for bycyling. It is also underdeveloped in an urban sense, and consist of many empty areas, including a parking lot that has been used many years for buses. It is an urban void and strategical for the growth of Trondheim in a dense way. Its close neighbors are Sintef to the east, private houses in the south, another parking lot to the west and other private houses in the north.

In the north the private houses are also divided in various apartments. The total area of my plot is 7000 m$^2$. The distance to Trondehim Torg is 2,5 km and the distance to Lerkendal is 400 m. It has a bus stop 150 meters away and is well connected to a lot of the bus lines in Trondheim. On the other side of the Holtermannsvei, there are tall residential buildings with 13 floors. Close to these we find some shops, a big supermarked and a gas station. But the Holtermannsvei is a big barrier that seperates the two sides.


My plot on tempe. AREA: 7500 m2. (Photo credits: Google earth)

One of the main objectives with this project is to increase the density of an area that are close to the city, and reduce the need for transportation. At the same time I will try to create well functioning neighborhoods that are safe and have a lot of activities. To achieve this, it will be necessary with a wide range of services and job opportunities near. I will try to create a neighborhood where the car will not be necessary to use.

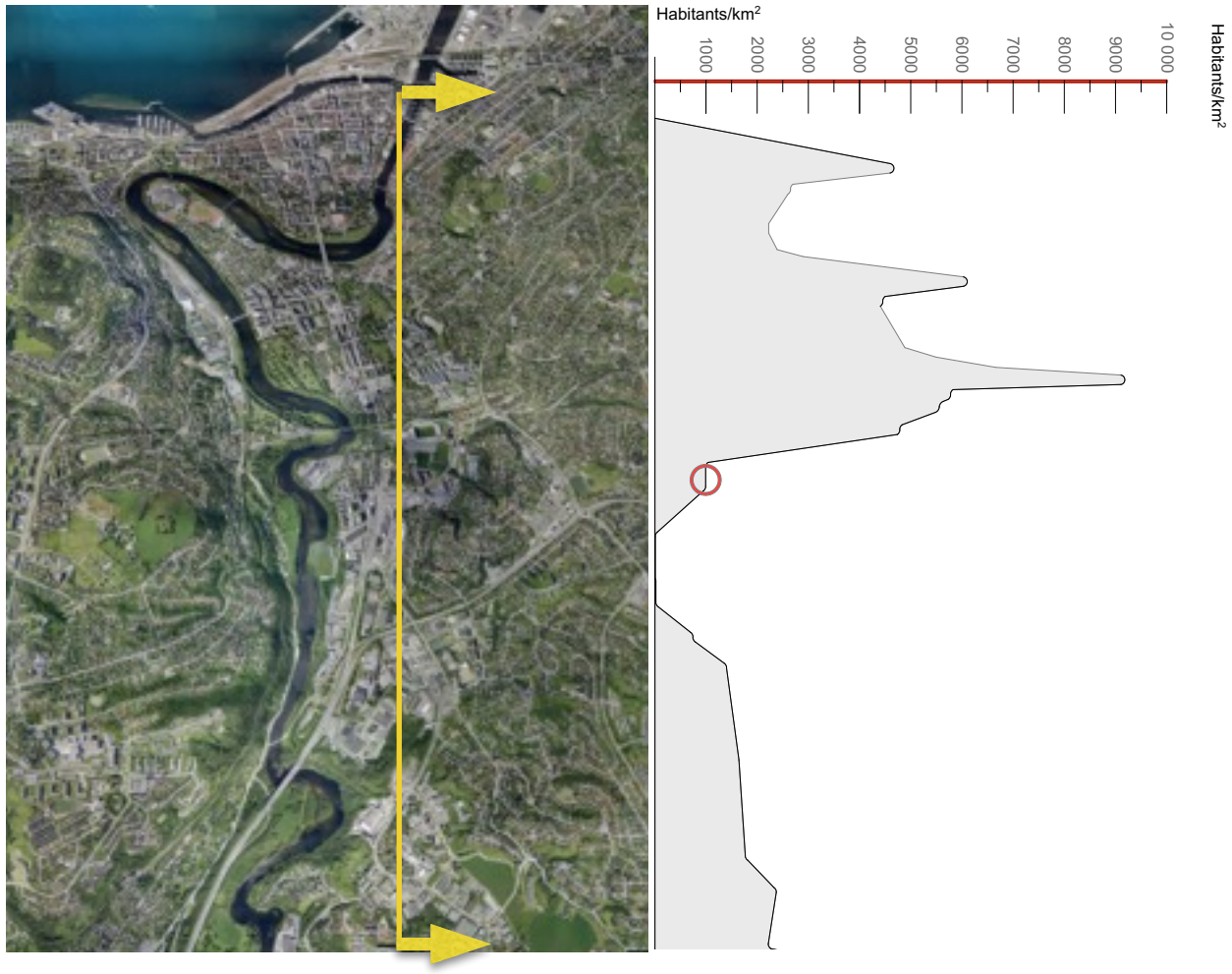
What I want to achieve in this project is to build a prototype of an apartment that is socially inclusive and sustainable. These are the topics and sub-topics that I want to work with in the process:

1. *Social integration*:
- Meeting places
- Mixed use / multiuse
- Food production

2. *Yearly energy budget:*
- Energy production
- Energy comsumption per capita
- Light/ventilation

3. *Environmental footprint on a life cycle*:
- Area efficiency
- Materiality, local vs. global
- Walkability

There will not be enough time to look deep into all of the aspects of this project. But I will look at some of them in particular, and briefly discuss the other themes, as I feel many of them overlap.




Satellite photo of Trondheim and a section showing density and how it decreases according to the distance to the city center. My intention is to increase the density in the Tempe area. (Photo credits: Google Earth).

## 5. Methodology:

The process will consist of three phases. First, I will do an analysis and collection of data. I will look at Trondheim and the development in recent years and look at the typologies being built. I will also look into the energy usage of people in the city and try to discover ways to save energy, and also the available technologies for energy efficiency.

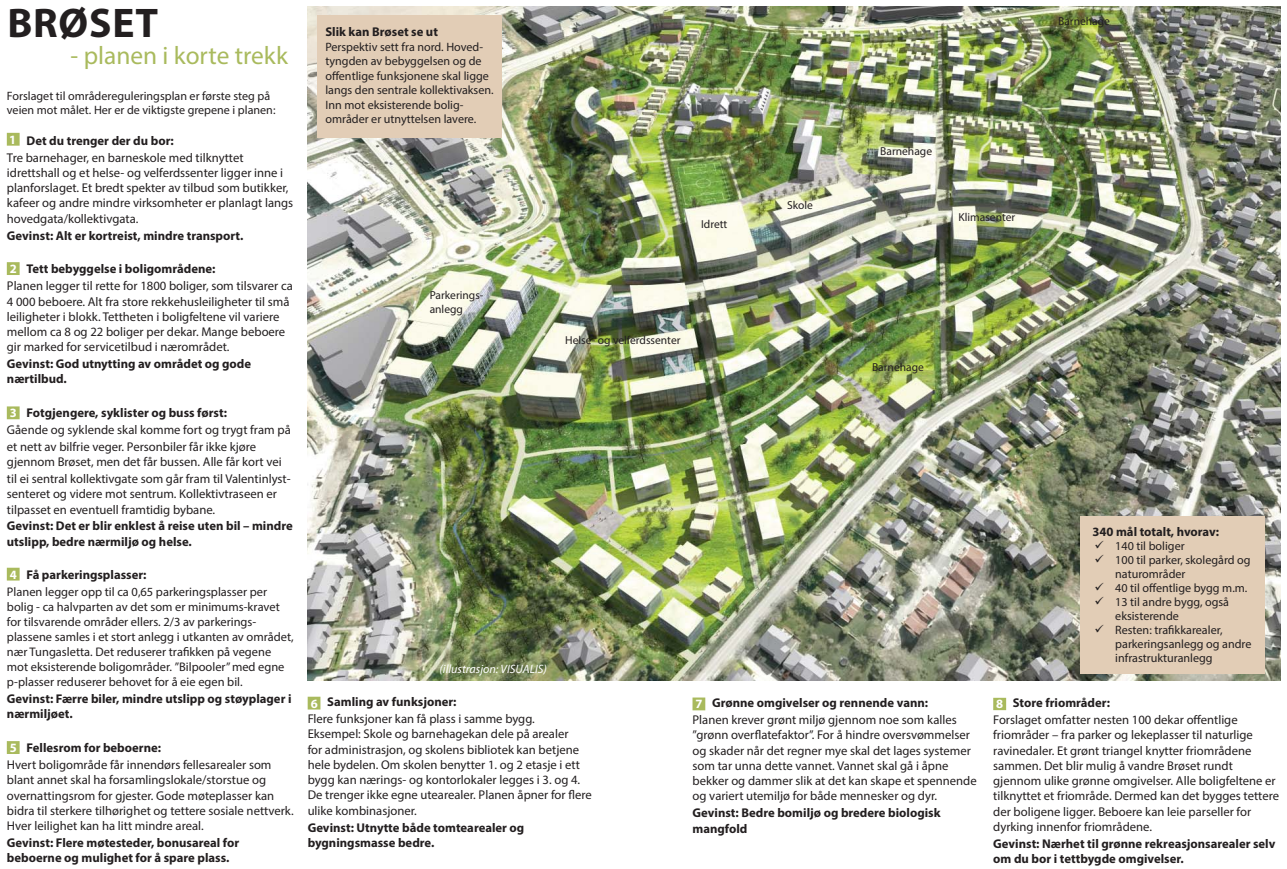
The second phase will be a design project, where I will propose a prototype of an apartment. This will be one apartment, applying the discoveries in the first phase.

The resulting prototype will then be put together with more of the same apartment, and small variations of this, to try to compose a bigger unit. Here, I will look at different typologies and try to optimize the chosen plot and try to compose the most efficient typology.

At the end of the project I will evaluate the impact and the efficiency of my project, and see whether I succeeded or not. I will look at the potential and also reflect on where I could have taken the project in different directions and what I would develop further, if given more time.

## 6. Reference projects:

I will also take the time to look into two different reference projects, that will try to achieve some of the same goals as I do. One of them is Brøset, a new part of Trondheim, developed with the intention of becoming less reliant on car transportation. The Brøset Project in Trondheim. This is an ecofriendly area planned to be built. We can see that it has an area with dwellings where the dwelling density is 13 units/decare.




*Source: Trondheim Kommune.*

Another reference project is the Eco village in Hurdal, a municipality in Akershus County, Norway. They have built very eco friendly and focused on materials that are environmentally friendly and focus on farming as an activity for the population living there. And at the same time, it also focuses on area efficiency inside each house and limited energy use.


Hurdal Eco Village

**7. Sources:**

Books:

Booth, C., Hammond, F., Lamond, J. and Proverbs, D., (2012) *Solutions to Climate Change Challenges in the Built Environment*, Oxford, Wiley-Blackwell

Internet:

Satellite Images from Google Earth

Population and density numbers:
Analysis based on numbers from trondheim.kommune.no