Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Natural Resources and Agricultural Sciences

Opportunities in rooftop greenhouses in Stockholm

– A study of the potential of commercial rooftop greenhouse urban agriculture in Stockholm

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Preface

I am very pleased to have accomplished this thesis. After having reviewed more than fifty articles, I am truly inspired of the alternative agriculture methods and the development of urban agriculture seen throughout the World. For me this has been an unexplored field and new theme under the sustainability umbrella. Even if it has been present for a long time I have somehow overlooked it. I sincerely hope that this development will be seen in more countries all over the World as a way to promote food security, reduce farmings impact on our environment and to foster a sustainable development.

My gratitude goes out to all the people who have had a great contribution to my thesis work. First of all, I want to thank my supervisor, Christine Haaland, for her insightful advice and constructive criticism. She has provided me with good tutorial and support throughout the whole thesis and I warmly recommend her. I would also like to thank Anders Larsolle, who has provided me with helpful information and guidance through the GIS method.

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Sincerely

Felicia Sen

Uppsala, 25th of January 2018

Abstract

Due to climate change, our resource depleation, population growth and further, our reliance on the world's food production creates vulnerabilities and we need to find alternative agriculture methods. Commercial rooftop greenhouses are developing all around the world and to Stockholm this create an opportunity to produce food all year. The aim of this thesis was to explore the potentials of commercial rooftop greenhouse urban agriculture in the city of Stockholm. Three methods were combined consisting of a qualitative and quantitative approach. Four companies that practice urban agriculture was studied, Bee Urban, Coop, Grönska and Plantagon. The results indicated that 490 roofs had potential and where 114 among these were better suited for a greenhouse. The combined methods approach showed that the areas Enskede-Årsta-Vantör, Bromma, Hägersten-Liljeholmen, Skärholmen, Rinkeby-Kista, Östermalm and Kungsholmen had better potential for larger operations considering the buildings and the industrial areas where most of these were placed in. Industrial symbioses, larger operations and a low-cost strategy was further identified to be better used in these areas. Södermalm and Spånga-Tensta had least potential for a rooftop greenhouse and were better suited for smaller operations if implementing one e.g. using a community supported agriculture business model. Finally, this thesis shows where and how a potential commercial rooftop greenhouse can be implemented and operated in the city of Stockholm. Further on, it suggests an alternative way of agriculture and to minimize our impact on the environment and how we can work to foster a sustainable development and a sustainable urban planning.

Keywords: Alternative food networks, business model, business strategy, commercial urban agriculture, rooftop greenhouses, short food supply chain

Summary

In a historical perspective, urban agriculture has always been part of the city in developed countries, where agriculture and cities have been closely interwoven. During the years, urban agriculture has for a long time been marginalized from the urban sphere but has recently started to redevelop. Due to the climate change, our resource depletion throughout the world, the growing population in urban areas and our reliance on the world's food production creates vulnerabilities and have influenced among other factors the redeveloping of urban agriculture.

Urban agriculture comes in many forms and under the urban agriculture umbrella one of the emerging technologies are rooftop greenhouses. For people living in the larger urban areas, especially those living in densely populated areas, the concept of cultivating food on a larger scale within our city limits may sound as utopia. However, commercial rooftop greenhouses are both evolving and being developed around the world and where most of these are located in North America. This thesis has studied the potential of commercial rooftop greenhouse urban agriculture in the city of Stockholm. In this context commercial means that it is possible to run these greenhouses as a profitable enterprise or company.

For the city of Stockholm, this creates an opportunity to produce food all year round even with its northern climate and to increase its food self-sufficiency as well as contribute to a sustainable urban development. To explore the potential of commercial rooftop greenhouses in the city of Stockholm, a two-dimension approach was used.

By analyzing the existing companies within the segment, that are or aim to practice urban agriculture in central Stockholm there are learning to be gained regarding business strategies and business models that could be used. The second dimension is studying how many roofs are potentially suitable for a greenhouse in the city of Stockholm by using GIS.

The study showed that the companies Bee Urban, Grönska and Plantagon operate partly in other ways than conventional agricultural companies. There is not one uniform way to be successful in this segment. Coop, the fourth company studied, was identified to use their urban agriculture as a secondary purpose, marketing, and where the activity is to educate their customers about urban agriculture and the environment. Due to the large amount of buildings found in the study area, municipality of Stockholm, the study further showed that the city of Stockholm has a good potential to implement rooftop greenhouses and where both smaller to larger operations could be made.

Further on, the districts within Stockholm municipality showed a high potential of implementing larger greenhouses on industrial buildings and where industrial symbiosis could occur. This thesis demonstrates that the city of Stockholm has a good potential for implementing a commercial rooftop greenhouse. Further on that a great amount of food can be produced locally and foster a sustainable development and a sustainable urban planning.

Sammanfattning

Sett utifrån ett historiskt perspektiv har stadsodling alltid varit en del av staden i de utvecklade länderna och där jordbruket och städerna har varit nära sammanbundna. Under åren har stadsodling länge varit marginaliserat från städerna men har nu på den senaste tiden börjat komma tillbaka. På grund av klimatförändringarna, våra minskande naturtillgångar, den ökade folkmängden i städerna och vårt beroende av den globala matproduktionen blir vi mer sårbara och tvingas leta efter alternativa jordbruksmetoder.

Stadsodlingen kommer i många olika former och en av dem är takväxthus. För människor som bor i större städer, speciellt dem som lever inom riktigt tätbefolkade delar av dessa städer, kan konceptet med storskaligt jordbruk inom våra stadsgränser kännas som en utopi. Men redan idag, både etableras och utvecklas kommersiella och takbaserade växthus runt om vår värld och där de flesta är belägna i Nordamerika. För Stockholm som stad, skapar detta koncept en möjlighet att odla året om, trots vårt nordiska klimat, samt att öka den egna försörjningsgraden av mat. Målsättningen med denna uppsats är att utforska potentialen för kommersiella takväxthus i Stockholm. I detta sammanhang betyder begreppet kommersiellt att det är möjligt att odla i takbaserade växthus som ett lönsamt företag.

För att undersöka potentialen användes en tvådimensionell strategi. Genom att analysera befintliga företag inom detta område som verkar idag eller tänker etablera sig i segmentet kan man dra lärdomar avseende vilka affärsstrategier och affärsmodeller som är lämpliga att använda. Den andra dimensionen som studerats är hur många av Stockholms stads tak som är potentiellt lämpliga för växthusodlingar och där detta studerades med hjälp av GIS.

Studien visar att företagen som undersökts, Bee Urban, Grönska och Plantagon har delvis olika sätt att verka jämfört med traditionella jordbruk. Det visar att det inte finns ett enda sätt att verka inom segmentet. Det fjärde företaget i studien, Coop, använde sin stadsodling med ett sekundärt syfte, marknadsföring och där denna aktivitet innebar att utbilda sina kunder om stadsodling och miljöarbete. Det stora antalet tak som hittades visar också på att Stockholm har en stor potential för takväxthus och där både mindre och större företag skulle kunna drivas.

Vidare visar denna uppsats att det finns stadsdelar inom Stockholms stad som uppvisar en hög potential för att etablera storskaliga växthusodlingar på byggnader och där industriell symbios kan uppstå. Uppsatsen visar vidare att Stockholms stad har förutsättningarna för att producera stora mängder mat lokalt och på så vis även bidra till en hållbar utveckling och stadsutveckling.

Abbreviations

AFN = Alternative food networks (Gliessman 2007; Wubben, Fondse & Pascucci 2013)

RTG = Rooftop greenhouses (Pons, Nadal & Sanyé-Mengual et al. 2015; Specht, Siebert & Thomaier at al. 2015)

SFSC = Short food supply chain - (Wubben et al. 2013)

UA = Urban agriculture - (McClintock 2010; Lin, et al. 2015)

Definitions

Building footprint area
The buildings rooftop area (Berger 2013).

Business model
A business model is seen as the structure of a company and explains how value is created, captured and delivered to its customers, with the purpose of making the company profitable (Pöllng, Prados, Torquati et al. 2017; Richardson 2008).

Business Strategy
A strategy is a pattern or a plan that incorporates a firm's major goals, activities and policies into a cohesive whole (Mintzberg, Quinn & Ghoshal 1999, p.5). A well-formulated strategy helps to allocate the resources of a firm, take a defensive or offensive action that helps create a defendable position in an industry and generate high profit (Porter 1998, p.34; Mintzberg et al. 1999, p.5).

Clean tech
Clean tech is interpreted as a technology that has a lower impact on the environment, e.g. lower emissions, less usage of natural resources, compared with conventional technology providing similar services or products. Furthermore, it covers renewable energy generation, energy efficiency and storage, improved resource efficiency in terms of water and waste management and more (Gosens, Lu & Coenen 2015).

Commercial urban agriculture
Commercial urban agriculture refers to all organizations or companies that uses urban agriculture for-profit.

Conventional
Conventional food production, or conventional agriculture, consists of extensive inputs in the food production process. It uses an industrial process and produces a great quantity of food to a lower price (Morgan & Murdoch 2000) compared to the traditional that uses more labor and local resources available (Gliessman & Engles 2015, p. 288).

Hydroponic
Hydroponic system is a cultivation technique consisting of cultivation of products with no earth. The basic concept is that the roots of the products absorb the nutrients and oxygen directly from the water (André & Jonsson 2013).

Profit margin
After paying all the variable and fixed costs for producing a product or service the profit is left, if there is one. If it is a low margin, the profit is low, and a high margin the profit is high. This is based on the assumption that critical sales volumes is achieved that covers the fixed costs.

Short food supply chain
Short food supply chain refers to a shorter food supply chain e.g. compared to the conventional agriculture which uses several steps before it reaches the end customer or consumer.

Traditional agriculture

Traditional agriculture was developed in times where only human and local resources were available, and where non industrial imputs are not or less frequently used. Traditional farming has similar production today and usually satisfy the needs to closer market demands, like regional or national level (Gliessman & Engles 2015, p.288).

Triangular method

Triangulation method is a method used for enhancing data from multiple sources. When using a data triangular method, more than one qualitative data collection method is done, for example using interviews, documents and observation. A methodological triangulation refers to the combination of a qualitative and quantitative methods (Bryman 2012, p.153).

Urban agriculture

The definitions of urban agriculture vary, but in its essence it is the production of crops and plants, the processing and distribution within urban areas and which in general are integrated into the economic and ecological system (Lin et al. 2015; Wedeberg 2016; Krishnan, Nandwani, Smith, Kankarta 2016). This is also how it is distinguished from the rural agriculture which in contrast to urban agriculture is not integrated in the urban ecological nor the local urban economic system.

Urban rooftop farming/agriculture

Farms or agriculture that are located on a rooftop (Buehler & Junge 2016).

Zero acre farming

Zero acre farming, or Z-farming, are urban agriculture activities that do not exploit and use open spaces or farmland (Buehler & Junge 2016). It is practiced on top of buildings, or as vertical gardens or indoor farms (Thomaier, Specht, Henckel et al. 2014).

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1 Introduction

Often, the question of urban agriculture is posed as: *"Is it realistic to grow food in urban areas?"* This is a critically important question. Yet I start by posing a dramatically different discussion: *"When oil gets scarce and expensive, how would any city survive unless it grows much of its own food?"*

(Meter 2016, p.39)

Human activities are affecting the climate and resulting in higher carbon emissions in the atmosphere. The processes can affect the climate with a great variability such as extreme weather or climate events (Cubasch, Wuebbles, Chen et al. 2013). Combined with natural resource depletion, these set the conditions and framework within which urban cities must adapt. In general, the future course must be heading in the direction towards a more energy and resource efficient society as well as a more sustainable production and operation. The increased global urbanization also results in increased challenges for the cities (The Delegation for Sustainable Cities 2012). To mention a few, food, water and energy security are concerns for many municipalities (Moglia 2014; Saha & Eckelman 2017).

According to Despommier (2013) in order to provide food for the whole world the global agriculture uses an area larger than South America. In this estimate the areal for grazing is not included. The large scale agriculture also comes with significant environmental costs such as deforestation, loss of biodiversity, soil depletion (Saha & Eckelman 2017). Our waterfootprints on the conventional agriculture sector further results in water scarcity risk and contamination of water bodies where the agriculture occurs (Sanyé-Mengual, Rierdevall, Ignacio Montero in Orsini, Dubbeling & de Zeeuw et al. 2017, pp.268-269). Furthermore, our demand is not often close to the supply and our reliance on the world's food supply chain creates vulnerabilities (Sjöström 2012; Moglia 2014; Saha & Eckelman 2017).

"The food chain is fragile, if one link fails we stand without food"
(Forsberg in Sjöström 2012)

To promote food security, an increased food production in many cities has emerged as a means to meet the global demand (Moglia 2014; Huang & Drescher 2015; Lin et al. 2015; Saha & Eckelman 2017). Choguill (1995) in Moglia (2014) summarized three key drivers to produce food in the cities: ability, necessity and opportunity.

Urban agriculture has for developed countries partly been seen as recreation, and for developing countires mainly as food security (Krishnan, Nandwani, Smith et al. 2016). The authors further claim that to developed countries, in addition to the recreational benefits, the social interaction and the nutritious food that the locally produced food can provide has also been of importance. To the developing countries, self-employment has further been a crucial factor as it generates revenues and contributes to a better local and social stability (Krishnan, Nandwani, Smith, et al. 2016). The points of view regarding urban agriculture now seem to have changed in the developed countries and where they now recognize the additional benefits of urban agriculture, UA (Krishnan, Nandwani, Smith, et al. 2016), interpreted as becoming more self-sufficient on food, the effects on the environment and further. Huang & Drescher (2015) reveals that many municipalities now strive for establishing edible landscaping, greenhouses and urban farms. Cities are incorporating more agriculture policies. The majority of these cities and municipalities are located in the Northern hemisphere (Huang & Drescher 2015). In addition, there is growing evidence that shows that incorporating appropriate urban agriculture leads to a more sustainable city, especially if these systems take advantage of resources and markets locally available (Lovell 2010).

There are several challenges for integrating agriculture in a constrained urban landscape and the debate has mostly centered on the land use of urban agriculture and its advantages versus other kinds of urban development (Lovell 2010; Lin et al. 2015; Huang & Drescher 2015). Further on, producing food in the urban sphere also comes with challenges such as limited land, contaminated soil and high labour costs (Liu 2015). The competitions between different actors interested in using the space is also an issue as it jacks up the price of real estate (Ivarsson 2016). Despite this, urban agriculture has managed to grow in many cities of the Northern hemisphere (Huang & Drescher 2015).

In Sweden, the interest in general for niche products such as environmentally friendly organic or locally produced food increases throughout the country. Regardless of this, the total production of food decreases in Sweden, a trend that been on-going since the nation´s entry into the European Union (Andersson in Wedberg 2016). In Stockholm, more citizens are becoming engaged in city farming and the interest is shown by the emerging of rooftop farms, cultivation on balconies, garden boxes and more (Fröjd 2014). This is in line with Bönnischen (2016) who also did identify this trend. The driving factors seem to be the densification and the reduction of green areas (Fröjd 2014). Other drivers are a raised food awareness and the enjoyable hobby of practicing urban agriculture. Furthermore, toxins, DNA modified vegetables, inferior workings conditions among agricultural workers and political agendas have influenced the citizens of Stockholm (Schaffer in Fröjd 2014). Another example, which further indicates the new demand, is IKEA who are focusing on home cultivation kits (IKEA n.d.). Other actors are also interested in urban agriculture and the development of the same. In Gummerson (2017) it was revealed that at the Royal Institute of Technology in Stockholm (KTH) they are planning to build a greenhouse placed on campus with the objective to inspire and to foster a greener food production. KTH aims to further show their competences within technology, cultivation of aglae and herbs, combined fish and vegetable cultivation. Lastly the greenhouse aim to work at an educational environment for students and a meeting place for the citizens of Stockholm (Gummeson 2017).

In the research of André and Jonsson's (2013) it was revealed that the major environmental benefits do not seem to occur in the locally cultivated production. Specially when it comes to the Nordic climate of Stockholm, with a shorter time of production of agriculture compared to warmer countries, larger production volumes seems unlikely. However, this does not imply that a broader urban agriculture practice in Stockholm is not worth to implement, the authors adds. The higher environmental benefits seem to be gained when circulation of flows occur compare to otherwise linear city flows, the improved biodiversity, the opportunity to biological waste treatment and the increased carbon sequestration (André & Jonsson 2013).

Forsberg in Sjöström (2012) argued it is crucial to find alternatives to agriculture and that Sweden will need to exploit unused space in larger urban areas. The arguments are that we are about to face an energy resource crisis whilst the global economy is near to collapse (Forsberg in Sjöström 2012). Further on, this is also argued by Hallett (2016, p. 27) that it is of importance to integrate alternative agriculture *before* our systems begin to collapse. Our resource depleation, and ecological decrease are in an inescapable collision. The fossil fuel crisis will converge with our decreasing water and soil resources and where all of this will occur in a world with climate change further pressuring our agriculture land (Hallett 2016, p. 24). In spring 2017, the Swedish Government launched a new food strategy stating that we must become more self-sufficient. Moreover, they also encouraged more innovative solutions (Regeringen 2017) (The Swedish Government), and concluded that urban agriculture could be one solution to meet these needs. The European Commission (n.d.) are also working on the Europe 2020 strategy, and how UA could help supporting it. The last four years the European Commission has been elaborating on urban agriculture, and the main conclusions and important policy recommendations are summarized in a book that aim to help develop the potential of urban agriculture (European Commission n.d.).

It is important to note that it is not feasible to become self-sufficient relying only on urban agriculture (Rasmusson 2017; Saha & Eckelman 2017). Gliessman (2007, p.18) further elaborates that we cannot fully abandon the conventional practices to supply all dwellers in the urban areas. We will need to use both practices, urban agriculture and the conventional food systems, in order to produce the amount of food we require. What is further needed is a new approach; a more sustainable practice in resource-conserving, while at the same time using ecological knowledge and methods in the development of sustainable food systems (Gliessman 2007, p.18). In the urban context of producing food, Huang and Drescher (2015) stresses that cities should focus on the commercial potential of urban agriculture such as greenhouses and urban farms which can produce food in larger quantities, given that citizens focus on the community agriculture and rooftop gardens or similar.

In many Northern cities such as Amsterdam, Berlin, New York, Montreal, St Petersbourg and more, have developed urban agriculture. In these cities a wide range of different technologies, solutions, production systems and actors have emerged (Mougeot 2006, pp. xiv-xv; Berger 2013). One of these technologies is commercial rooftop greenhouse urban agriculture and rooftop farms and today there are many examples worldwide (Hedin 2015). It is also seen as a resource effective option since it generate new agricultural spaces in the urban sphere without exploiting new area (Pons, Nadal, Sanyé-Mengual et al. 2015). Other reasons the rooftop greenhouses and open farms have been placed on roofs are due to the high landlease costs and competition of real estate in urban areas, Berger (2013) reveals in her study of New York. The comparatively low revenues that urban agriculture brings cannot compete with other types of urban development such as housing. Despite the lack of land, urban planners have noticed the importance of local food production and the integration of urban agriculture in the long term planning (Berger 2013). The trend clearly seems to come from North America according to Buehler & Junge (2016) where 70% of all rooftop farms open and closed in the world are located. Their, the North Americans, main purpose of rooftop farms is to increase quality of life. They refer to healthier and more nutritious food as well as to educational and social purposes (Buehler & Junge 2016). The second most common purpose for rooftop farms was for commercial purposes and where all of theese are using hydroponic systems (Buehler & Junge 2016). Moreover, implementing large scale operations at relatively high latitudes is feasible and this has been shown in several studies (Haberman, Gillies, Canter et. al. 2014). Looking more specifically into rooftop greenhouses, RTGs, has significant advantages in energy, water and carbondioxide flows and they are also more protected in contrast to rooftop farms (Montero, Baeza, Muñoz et al. 2017, pp. 83-84). Most of the commercial greenhouses produces salads and herbs, but tomatoes and fruits have also been identified as interesting crops in some of the greenhouses (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015).

Meijer (2015) concluded from a research study carried out in Sweden that commercial rooftop greenhouse urban agriculture has potential in Sweden, where exact was not specified in the study. What was criticized in the study of Meijer (2015), was the economic viability. Commercial operations run by the private sector were thought to be more economically feasible due to the large demand of energy. Rooftop greenhouses, compared to many other types of agriculture in the cities and in contrast to the conventional agriculture, also allows for cultivation throughout the year (Meijer 2015), and could therefore be a good complement to the conventional agriculture during the colder months (Haberman, Gillies, Canter et al. 2015). The results of Meijer´s (2015) showed that there was a discussion of what kind of business model that could be applied, in other words, what may the operations would look like or what kind of operation could be runned for commercial RTG. In another study by Wedeberg (2016), focusing on greenhouses on top of buildings in the city of Malmö, it was acknowledged that most of the interviewees believed in niche commercial companies or combined usage, for instance a marketing tool for companies or social business models, as a method for rehabilitation or for pedagogic purposes and more. The reason why the respondents in the research, (various people within the food sector), believed in commercial rooftop greenhouses is because of the development and emerging commercial rooftop greenhouses seen around the world (Wedeberg 2016).

According to Fröjd (2014) Stockholm was the last of biggest cities in Sweden to adapt urban agriculture when compared to Gothenburg and Malmö. Furthermore, Stockholm differs from many other Northern cities that have applied commercial urban agriculture, in demographics and population. As most of the conducted research regarding of commercial UA in Sweden has been centralised to the Southern parts, the literature exhibits a gap as for the situation in

Stockholm. Given this fact, it leaves space and an opportunity to investigate the potentials for commercial rooftop greenhouse urban agriculture in Stockholm.

1.1 Aim, research questions and delimitation

The aim of this thesis is to explore the potentials of commercial rooftop greenhouse urban agriculture in the centre of Stockholm and to serve as a research basis for the future decision making for new potential business makers, as well as for general knowledge base for the municipality of Stockholm, for urban planners and for other actors interested in urban agriculture. Furthermore, this thesis aims to provide possibilities in how to work with sustainable urban development.

Research on the economic advantages of urban agriculture and profitability of commercial rooftop greenhouses has been conducted in Sweden (Gullers 2015; Meijer 2015). The profitability was considered possible and especially if the company uses the waste resources the urban sphere provides, such as rainwater or residual heat from buildings (Meijer 2015). Gullers (2015) concluded that UA has a clear competitive advantage if it provides superior products of high quality. How this could be done has not been researched in the context of Stockholm, rather speculations on how it could emerge as previously mentioned. This leaves a knowledge gap in understanding how commercial urban agriculture could evolve in the Stockholm market.
Today there are only four practicing urban agriculture in Stockholm, Bee Urban, Coop, Grönska and Plantagon. To explore which kind of business models that are used today by these can give an insight in how these kinds of business can be operated.

A business model is seen as the structure of a company and explains how value is created, captured and delivered to its customers, with the purpose of making the company profitable (Richardson 2008; Osterwalder & Pigneur 2010; Pöllng, Prados, Torquati et al. 2017).

Furthermore, the business model has in the reality a more complex integrated system of components (Pöllng, Prados, Torquati et al. 2017). A good strategic management template is the *Business Model Canvas* (Pölling, Prados, Torquati et al. 2017). It is a simple framework which could be used as a guideline when creating, developing and visualising the business model and there are multiple opportunities and alternatives of how these may look like (Osterwalder & Pigneur 2010).

In the context of commercial urban agriculture Wubben, Fondse and Pascucci (2013) argue that there are only a few researchers that have studied commercial urban agriculture companies from a business perspective. Gliessman (2007, pp.334-337) identified a few commercial business models that originated from concept alternative food networks. These networks are similar to the conventional agriculture but use a shorter food supply chain (Wubben Fondse and Pascucci 2013). In current research, Hedin (2015) managed to identify the most commonly used business models within for-profit urban agriculture in developed countries worldwide. Together the

models of Gliessman (2007, pp.334-337) and Hedin (2015) these shape a solid framework of business models used within commercial urban agriculture.
Richardson (2008) states that a well-designed business model creates an overview of the model and its activities with a consistent logical structure to execute the strategy. According to Porter (1998, p.34) a company's business strategy helps a company to position itself on the market, and using only one strategy is to prefer as one can risk losing focus and get "stuck in the middle". Van der Schans (2015), has in contrast to Porter found that within the European for-profit urban agriculture sector that is quite young and has yet to find its form, the urban agriculture companies uses several strategies (Van der Schans 2015).

As previously noted, urban agriculture distinguishes itself from the conventional agriculture (Gliessman 2007, pp.334-337). Wubben et al. (2013) elaborates on alternative food networks and identifies a crucial part of the urban agriculture business model, the short food supply chain, which according to Hedin (2015) has a central role in business model. It was further noted that this is how value is created and transparency is made (Wubben et al. 2013; Van der Schans 2015). Moreover, it is also how higher profit margins could be reached (Wubben et al. 2013) since urban agriculture differs from the conventional agriculture in this aspect (Gliesman 2007, pp.334-337) using fewer intermediaries as the urban agriculture is already close to the customer (Wubben et al. 2013).

For these reasons, it is of importance to study the business models, their strategies and the supply chain of the commercial urban agriculture companies in Stockholm in order to gain and understanding in how these firms operate. This leads to the first two research questions of three:

RQ 1: What are the current business models and strategies of the commercial urban agriculture companies in Stockholm?

RQ 2: What are the supply chains of the for-profit urban agriculture firms in Stockholm?

Such an analysis also needs a further investigation of where a greenhouse can be implemented to fully answer what is the potential Stockholm could offer for commercial urban agriculture. According to the researchers André and Jonsson (2013), site specific solutions combined with urban agriculture greenhouses were identified to be possible. Further more, the results also showed that industrial ecosystem, e.g. using the buildings waste heat as in a symbiosis, offer a potential in Stockholm and the authors suggested looking into where these industrial symbioses could become reality. In another study conducted years later, it was found that stakeholders in Sweden wanted help to know where a greenhouse could be implemented as such an investigation takes a lot of resources in terms of time to find out where it could be placed (Wedeberg 2016). While several studies ask where a commercial urban agriculture greenhouse can be placed and implemented, this thesis attempts to explore the following unanswered question.

RQ 3: How many roofs are potentially suitable for a greenhouse in the city of Stockholm?

To gauge the aim in this thesis, these two elements, *how the commercial urban agriculture companies in Stockholm operate* and *the potential roofs for implementing rooftop greenhouses*, are considered to be complementary to each other and to give a more holistic comprehension. Holistic, by the means of piecing together evidence from different methods (Alasuutari, Bickman & Brennon 2008, p.592). Furthermore, the elements of analysis in this thesis, are considered to answer the aim and sort out the unexplored field of what potential the city of Stockholm has for commercial rooftop greenhouse urban agriculture.

Stockholm

Since the city of Stockholm is too big in size, to study all areas, regarding suitability of roofs for rooftop greenhouses, within the city is not feasible. For that reason this thesis is limited to certain districts of Stockholm. The specific districts of the city have been chosen with consideration to the scope of this thesis project.

According to Stockholms Stad (2017), (the municipality of Stockholm), Stockholm is one of the top five fastest growing urban regions in Europe. Stockholm municipality holds a population of approximately 935 000 inhabitants (2016) (Stockholms Stad 2017), the whole city consists of a population of 2,27 million. In total Sweden has 9,995 million inhabitants (2016).

The map below provides a simple visualisation of the Municipality of Stockholm. The total area is 187km^2, water is excluded, and 40% consists of parks and green area, The population density is 5 inhabitants per square kilometre of land (2015) in the Muncipality of Stockholm (Stockholms Stad 2017).

Map 1. Based on data sets provided by: Stockholms Stadsbyggnadskontor (2017)

There are in total 14 district administrations and where 10 of these areas will be used in this thesis, the dark green areas in the map (Stockholms Stad n.d.). A further explanation to how these specific areas was chosen is described in Chapter 2, Methodology, section 4.3.2.

Delimitations

This thesis project will not have capacity to study the technical aspects of implementing rooftop greenhouses e.g. building construction. Neither will policies nor other legal constraints be taken into account. More information will be provided in the following chapter, Chapter 2 Methodology.

2 Methodology

2.1 Outline

This thesis consists of an Introduction (Chapter 1), Methodology (Chapter 2), Theoretical framework and Conceptual framework (Chapter 3), Literature review (Chapter 4), Results (Chapter 5), Discussion (Chapter 6) and Conclusion (Chapter 7).

The purpose of Chapter 1 is to capture the reader's interest as well as to explain the purpose and aim of this thesis. Chapter 2 aims to explain why and how the methods were conducted, to examine and evaluate the chosen methods and to explain the further limitations made in this study. Chapter 3 aims to provide a solid framework of theories that will be used for to analyze the Swedish urban agriculture companies in Stockholm and put it in a comprehensive academic context. Chapter 4, provides the literature found within the frame of the topic in this thesis. Chapter 5 shall present the empiric data gained from the interviews, further data collection and the data conducted from the GIS study. Chapter 6 analyses and discuss the research findings from the Swedish urban agriculture companies, the GIS study and literature review, and answers the three researches question in this thesis. It further provides a section of limitations of study. Chapter 7 shall provide a conclusion of the most important findings, answer the aim and provide a section of suggested further research.

2.2 Research Design

The thesis seeks to understand what potential the city of Stockholm could offer for commercial rooftop greenhouse urban agriculture. Where a potential greenhouse can be installed and how it could be operated. To answer the aim of this research, a data and methodological triangular method approach was used, namely three different methods were combined to act complementary to each other and to give a more holistic perspective (Alasuutari, Bickman & Brennon 2008, p.592; Bryman 2012, p.153).
A qualitative approach in forms of a literature review and interviews was conducted. The method consisting of a literature review had two purposes and it aimed at giving a general background information for this thesis and for the theoretical framework. It further had the purpose of being a complementary literature review to the quantitative method, the GIS study.
The second method informs of interviews was conducted to gather a larger amount of data from a few resources (Robson 2011, p.19) in order to gain an in-depth understanding for what kind of operation could be applied and to answer the two first research questions in this paper. "What are the current business models and their strategies of the commercial urban agriculture companies in Stockholm?" and "What are the supply chains of the for-profit urban agriculture firms in Stockholm?"
Last the third method. The study also uses an explorative approach, with a quantitative method, a case study to find unused urban spaces in Stockholm to answer the third research question, "how many roofs are potentially suitable for a greenhouse in the city of Stockholm?"

2.3. Theoretical framework

When developing the theoretical framework and choosing the theories, this occurred in a parallel process to the literature review, which had the purpose of providing an understanding for how the different theories had evolved and to give a general background of the researches they been derived from.

The theories for the theoretical framework were carefully chosen. Consideration was taken for what purpose the theories have, in this case business model or a business strategy. Further on, what data the research consisted of, in this case, only literature on studies on urban agriculture in developed countries were selected. Preferably, researches that contained cases in several developed countries rather than studies refering to only one country as the former contain a wider and more broadened data. As an example, in this thesis, investigating in what business models that are used, a theory that could explain most of the commercial agriculture companies' business models was therefore desired, e.g. Hedin's (2015) research.
One exception, some of the researchers did not distinguish community farms from urban agriculture in their research, but according to Hedin (2015) many urban agriculture companies shared similar business models as community farms. This is why the theory was included in the theoretical framework. Another argument is that very little research has been conducted on business models within commercial urban agriculture (Wubben et al 2013; Gullers 2015; Pölling, Lorleberg, Orsini et al. 2015) which in this case made it hard to require literature that specifically focused on commercial urban agriculture. A final argument, when choosing the theories, some of the ones chosen were used as a base in other theories for example the research of Van der Schans' 2010 which for that reason made the current research studies more reliable, e.g. Van der Schans 2015 research or Pölling Prados Torquati et al 2017.

2.3.1 Conceptual framework

The conceptual framework has the purpose to help conceptualising the theoretical framework and to provide the reader an understanding for how these theories are connected to each other.

2.3.2 Literature review

To gain an understanding for commercial urban agriculture and to define the *first two* research questions for this thesis a literature review was first conducted. Further on the review also served as a background, to help identifying relevant theories, framing the 'Theoretical Framework' and serving as a complement to the quantitative and qualitative method.

Using the third method literature review as complementary in this thesis refers to as Alasuutari, Bickman and Brannen (2008, p.592) describes it, finding additional data that is directly related to the other data collection and can be discerned only together. Furthermore, the data set should be either theory driven or have a specific purpose, and where the latter is the intention for this thesis.

A systematic literature review was conducted, reviewing a particular subject (Bryman 2012, pp. 92-93), was chosen as to provide an understanding for the subject and to find how this research could contribute with new knowledge within this field (Bryman 2012, p. 95).

Primarily, main focus was to find studies on commercial rooftop greenhouses urban agriculture worldwide. Furthermore, that the literature primarily been conducted in developed countries with similar climate and demographics to achieve a better understanding for the subject. Secondly, was to find researches in Sweden to get an insight in what has already been conducted. In this way the literature review helped to shape the objectives of this research. Furthermore, as the two research questions were shaped, a literature review on business models, distribution and the market used in commercial urban agriculture was also conducted in order to help framing the theoretical framework. Based on the literature review, theories for the theoretical framework that would be best suited to meet the purpose of the essay, were in this way also identified and later on applied.

The literature conducted in this research were searched through, ScienceDirect, Sweden University of Agriculture Sciences Library search engine, Uppsala University Library search engine, Web of Science and Google Scholar in the order of which has been used most frequently to less frequently respectively. Since commercial urban agriculture is still relatively new in some parts of the world, the material conducted for the literature review exists of several different types of sources. The majority consisted primarily of journals and secondly of other kinds of researches, news articles, websites and published literature.

2.3.3 Limitations and source credibility on 'Literature review', 'Theoretical framework' and 'Conceptual framework'

In the 'Theoretical framework' there has been a confusion in whether the proposed models are business models or strategies.
The business model concept has been applied and used broadly in several researchers and which has thus affected and influenced the choice of the chosen theories for this thesis. Some of the theories that used the business model concept have in this thesis been interpreted differently, e.g. some of the researchers defined their models as business models, and the interpretation in this thesis were sometimes different and rather interpreted as business strategies. To avoid creating a conflict using the theories wrong, the theories were carefully selected due to what the researchers defined them as and also in line what they had been interpreted as in this thesis and were then used there after.
This could have caused an effect that "better" or more "appropriate" theories were dismissed.
For the 'Literature review', since commercial urban agriculture is quite new in Sweden, there is not yet much research conducted that has resulted in other types of data then reviewed literature was used, such as news articles or websites. Further on, one personal message was also used. Finally, information about a few companies has been conducted from respectively website and the information might therefore not be fully objective.

2.4 Interviews

The objective of using interviews has been to gain a greater understanding for how the commercial urban agriculture companies in Stockholm are operating. The interviewed companies were: Plantagon, Grönska and Bee Urban. Quite late in the thesis work it was discovered that Coop also practiced urban agriculture and therefore collection of data through internet was preferably and chosen due to the small amount of time left.

The interview with Plantagon was held in Stockholm at the head office with Sepher Mousavi, sustainability strategist and member of Plantagon International Association Board. Furthermore, it is important to note that this thesis will only study the Swedish operation of Plantagon. It will not take into consider to the other countries within this company.
The second interview, Grönska, was conducted via telephone with Nathalie de Brun Skantz, one of the founders of the company. The time limit of the interview was 20 minutes as the interviewee could not provide more time due to other obligations.
The third interview was with Josefina Oddsberg, acting CEO and Research & Developer at Bee Urban. The interview was conducted via mail.
Moreover, the first two interviews, with Plantagon and Grönska, was conducted quite early during the work on this thesis, and to gain a more broader understanding for commercial urban agriculture in the context of Stockholm, additional questions were asked at a later date.

One of the methods used for qualitative data collection of this paper was made in forms of interviews. It was chosen as the study aims to look into specific cases and gather specific type of data. A semi-structured interview was chosen to more easily adhere to the subject as well as be able to ask further questions if the responses were not clear. It also made it possible to explore answers that had a greater significance for the subject. By using a qualitative method such as interviews in this case also offered a better alternative in order to gain more detailed answers compared to use a survey. Using interviews also enabled the respondent to develop her answer, define or describe an event or situation compared to a quantitative method (Saunders et al. 2009, pp.151-337).
When designing the interviews, an interview guide was developed with questions that served as a basis for the interviews. It was designed according to the ‘Theoretical framework’ and the questions were structured after the theories from the theoretical framework and translated into practical questions. How the interview guide was operationalized is described in ‘Appendix 1’.

2.3.1 Additional data collection

Practical information about the companies was not asked during the interviews due to respect of the interviewees time and instead gained through internet.
The interview with Grönska was much shorter, 20 minutes compared to Plantagon 1h and therefore further data was collected since not all the questions could fit within the time frame.

The interview with Bee Urban that was conducted via mail, the parts that were not clear got complemented by further questions and additional data collection was also conducted to save time for the respondent.
Information about Coop was only conducted through internet sources. A phonecall to Garnisonen was also made to make sure the project was in progress.

2.3.2 Argumentation of the chosen companies

Since commercial urban agriculture is quite new in Sweden (Gullers 2015) and in the context that it starting to redevelop again in the cities, Stockholm does not offer many examples of commercial urban agriculture. All the existing urban agriculture companies in Stockholm was for that reason of interest and chosen for this research. The companies chosen were Bee Urban, Grönska, Plantagon, and Coop. Finally, this thesis will only be studying the respectively operation in Sweden and not include their international operations. This is referring to the companies Plantagon and Coop.
The company Bee Urban is well established, the second one, Grönska is still in the startup phase but have an established network of business partners and a production. The third one Plantagon, have not yet opened their facilities. Coop the fourth company is the only one that is about to practice greenhouse urban agriculture for profit but the activity is relatively new, (not the company), and they are still building it on one of their supermarkets in Stockholm. The latter, the company's main occupation is not within commercial urban agriculture but they use it as one of their activities in their organization. Most importantly though, it is the only actor aim to use a rooftop greenhouse in Stockholm.

2.3.3 Limitations, source evaluation and ethical considerations

As there are only four current operators working and where the majority aim to work with urban agriculture in Stockholm a alternative selection of participants was not possible. For that reason also a more in-depth understanding for how to operate on the Swedish market was limited since these companies have not yet matured.

Vetenskapsrådets (2010) ethical guidelines were used during the interviewing. In addition, not only considering the ethical aspect, these guidelines are also a good method to build trust to the researcher, in order to gain honest responses (Saunders et al. 2009, p. 36).

Vetenskapsrådet (2010) has elaborated four main criteria within guidelines of good science. Firstly, the *Information requirement*, that the respondent gets informed of the purpose and structure of the interview. Secondly, the *Consent requirement*, that it was clearly mentioned that the interview was voluntary and an approval conducted firstly from the interviewee before commencing the recording of the interview. The respondents did also get an opportunity to comment on the empirical data in the thesis before final submission. Thirdly, the *Confidentiality requirements,* that the respondents were reassured that no unauthorized person or persons would have access to the collected primary data before consent was obtained for final submission. Lastly, the *utilization requirement,* that the material gained would not be used for any other purpose than the purpose of this thesis.

Information about Coop was only conducted through internet sources and a full interpretatation of the urban agriculture practice was therefore not possible to obtain. Furthermore, there were similar information on several websites and other information of the project was not found. Another limitation might be that these articles were not fully objective.

2.5 GIS study

The third research question was to identify how many roofs in the city of Stockholm are potentially suitable for greenhouse implementation. To answer the research question a quantitative method using GIS software, geographical information system, was applied.
GIS is a computerized information system that collects data, analyzes, integrates and displays geographical information (Harrie 2013, p.21). Geographical information refers to data that is connected to a certain geographical area. Usually it displays visual information of geographical data, but it could also be used for to make a selection and search. GIS is a suitable tool to use for to analyze different types of data of a specific area and to solve problems (Harrie 2013, p.21). As for example, GIS allows analyzing of geospatial data and could be used to calculate the buildings footprint area (Berger 2013) which is specifically needed in this research when studying which roofs that has potential for implementing a greenhouse. Finally, the key strength of using the proposed method is the GIS capability to create maps and help decision making despite with a minimum of information provided (Amer, Mustafa, Teller et al. 2017).

The programs normally used for GIS should be able to process geographical data from different sources (Harrie 2013, p.21). Within this thesis the software ArcGIS 10.5 was used. The model to identify the roofs was created by using various datasets.

2.5.1 Framing of quantitative method

The purpose of this section is to help framing the quantitative methodology. Various aspects were needed to take into consideration to find the most suitable buildings for rooftop commercial greenhouse urban agriculture. According to Freisinger, Specht, Sawicka et al. (2015), rooftop greenhouses are similar to the ones that are built on the ground, but since they are placed on a roof there are certain requirements of the location of the building and its construction to take into account to find an appropriate roof. Many of these criterias are too time consuming to be studied in this short of time limit. Therefore this method needed to be delimited in order to be accommodated within the timeframe.
Various aspects has been taken into account of the studies of Svännel & Sang (unpublished report) who studied the potential of green roofs in Malmö in Sweden and a second study by Amer, Mustafa, Teller et al. (2017) which researched on the potential of roofstacking in Brussel.

Both these studies has provided helpful information in the decision making and framing of the quantitative methodology.

Legal constraints

The most important and crucial part in the final end are the property owners agreement to invest in someone using the roof of their buildings (Wilkinson 2009 in Svännel & Sang unpublished report). This conclusion is assumed to be valid within this thesis as well.

Historical values

There can also be local restrictions of the use of buildings, for example the ones that are classified as historical monuments or buildings in neighboorhoods that are parts of historical events (Gorgolewski & Straka in: Orsini, Dubbeling & de Zeeuw et al. 2017, p. 113).

Construction, weights and wind load

Another important aspect is the roof's capacity (Wilkinson 2009 in Svännel & Sang unpublished report). Whether a roof is suitable for a greenhouse or not is more often decided by the buildings load capacity. Furthermore, a roofs capacity to carry weights such as equipment, agriculture, substrate, drainage materials, moving weights such as workers are a necessity when implementing a greenhouse on a roof. Also weights that are unguided by human like animals, snow and water (Dunster & Coffman 2015; Freisinger, Specht, Sawicka et al. 2015).

Moreover, the roof's design and material does also needs to be investigated. The construction design of a rooftop can vary from four different types, warm, cold, inverted and water impermeable concrete roof. Regarding on the structure of the building these roofs differ and what would be most suitable for greenhouse or greening may in specific cases be investigated by experts in civil engineering or static (Freisinger, Specht, Sawicka et al. 2015).

In addition, the height of the building does also influence the capacity of the building. Adding a greenhouse changes the wind load of the building and therefore it is important to take it into account when planning rooftop agriculture to ensure that the building can cope with the new wind load (Freisinger, Specht, Sawicka et al. 2015).

Rooftop area and design

There are different opinions of how big a roof should be for commercial urban agriculture and whether if it could have a small incline. It is argued by Berger (2013) that the larger the roof the better in order to be more profitable. Furthermore, a flat surface was considered crucial (Berger 2013). Other researchers suggest's to be economically viable, the size of the roof needs to be around a minimum of 1000 square metres, it could be less depending on yields, sales planning, and the height of the greenhouse. A flat surface is best suited for a greenhouse but could also be constructed on a very small inclined surface (Freisinger, Specht, Sawicka et al. 2015).

Height and accessibility

Obstacles with rooftop greenhouses are construction regulations like height (Thomaier, Specht, Henckel et al. 2014). According to Berger (2013) and Freisinger, Specht, Sawicka et al. (2015), a building cannot be too tall or too low for rooftop agriculture. A more suitable building would be around 10 floors or less, this to facilitate logistic such as movements of people, supplies and production. Since the research of Berger (2013) consisted of studying buildings in New York, this criteria was therefore not taken into account as the buildings of Stockholm does not have the same heights, skyscraper buildings, as in New York. Due to the limited amount of time and the constraints of data, an assumption was made that majority of the buildings are less than 10 floors in the city of Stockholm.

Accessibility must also be ensured, such as access to the roof and considerations need to be taken to structural and organizational aspects. For example a building with not too many floors or a lower building would be more preferable since it facilitates the access to the roof and make it possible for an elevator to be installed. Requirements for production logistics such as places which enables transports, for example in industrial areas are also important (Freisinger, Specht, Sawicka et al. 2015; Meijer 2015). However, Mousavi (interview 2017) claimed that the city of Stockholm has a good grid of infrastructure, therefore also good transportation opportunities. Likewise, as previously mentioned, to take in consideration to the height of the building was not the primarily focus and it would take too much amount of time for this thesis to investigate further.

Sunglight

The access to light is also crucial for urban agriculture (Meijer 2015). For the plants to grow both sunlight and sunlight protection is needed in case of solar radiation and heat stress (Freisinger, Specht, Sawicka et al. 2015). Since the rooftop greenhouses are similar to the conventional (Freisinger, Specht, Sawicka et al. 2015), and as there are existing conventional greenhouses in Sweden (Meijer 2015), furthermore there are many citizens in Stockholm today are practicing urban agriculture (Bönnischen 2016), which proves it is feasible, for that reason further research on solar radiation and heat stress will not be further investigated.

Building year

Several studies points out that buildings that are older than 40 years, or built before 1968, were over dimensionally built and contains a higher roof load (Berger 2013; Svännel & Sang unpublished report). Since this data had not been gathered into one file for to use within a GIS software, to look it up individually would be too much work. Furthermore, it has been argued by Amer, Mustafa, Teller et al. (2017) that roofs can be strengthened afterwards. For these reasons this was also left out.

In conclusion, before implementing a greenhouse, the three key aspects, construction, weight and height are crucial to investigate to make sure that a roof could carry a potential greenhouse (Freisinger, Specht, Sawicka et al. 2015). It was further revealed in the study of Meijer (2015) that all of the buildings are unique and respectively building that is of interest for placing a greenhouse will therefore need a further investigation individually. Moreover the property owners agreement and neighbors are the must also be taken into consideration in order to aviod conflicts (Gorgolewski & Straka in: Orsini, Dubbeling & de Zeeuw et al. 2017, p. 113).

The majority of the previous presented constraints are too time consuming for this thesis project and will therefore only be limited to a few variables. The variables were, a flat rooftop area and a minimum of 1000m^2 was chosen as it would hopefully give a result that is not too big as it need to be within the time frame of this thesis.

2.5.2 Operationalization GIS study

The datasets used in this thesis was created by The City Building Office, *Stadsbyggnadskontoret* and Environmental Management, *Miljöförvaltningen,* in the municipality of Stockholm, *Stockholms Stad.* These were the database which was further used in the ArcGIS 10.5 software for to make the calculations of the buildings.

The datasets used:

- Stockholms Stads Solkarta shp-fil. CC By: Stockholms Stad
- Stockholms Stads Statskarta shp-fil. CC By: Stockholms Stad

In the case of the area of the roof, to identify potential roofs in software ArcGIS Map 10.5, there needed to be a minimum size in order to scale down the amount of buildings, therefore the suggested minimum of 1000m^2 was used. The reson to this was that the software ArcGIS Map 10.5 could not identify roofs that consisted of a flat surface, this needed to be studied individually for respectively building. Furthermore, Freisinger, Specht, Sawicka et al. (2015) claimed that a roof could be less than 1000m^2, therefore, for the roof not to be too small including roof rack or similar the minimum was for that reason set to 1000m^2.

The study of potential roofs was conducted in three phases.

First phase
Primarily, the first phase was to make a selection of all roofs with an area of a minimum of 1000m^2. The minimum requirement according to Freisinger, Specht, Sawicka et al. (2015) was approximately 1000m^2 for a commercial urban agriculture to be economically viable, but as the ArcGIS software does not distinguish the rooftop area and the building footprint area (Berger 2013) one thousand square metres was for that reason set to calculate with the "lost" surface.
Rooftop area is interpreted to exclude roof obstructions and protrusions (berger 2013). Building foot print area refers to the whole roof of the building (Berger 2013).
Though, in this thesis, these two concepts ahave been further used as the same definition, and where rooftop area is the same as the building foot print area.

All the districts each contained a shapefile with 'Byggnads area', *building area.*

The layer was selected for all respectively districts and the same procedure was performed for each. In the ‘Attribute table’ the area of the buildings were calculated and all the ones that had an area of minimum 1000m^2 or larger was selected. A new shapefile was created with only the selected buildings, this in order to not mistakenly choose a building that did not fulfill the criteria set.

Second phase

For the second phase the solar radiation map from the Environmental Management (2017) at Stockholm Municipality, (Miljöförvaltningen på Stockholms kommun) was chosen as a ground layer in order to determine which roofs that had a flat surface and large solar potential. Freisinger, Specht, Sawicka et al. (2015) suggested that roofs with a slightly degree could also be used for commercial greenhouses, but as the map could not display the angle of the roof, only roofs with flat areas were for that reason chosen.

The new created shapefiles of ‘Byggnads area’, *building area*, were placed on top as a second layer. All the buildings with a flat area was then selected individually and given a value ‘1’. All other roofs that was not selected was given value ‘0’.

The ArcGIS Map 10.5 program could not distinguis flat surfarces and the ones with an inclination therefore every house had to be studied.

Third phase

Freisinger, Specht, Sawicka et al. (2015) claimed that for smaller greenhouse construction companies it could be economically difficult to produce a specialized greenhouse, but the ones that are more homogenous is more simple to build. Further on, this in turn minimizes the costs for the commercial urban agriculture company. Consequently, this led to a second selection and where all the buildings with a more homogenous rooftop area, squared or rectangular and also relatively “empty” area, e.g. free from bigger ventilations placed on the middle of the roof, was given a vale ‘2’.

Description	**Value**
All roofs ≥1000m^2	0
All roofs with a flat area.	1
Roofs with a rectangular or square shape, or “suitable” for a greenhouse and clear from ventilations or similar	2

Table 2: *Presentation of descriptions of valuing buildings*

”≥” – This means roofs that have an area of 1000m^2 or larger.

2.5.3 Presentation of data

According to Harrie (2013, p.37) it is rarely desirable to show too much data, therefore only a small geographic data volume was chosen to present. In the presentation of data in the ‘Results’ it was chosen to show the identified roofs, all the other buildings and water since the city of Stockholm is built around it. In the ‘Appendix 4’, for the geographic data of the selected roofs, four other additional data was also chosen. The data presents the infrastructure, the roads, the buildings and water. The infrastructure and roads were chosen as to easier locate where the identified roofs for potential greenhouses are placed in the city, likewise the data over the remaining buildings.

Furthermore, in the results section, some of the maps does not display the whole area. The reason for this was that neither of the identified buildings was in that area or only a few and the reason to exclude the area was as the map could be zoomed in even further and therefore provide a more clear picture.

2.5.4 Limitations and source credibility GIS study

The geographical data that can be used for analyzing, problem solving or to create new data is depending on the existing data of a specific geographical area. Information, that is suitable for using within a geographic information system, about the building year, the load capacity or the slope of the roofs of the buildings had not yet been conducted and to take those into account was therefore not possible. Furthermore, such kind of investigation takes to much time for this thesis project.

The risk of setting a minimum requirement of a rooftop area 1000m^2 or more, could have resulted in missing potential roofs for placing a greenhouse since Freisinger, Specht, Sawicka et al. (2015) suggested that it could be less than 1000m^2.
Furthermore, making an assumption that the buildings are lower than 10 floors, which was the maxium height according to Berger (2013), an error might have occured in the results, showing buildings that might be higher.

Another limitation was that the software ArcGIS Map 10.5 could not identify roofs that consisted of a flat surface, this needed to be studied individually for respectively building. This could have resulted in buildings being omitted and therefore not included in the results. To avoid this, the different areas were studied twice, but it is still not a guarantee unfortunately that all of the buildings with a flat roof and an area of 1000m^2 or more got included.

To meet the threat of choosing too low buildings with inferior solar conditions as Berger (2013) claimed in her study of New York, the solar map was used and roofs with lower sun potentials could therefore be avoided.

The source credibility of the data was also considered. The solar radiation map created by the Miljöförvaltningen (2017), (Environmental Management) used within the ArcGIS map software, does only expose the solar potential for each roof. Further on it does not visualise if the roof is already occupied by another activity, e.g. rooftop bar. Using Google Earth map or an orthophoto to judge if the roof was unsused or not was considered, but given the time frame of this thesis, this was left out.

2.5.5 Area of Stockholm

The aim of this thesis was to study the potential of rooftop greenhouse in the city of Stockholm. For that reason, all specified areas such as industrial, residential, peripheral are of interest and included. Since the city of Stockholm is too big in size the research needed to be scaled down.
The studied area in this thesis was firstly selected due to the solar map of Stockholm region, created by the Energy and Climate advice (2017), (Energi- och Klimatrådgivningen). The map presents the solar conditions of Stockholm and indicates that the inner city districts of Stockholm have better conditions, see ’Appendix 2’ for solar map of Stockholm region.
The municipality of Stockholm consist of the areas with the best solar potential (Energy and Climate advice 2017and thus this municipality was chosen for to study the potential roofs for greenhouse implementation.
Nacka Municipality were one of few areas with large solar potential, but due to the limit of time it was excluded. Furthermore, why the the municipality of Stockholm was preferably and better option compared to Nacka is because it is more central and most importantly it has more buildings (Nacka Kommun 2017; Stockholms Stad 2017) which is essential within this research.
The municipalities Salem, Huddinge, Haninge, Tyresö, Lidingö, Danderyd, Solna, Sundbyberg, Sollentuna and Järfälla, also within the city of Stockholm, had inferior solar conditions and was for that reason not chosen for this thesis. Please see Appendix 2 for further information.

The shp file for the ArcGIS Map software, gained from The City Building Office, consisted of fourteen maps over the city districts of Stockholm Mumicipality and where some of the districts have city areas that are grouped together e.g. Hägersten-Liljholmen. Due to the time limit, the area chosen needed to be further scaled down and some of the districts were therefore excluded. How this was determined was according to two aspects. The first aspect were the ones that had less flat roofs with an area of 1000m^2 or more compared to the other districts. The second aspect was the ones that had fewer homogenous roofs, squared roofs and further, was also excluded. This resulted in ten districts being analyzed within this thesis. The districts are: Bromma, Enskede-Årsta-Vantör, Hägersten-Liljeholmen, Kungsholmen, Norrmalm, Rinkeby-Kista, Skärholmen, Spånga-Tensta, Södermalm and Östermalm. Please see ‘Appendix 3’ for more information.
Furthermore, a limitation to ten areas was considered to be accommodated within the timeframe.

2.6 Analysis of the empirical data

The most preferable strategy when analyzing the qualitative data is to rely on the theoretical proposition which in turn should consist of academic theory. Further on, it should have shaped the objectives of the study (Yin 2009). In this thesis the literature review helped shaping the objectives, the first two research questions. Further on to it aid to finding the academic theories for the theoretical framework used to analyze the empirical data, the Swedish urban agriculture companies.

Common aims when analysing empirical data is to find patterns in the data. A preferable approach for analyzing the empirical material is by using thematic coding according to Robson (2011, pp. 471-485). By coding and categorising the data for different themes, it makes it easier to analyze it in later steps and also helps to minimize the problem of overloading the material (Robson 2011, pp. 471-485). The thematic coding will in this thesis be derived from the theoretical framework.

Presentation of the empirical data in the analysis, will be presented as a cross-case analysis. It aim to gain an understanding of several cases (Khan & Van Wynsberghe 2008). The cases will be discussed after the shape of the theoretical framework.

2.7 Credibility

Saunders, Lewis and Thornhill (2009, pp. 156-158) claimed that a thesis, in order to be credible, must have a research design that meets requirements for reliability and validity. Reliability refers to the idea that the research is done in a way that it could be replicated by another person. Furthermore, that there is a transparency in how the collected data been translated and into something that is understandable to the researcher. Validity, is questioning if the research really answer to the aim and purpose of the thesis. E.g. in this thesis, the data collection consisting of interviews, were the right questions asked?

Leppink (2017) underlines the necessity of replication, without it the research is seen as to have inferior credibility. It is for that reason important to ensure that all decisions and reasons why and how the study was performed is well documented, in order to be able to replicate the study (Leppink 2017). Quantitative methods are considered to have a higher replicability and qualitative a lower. In order to minimize this problem and to higher the credibility of the research, as much as possible was described for the different methods.

Threats to the thesis credibility described by Saunders et al. (2009, pp.156-158) influenced the design of the data collection. E.g. the respondents had the possibility to decide when, where and how the interview would be held in order to prevent stress or other physical limitations that could have influenced the answer. Another threat that is problematic and difficult to avoid when having interview as a method, is to avoid that the respondents shaping the answer and not telling the truth. In order to minimize that problem the respondents were informed about the interview in advance, and therefore had the possibility not to participate. The last threat to credibility is

parsing, when interpreting the answers misunderstandings could appear. By using a qualitative method such as interviewing, it has the opportunity to asks further questions if an answer was not clear.
The validity of the research could also be threatened (Saunders et al. 2009). For instance if something has happened recently at the company it might influence their answers. To meet this threat, studying websites and looking through other channels such as news and similar were done. As there were three interviews held, research could therefore not contain a high generalizability (Saunders et al. 2009, p.158).
On the other hand, as urban agriculture is quite new in the academic field, qualitative data collection is a more appropriate choice according to Mok, William, Grove et al. (2013) in Gullers (2015). Furthermore, most of the published papers conducted in Sweden are from 2008 and onwards which also confirms the theory (Gullers 2015).
Using a survey as a method of studying the consumer demand in urban agriculture products of citizens of Stockholm was considered as it would have given a further holistic picture of the purpose of the thesis, the potential for rooftop commercial urban agriculture in the city of Stockholm. Due to the limit of resources and time this method was therefore not chosen. Another argument for using interviews, are that according to Gullers (2015) most of the researchers conducted in Sweden uses a qualitative method as a main source to collect data, and for that reason interviews were interpreted as to be a stronger method and a better alternative.

Lastly, by using a triangulation as a method, the problem area of the study is being analyzed from different angles, thus increasing the reliability of the research (Jick 1979). Though, using mixed methods might lower the generalisation of the study (Leppink 2017).

3 Theoretical framework

3.1 A definition on business models, strategies and supply chain

A business model is seen as the structure of a company and explains how value is created, captured and delivered to its customers, with the purpose of making the company profitable (Pöllng, Prados, Torquati et al. 2017; Richardson 2008).
According to Richardson (2008) a well designed business model creates an overview of the model and its activities with a consistent logical structure to execute the strategy. The activities within the business model are the ones who deliver *value proposition* (the value offered to the customer). *Value capture,* refer to how the firm capture value, produces revenues and receive a high profit margin. A superior business model both increase value for its customers and for the firm (Richardson 2008).

In the urban agriculture context, the product itself creates value, freshly produce, nutrients and more by the performance of urban agriculture activities according to Hedin (2015). This thesis will therefore not analyze the value proposition any further. This framework will instead consist of *value capture,* how the urban agriculture captures value, i.e. generates money. It will focus on the business model and its strategies. Theories on business models, business strategies and supply chains within commercial urban agriculture will be explained further in order to shape a solid framework used for to analyze the Swedish urban agriculture companies in this thesis.

According to Hedin (2015) many of the firms he studied used similar business models as urban farms. As there is not much existing literature on commercial agriculture and its business models, some of the theories used in this chapter are derived from studies on community farms.

In the table below, feature a summary of the business "models" that recently been developed within the field urban agriculture. Hedin (2015), Liu (2015) and Pölling, Lorleberg, Orsini et al. (2015) and Van der Schans et al. (2016) specifically classify their theories as business models while Van der Schans (2010), Van der Schans (2015) as business strategies.

Researchers	**Gliessman (2007)**	**Van der Schans (2010)**	**Hedin (2015)**	**Liu (2015)**	**Van der Schans (2015)**	**Pölling et al. (2015)**	**Van der Schans et al. (2016)**
Business models or strategies	- Community supported agriculture - Extended I AFN - Extended II AFN	-Specialisation -Differentiation -Diversification	- Small production - Large production - Secondary purpose	-Primary food production -Value differentiation -Diversification -Service provision -Innovative operations	-Low cost -Differentitation -Diversification -Reclaiming the commons -Experience	-Cost reduction -Differentiation -Diversification -Shared economy -Experience -Exprimental	- Low cost -Differentiation -Diversification -The commnons -Experience
The researchers definition	Business models	Strategies	Business models	Strategies	Business models	Business models	Business models
Interpretation of the models in this thesis	Business models	Strategies	Business models	Unclear	Strategies	Strategies	Strategies

Table 3. Classification of commercial urban agriculture business models and strategies
Based on: Pölling, Prados, Torquati et al. (2017) & Gliessman (2007, pp.334-337)

When studying these models, there seems to be a confusion whether it is a business model or a strategy. Casadesus-Masanell and Ricart (2010) in Hedin (2015) defined a business model versus a business strategy as:

"*Business model refers to the logic of the firm, the way it operates and how it creates value for its stakeholders and a strategy refers to the choice of business model through which the firm will compete in the marketplace...*"

Casadesus-Masanell and Ricart (2010) in (Hedin 2015, p.9)

The authors Casadesus-Masanell and Ricart though do not distinct the different concepts strategy and business model as the latter according to them still can influence the market

position. In contrast, Shafer et al. (2005) argue that these are separate concepts and states that a business model facilitates analysis, testing, and validation of a firm's strategic choices. The business model itself is not a strategy. Porter (1999, p.34-37) further argue that in very rare cases, a strategy can influence the business model, as for example in the case of *low-cost* strategy and where it influence the activities in the business model.
A strategy can be seen in four different ways; as a plan, pattern, position or a perspective. When looking backwards, the strategic choices can be seen as a pattern, and in the future as a plan. The most well-known, is strategy as a position, *Porter's Generic Strategies*. The last perspective, is seen as choices about how the business model is conceptualised. The views all differ but what these views have in common, is making choices (Shafer et al. 2005).
In this thesis, the interpretation of the suggested models is that the ones of Hedin (2015) and Gliessman (2007) are examples of business models used within commercial urban agriculture. Whereas Van der Schans (2010), Liu (2015), Van der Schans et al. (2015), Van der Schans et al. (2016) and Pölling, Lorleberg, Orsini et al. (2015) are mainly business strategies, in some of the researches they are describes as business models. However, the theories chosen for this thesis were the ones that classified themselves as business models respectively business strategies. This in order to not create any confusions and most importantly to use the theories as the researchers have identified, developed and classified as such.

One activity in the business model is the supply chain, the key partnership which helps capture value to the company (Osterwalder & Pigneur 2010 in Pölling, Prados, Torquati et al. 2016). Wubbe, Fondse and Pascucci (2013) showed the importance of a short food supply chain in urban agriculture products and how it affects the business model in different ways, in terms of profit and transparency to the customer. In case of urban agriculture products, it is seen as a crucial part in the business model as it higher the profit margin for the producers and creates value to its customers and/or consumers (Wubben et al. 2013).

3.2 Business model

In this thesis, when studying what business models the Swedish urban agriculture companies are using, the business models of Hedin and Gliessman were both chosen as to act complementary to each other.

Gliessman (2007, pp. 334-337) argues for alternative business models which would be better suited within commercial urban agriculture compared to using the old farmer's markets model. By applying different sales and distribution channels, higher margins could be reached by shortening the distribution chain. Compared to the global food system these business models differ greatly and as the name of the model also implies it has a stronger social and economic bond within the local context.

Gliessman (2007, pp. 334-337) suggested three types of business models for commercial urban agriculture:

Community Supported Agriculture, is when a group buy a part of a farm and the final production. It works as a subscription and where the subscriber receives a basket or bag of products which the company puts together. To the farmer, this reduces the risk if the harvest becomes poor. To the consumer this means a low or high food production to either a high or lower price respectively. The farmer could either receive money at the harvest or in the beginning of the season. Most of the community supported agriculture offers a diversity of products (2007, pp. 334-337).

From alternative food networks, AFN, two other models have evolved, extended networks. Extended networks are not restricted to the local context and are instead offering a shortened food supply chain of the global food network. The alternative food network stretches beyond the local and through and takes advantage of the existing information and distribution systems to connect consumers and suppliers. Coffee is a prime sample (2007, pp. 334-337).

Extended I AFN, refers to commercial agriculture that are selling directly to consumers. E.g. the consumer buy coffee directly from the supplier without any intermediaries, and works as a subscription program (2007, pp. 334-337).

Extended II AFN, this type of network uses the established traditional retail channels and where the distribution chain has been shorted. The producers are offered a higher price for their products compared to when using the mainstream market, e.g. Fair Trade coffee (Gliessman 2007, pp. 334-337).

In the more current research of business models used within commercial urban agriculture, Hedin (2015) identified three types of models that were the most commonly used. It is worth noticing that within the three main classes discovered, there are further variances between the urban agriculture companies since all of them are unique in their everyday operation (Hedin 2015). The models are being defined as:

Small production, consist of a production focus. It could be very specialized or contain a variety of products, but never a larger production. These exclusive products are sold later via farmer's markets or to restaurants. If the firm offers several products it normally focuses on managing subscription programs.

Large production, refer to a scaled commercial firm that has a production focus and a narrow production line consisting of highly perishable products. Normally with a few products, in most cases specialized on one to two. The products are being sold to retail and in some cases to restaurants. Within this model, customers are willing to pay a premium price for products of high quality, fresh and local produce.

Secondary purpose farms, generally consist of the production of a great variety of products, and where the company benefits financially from another business activity than farming by using the attention the business provides or the properties of the urban farming operation.

Examples of secondary purposes include marketing, recreation services, self-farming and distribution (Hedin 2015).

Hedin (2015) claims that the business model *Small production,* is not a very sustainable and long term business model. It needs to be developed and to capture other created value by for example using other products or decrease the price for the products offered. This cluster is a temporary development stage for companies to later develop into a; a) large scale production sited outside the urban sphere and therefore leaving the urban agriculture, b) scale up by efficient production methods and produce a volume that are of interest for retail or, c) find options to harvest values and become a secondary purpose farm which benefits from the already established urban agriculture firm (Hedin 2015).

3.3 Strategies - Positioning on the market

A strategy is a pattern or a plan that incorporates a firm's major goals, activities and policies into a cohesive whole (Mintzberg, Quinn & Ghoshal 1999, p.5). A well-formulated strategy helps to allocate the resources of a firm, take a defensive or offensive action that helps create a defendable position in an industry and generate high profit (Porter 1998, p.34; Mintzberg et al. 1999, p.5). According to Porter (1998) a superior strategy for a given company is a unique composition reflecting its particular circumstances. The firm can consist of one or several strategies in order to create a defendable position and in the long-term perspective outperform competitors in a specific industry (Porter 1998, p.34)

As explained previously in this chapter, there are several different business strategies/models that has been proposed and according to Pölling, Prados Torquati et al. (2017) there is still some uncertainty regarding what these concepts can look like. The models are yet developing and for this research, the model of Van der Schans (2015), underlining that the author classified his theories as business strategies, was chosen as it is the more current within the field of urban agriculture business strategies. Furthermore, these strategies Van der Schans (2015) purpose have also been elaborated or used as a basis in later researches, e.g. Pölling, Prados, Torquati et al. (2017) research, which significances that these are still up to date and used within urban agriculture companies.

The strategies developed of Van der Schans (2015):

Differentiation, refers to providing quality products that are different from the conventional agriculture. The main distinction of urban agriculture in contrast to the conventional is the transparency it provides, regarding the origin of the production, and the condition under which it is produced. Urban agriculture can offer products such as species of other products, heirloom, ethnic or perishable vegetables and fruits, lastly also more tasteful varieties. The latter, perishable vegetables and fruits, refer to those products that are more difficult to transport long distances. For example, special developed vegetables or “forgotten” vegetables, in other words products that are not found on the regular market (Van der Schans 2015).

Diversification, in urban agricultural contexts, Van der Schans (2010) refers to, in addition to the products and services offered, the diversified activities it could bring and the synergy it can adapt between the different activities. In this strategy, several activities have been identified going well along with food production. In addition, it can use both business-to-consumer market activities as well as business-to-business activities. E.g. activities such as landscape services and nature management combined with social care as education or rehabilitation (Van der Schans 2015).

Low cost, this strategy resembles low costs solutions, or low external input farming. Compared to the conventional using large scale it is for the urban context harder to develop as there is considerably less space to use in urban areas as on the same time it is supposed to operate efficiently. There are a few ways to realize a low cost strategy. As for example, using urban resources that are not fully utilized or not used at all. E.g. vacant plots of land, empty buildings, urban waste such as organic and heat waste (Van der Schans 2015).

Reclaiming the commons, refers to that the citizens have an opportunity to regain control and to become aware of their food supplies source, compared to the new global food system. The urban agriculture introduces the old feeling of ownership, in some cases literally when the consumers become co-owners in the production (Van der Schans 2015).

Experience, this strategy relies on that further value is added when offering memorable products or experiences than basic products or services. As urban agriculture products are closer to the consumer the farmer could provide a more unique experience. In addition, it could create a more direct and exciting interaction between the green space and the grey buildings. For example, roof gardens (Van der Schans 2015).

Van der Schans (2015) points out that in practice, urban agriculture firms often combine different strategies. E.g. the production of a differentiated product (*differentiation)* has been cultivated and harvested by volunteer or social care clients or similar, (*diversification* and *low cost).* Furthermore, Van der Schans (2015) states that finding combinations that works in a symbiosis is precisely what distinguishes a well-run urban agriculture firm from a less well-run one.

3.4 Supply chain

Short food supply chains, SFSC, aim to shorten the supply chain and be valuable for the producer as well as for the consumer. In contrast to the conventional agriculture which uses a longer supply chain the SFSC business model aims to produce and distribute the food within a region in order to enhance and generate extra value to the consumer (Marsden, Banks & Bristow, 2000). With a shorter supply chain, it increases the margin and the producer could get more money for their products. For the consumer, it hightens the transparency and realises the quality of the product (Wubben et al. 2013) and also helps to distinguish the company from the mainstream (Pölling, Prados, Torquati et al. 2017). Further on, the most important drivers of SFSC according to the studied firms in the research was the economic viability, the connection between producers and consumers and the quality of the product (Wubben et al. 2013). Wubben et al. (2013) expressed it in this way:

"When the value proposition claims to supply high quality foods, that should evidently be reflected by activities (of all chain parties) that realise that quality. SFSCs attempt to shorten the supply chain, with the aim to be valuable for both producers (e.g. increased margin) and consumers (e.g. transparency). "

(Wubben, Fondse & Pascucci 2013, p.13)

Wubben et al. (2013) identified three types of key partnerships used in business models with short food supply chains.

The first category, the SFSC is driven by initiator stakeholder with the aim to increase the economic viability of their business, and focus on income and growth. These are not likely to have a strategic collaboration, no intermediaries, and are instead using a face to face producer-consumer interaction as their value proposition. They create a competitive advantage by using the market to govern their transactions and where the pricing is also made there after. Within this category, the aim is to raise the profit. Compared to other stakeholders, they are likely to have a higher profit margin than average (Wubben et al. 2013).

The second category, involves support to the producer and where the intermediaries intent is to offer a shorter channel for the products produced compared to the conventional channels. The supporters, or intermediaries, have a profit-oriented interest, and their value proposition is centered at reducing the transportation miles of the produced food. In conclusion, this category is characterised by a strategic collaboration with contracts and relation-based alliances, and where integrated governance structures then the market are used (Wubben et al. 2013).

The third category, is the smallest one and characterized as having the strongest relationship between the producer and the customer, compared to the other categories, and where the connection between these is the most important to the initiator stakeholder. Furthermore, the connection between the producer and the customer are most of the times reflected in the results and in a variety of combinations. The value creation and capture is not clear in this model (Wubben et al. 2013).

3.5 Conceptual Framework

To put these concepts together, the theories from the Theoretical framework, and to explain it in a comprehensive way, the *Busines Model Canvas* will be used. But firstly, it will sort out the definition av a business model and its component.

Shafer, Smith and Linder (2005) studied the definition of a business model and found 12 definitions and 42 different business model components, and where none of those definitions founded seemed to be fully accepted. The reason, according to the authors, may be because of the many new different perspectives such as technology, information systems, e-business that has emerged on the market compared to when the first original definition of a business model was founded (Shafer et al. 2005). Most of the viewpoints on business models seem to be the company's offerings and the associated activities it has taken in order to produce them (Morris, Schindehutte & Allen 2005).

A good strategic management template is the *Business Model Canvas* (Pölling, Prados, Torquati et al. 2017). It is a simple framework which could be used as a guideline when creating, developing and visualising the business model. It was designed by over 470 practitioners from 45 countries (Osterwalder & Pigneur 2010). The four main blocks are the customer, offer, infrastructure and financial viability of the nine basic blocks in the business model canvas (Pölling, Prados, Torquati et al. 2017).

<table>
<tr><td colspan="10">Business Model Canvas</td></tr>
<tr>
<td colspan="2" rowspan="2">8. Key partnerships
Activities that are outsourced or that are aquired outside the company</td>
<td colspan="2">7. Key activities
The activities needed in order to produce the product or service</td>
<td colspan="2" rowspan="2">2. Value proposition
How the company satisfy the customers needs and solves its problems with the value proposition</td>
<td colspan="2">4. Customer relatioships
It describes the relationship that the company maintains for each custmer segment</td>
<td colspan="2" rowspan="2">1. Customer segments
The different customer segments the company aims to reach</td>
</tr>
<tr>
<td colspan="2">6. Key resources
These are the company's assets that are required for to deliver the other elements in this model.</td>
<td colspan="2">3. Channels
This element describes how the company through the different channels, sales, distribution and communication, delivers its value proposition to the customer</td>
</tr>
<tr>
<td colspan="5">9. Cost structure
Some of the costs can be structured after the key activities, resources and partnerships. Some models are entirely structured around low cost.</td>
<td colspan="5">5. Revenue streams
These are created by the value proposition if successfully offered to its customer</td>
</tr>
</table>

Table 1: Business Model Canvas
Based on: Osterwalder & Pigneur (2010)

The model only visualises a simple structure. In the reality, a business model is more complex and forms a well integrated system between its components (Pöllng, Prados, Torquati et al. 2017). Furthermore, there does not exist only one single business model, there are multiple opportunities and alternatives (Osterwalder & Pigneur 2010).

The main four blocks in the Business Model Canvas are ‘Customers’, ‘Offer’ (value proposition), ‘Infrastructure’ (key activities, partnerships, resources) and ‘Financial viability’ (revenue streams and cost structure) (Pölling, Prados Torquati et al. 2017). The ‘Value proposition’, how the company offers value to the customer is already created by the urban agriculture product itself according to Hedin (2015) and the ‘Customers’ segments are the ones interested in these products.
The business models of Hedin (2015) and Gliessman (2007) shows how commercial urban agriculture can be operated, whereas Wubben et al. explains the most central of the business model, that influence the ‘Financial viability’ and ‘Infrastructure’, the two last main blocks in the Business Canvas Model.
The strategy, is the plan or pattern in how the firm should act in order to create a defendable position (Porter 1998, p.34; Mintzberg et al. 1999, p.5). These three elements, the business model, strategy and supply chain, shapes a conceptual framework to analyze the commercial urban agriculture operators in Stockholm.

4 Literature review

4.1 Urban agriculture in developed countries

In a historical perspective, urban agriculture has always been part of the city in developed countries, where agriculture and cities have been closely interwoven (Pölling 2016; Pölling, Mergenthaler & Lorleberg 2016). The relationship between urban areas and agriculture has been mutual where food been produced for the citizens and then recycled back to organic matters. Despite this, the urban area and the urban agriculture are many times seen as contradictions (Pölling, Prados Torquati et al. 2017). During the years, urban agriculture has for a long time been marginalized from the urban sphere and has been seen as an obsolete form of economic activity (Pölling 2016). The rural agricultural system and large scale agriculture combined with globalization has been taking over the production of food. Until recently, cities have though been rethinking and an increased awareness and interest for food production within and around urban areas has grown (Pölling 2016).

In the existing literature, several different actors have been identified as being involved in the current development of urban agriculture (Huang & Drescher 2015) and there are many different purposes of applying urban agriculture such as for the production of vegetables, medicinal plants or livestock in the developed urban areas (Lin et al. 2015; Pölling 2016). The actors are connected to various practices in the urban system such as health, land use, waste management and transportation (Huang & Drescher 2015). A major driver in the development of urban agriculture has been the food security perspective and urbanization as it is estimated that more than 60% will be living in the cities in the future (Lin et al. 2015). Concerns regarding sustainability and climate change have also contributed to the development (Huang & Drescher 2015). Further drivers to urban agriculture have been the health and the economic aspect (Moglia 2014), as UA products among other contributions can contain more nutrients, reduce childhood obesity and contribute to the local economy (Gliessman 2007; Berger 2013). Last but not least, it has been a desire for urban populations to control the ethical and ecological quality of the food they consume and is considered to be a part of the movement of increased food awareness (Moglia 2014).
In the last thirty years urban agriculture has expanded rapidly in developed countries, as for example in North America, and calculations estimate that 15-20% of the food could be produced in the cities, as UA can be very productive (Lin et al. 2015). Important driving forces in the developed areas has been the reconnection between consumers and farmers as well as the creation of circular local economies that urban agriculture brings (McClintock 2010; Liu 2015). The latter, circular local economies, refers to the money that is being kept and circulated locally (McClintock 2010). Another great driving force is that urban agriculture is also promoted for the ability to raise awareness of environmental problems and human health, which further influenced the development of urban agriculture (McClintock 2010; Liu 2015).

4.2 Sustainability perspective on urban agriculture

Ecological

Urban agriculture, those crops that are cultivated outdoors, can contribute to an urban biodiversity and the creation of a green network in the urban sphere (Bretzel, Vanucchi, Benvenuti et al. in Orsini et al. 2017, p.235).

Urban agriculture brings back the biodiversity to the urban environment, it can use local water systems and also minimizes transports. The later becomed true if crops are cultivated in the same area as their consumers (André & Jonsson 2013; Wedeberg 2016). Urban agriculture can be instrumental in meeting other priorities in cities such as benefit water management, reduce the urban island heat effects, decreasing food deserts and increase the green spaces in urban areas (Gorgolewski & Straka in Orsini, Dubbeling & de Zeeuw et al. 2017, p.114).

Urban agriculture offers several benefits for available and renewable resources. An example is the resource of water there urban agriculture can make us of storm-, grey- and reclaimed water (Hallett in Hodge Snyder, McIvor & Brown 2016, p. 27). In closed systems less water is used and water can be recycled within such loops (Montero, Baeza, Muñoz et al. in Orsini, Dubbeling & de Zeeuw et al. 2017, p. 83-99).

The most frequently used technology is hydroponics according to Orsini, Dubbeling & de Zeeuw et al. (2017). Using hydroponic systems leads to less use of fertilizer and less leakage (of what) into the environment. The closed-looped irrigation system that rooftop greenhouses and other zero-acre farming with protected area can use, decreases the usage of fertilizers (Montero, Baeza, Muñoz et al. in Orsini, Dubbeling & de Zeeuw et al. 2017, p. 93). According to Moglia (2014) urban agriculture emphasizes the possibility of recycling organic food waste. Futhermore, it creates a possibility to recycle phosphorus and nitrogen close to where it is used. This is true within the production of urban agriculture, enhancing the economic viability of recycling. With a global perspective this will foster a reduced phosphorus depletion (Moglia 2014).

In Grewal and Grewal (2012) it is argued that urban agriculture minimises food waste. This is if the food is produced and is also consumed locally which in turn reduces losses of food during transportation. In comparasion traditional agriculture uses several intermediaries and it is among them many food losses occur (Grewal & Grewal 2012).

In a study of urban agriculture United Kingdom it was revealed that if UK would produce and consume food locally, this would minimize the carbon emissions from transports by 22%. Twice the amount that UK as a nation have committed to reduce under the Kyoto Protocol (Grewal & Grewal 2012).

In contrast to the land based greenhouses there are differences in zero acre farming techniques such as rooftop greenhouses. Synergies such as irrigation of rainwater, residual heat, CO_2 exchange are examples that can occur as an effect of the RTG metabolism with the underlying building (Montero, Baeza, Muñoz et al. in Orsini, Dubbeling & de Zeeuw et al. 2017, p. 83).

The benefits of using for zero acre farming techniques such as indoor or roofs are according to Rodríguez-Delfín, Gruda, Eigenbrod et al. in Orsini, Dubbeling & de Zeeuw et al. (2017, p. 62), that these are unused spaces non suitable for traditional agriculture that are exploited.

Furthermore, the yields of using hydroponic systems compared to soil based outperform the traditional agriculture significantly. This is because of a faster growth of the plants. In some parts of the world, where it is not feasible to cultivate all year round, urban agriculture results in an increased harvest per year compared to the traditional agriculture (Rodríguez-Delfín, Gruda, Eigenbrod et al. in Orsini, Dubbeling & de Zeeuw et al. 2017, p. 61)
Enormous water savings can be achieved using hydroponic systems. By recycling water the system can reduce the water required with between 5 to 10 times, then what is normally used for vegetables in conventional farms. Rooftop urban agriculture can produce approximately the same yields as conventional farms and use up to 75% less water (Sanyé-Mengual et al. in Orsini, Dubbeling & de Zeeuw et al. 2017, p.269).

Social

In the case of U.S., food insecurity for the poorer people has not been the issue of insufficient food but an limited access for low wage earners. To address the issue, many urban agriculture programs has emerged and been focusing on donating food to the poorer people (Tagtow 2016, p.11). Urban agriculture has the potential of improving the public health in many aspects such as more nutritious food, increased wellness, addressing childhood obesity. Urban agriculture has the potential of improving the public health in many aspects such as more nutritious food, increased wellness, addressing childhood obesity. Due to the former mentioned benefits, a desire to produce food in urban areas has for those reasons, among others, increased (Berger 2013; Lin et al 2015). The production of urban agriculture could cultivate healthier products with more nutrients by harvesting much later as the production is closer to the demand. It is also possible to use older seeds which contains more nutrients. Th this is as the urban environment is more protected against pests and contamination compared to conventional agriculture, where these older seeds are too sensitive for use in production (Gliessman 2007). With healthier products problem areas such as obesity can be addressed (Berger 2013, Lin et al. 2015). A physical result of lack of food is hunger and could lead to malnutrition. Malnutrition could also be a result from theoverconsumption of calories when eating food that contains lower levels of nutrition (Tagtow 2016, p.12).
How a human being, a family or a community feeds themselves influences their health, their economic, social and ecological capacity to support future generations. Children that eat healthy food are able to learn and grow into productive adults as well productive humans who work in thriving communities (Tagtow 2016, p.15).
Rasmusson (2017) argues that urban agriculture products are not necessarily more healthy than the conventional products, since much of the result depend on the farmers knowledge and how the crops are produced. As an example, within the hydroponic system, nutrients have to be added (Rodríguez-Delfín, Gruda, Eigenbrod et al. 2017, p. 61).
The reduced urban heat island effect is also another benefit gained by integrating green areas in urban areas. This is because of that properties with vegetation have natural processes that can contribute with a cooling effect (Georgiadis, Iglesias & Iglesias 2017, pp.253-256).
Urban agriculture outdoor is not completely risk free. The term *risk* in the urban agriculture production refers to the possibility of a harmful effect, to either humans and/or to the ecological

system. These risks can be either chemical, physical or biological (Hodge Snyder & Obrycki 2016, p. 122).
Chemical hazard could be an exposure to the population due to the pollution from traffic. Contamination could also occur from land previously used and also from areas the ones that currently used. Biological contamination such as bacteria and viruses, are examples of other threats to food safety and health concerns. Last but not least physical risks such as solar radiation that could increase the risk to skin cancer, if the skin is not protected. High temperatures could also influence the health in a negative way (Hodge Snyder & Obrycki 2016, pp. 122-123).

Economical

In poorer areas, urban agriculture can have an impact on both the food quantity and quality according to Tagtow (2016, p.12). As an example, poorer areas are more likely to have food insecurity due to less access to affordable local community services such as child care, public transportation, education among others. The economics of households directly influence the economic viability in the communities. These economics also influence the food retail within that specific community (Tagtow 2016, p.12). By implementing urban agriculture the incomes of disadvantaged populations can improve and generate self-employment in households and within the specific community (Rodríguez-Delfín, Gruda, Eigenbrod et al. 2017, p. 61).
Looking at the topic from an economic perspective, urban agriculture contributes to the local economy, offers new job opportunities (Moglia 2014; Huang & Drescher 2015) and offers the farmer a higher profit margin as the distribution chain shortens (Grewal & Grewal 2012). Furthermore, as cities grow, the new alternative food market arises and creates jobs throughout the food sector. In addition these can also be created in the production such as within processing and marketing, agriculture knowledge and further (Grewal & Grewal 2012; Bretzel, Vannucchi, Benvenuti et al. 2017, p. 240). The potential to generate new jobs has been criticized by Moglia (2014) since they depend on each local environment and the local state of the labour market such as whether there is unemployment or not.
Strengthening local economies, it was found in Grewal and Grewal (2012) that the annual economic leakage of money for Cleveland could be minimized by \$29 M to \$115 M by practicing urban agriculture. Furthermore, the authors claimed that practicing urban agriculture requires significant financial capital, government involvement, public commitment and labour. City governments, planners and non-profit organisations can play a big part in making it happen. Even if not a community does not become a hundred percent self-sufficient in food production, there are considerable economic benefits of enhancing the locally produced food (Grewal & Grewal 2012).

4.3 Commercial rooftop greenhouse urban agriculture

Looking more specifically into for-profit urban agriculture, Midmore and Jansen (2003) predicted in 2003 that it would be difficult for commercial UA to be economically viable since competition of unused urban space with other operators raises rents and because of the increased cost for labour, unless there will be technical advancement within the area. Nevertheless, this was in 2003 and many commercial urban agriculture operators in developed countries have emerged (Hedin 2015). Among these technologies are rooftop greenhouses, RTG. North America is the region where most of the RTG have increased in urban areas, using different types of commercialization such as their own marketplaces or community supported agriculture (Pons, Nadal & Sanyé-Mengual et al. 2015) or selling their products in supermarkets (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). Most of the RTGs uses hydroponic systems and substrate culture systems (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015).
The former, hydroponic system, is a high technology and a strong investment and being successfully applied in developed countries (Rodríguez-Delfín, Gruda, Eigenbrod et al., p. 62). Furthermore, controlled environment technologies are more often used when cultivating several agriculture products in the same rooftop greenhouse (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015).

In the US, there been various purposes of the for-profit urban agriculture, for example Brooklyn Grange, was founded to create a sustainable model for urban agriculture and to produce healthy food and minimising the impact of our ecosystems. It is the largest rooftop soil farming in the World and consist of both an open farm and a greenhouse and produces about 25000kg organic vegetables oer year among other food products (Brooklyn Grange n.d.). Brooklyn Grange was built on an older industrial building that had spare structural capacity (Gorgolewski & Straka 2017, p.116). Gotham Greens, focusing on RTG commercial agriculture, provides locally grown high premium products (Gotham Greens 2017) salads and basil (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). Their greenhouse is 1400m^2 and they plan to expand their business by two new RTG resulting in a total acreage of 18000m^2. The Vinegar factory in New York consist of an RTG of 840m^2 and provides fruits and vegetables. The RTG of Lufa Farm in Canada has an production area of 2900m^2 and produces lettuce, herbs, tomatoes, eggplants and more, in various thermal zones (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). This had been placed on a commercial/industrial building and where the building was already constructed to bear another floor which further was never built. Therefore the building already had an extra capacity to carry larger weights because of the design of the building to carry an additional floor (Gorgolewski & Straka p.117). Other RTGs found in North America have other purposes of their for-profit operation such as educational or medicinal (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). Furthermore, looking more specifically at the application for rooftop greenhouses internationally, the for-profit urban agriculture consisted of the private sector only (Wedeberg 2016).

In Europe most of the urban agriculture initiatives are zero-acre farming (Buehler & Junge 2016) and among those techniques are rooftop greenhousesaccording to the authors Pons, Nadal & Sanyé-Mengual et al. (2015). For example, Urban Farmers, with a vision of 20% of the food should be produced in the cities (Urban Farmers n.d. a), installed two for-profit rooftop greenhouses one in the Netherlands 1500m^2, providing fish and vegetables (Urban Farmers n.d. b). The other one in Switzerland 250m^2, providing vegetables and fish. It is using a weekly basket as sales model (Urban Farmers n.d. c). In Denmark, the commercial UA company ØsterGRO, is using both a rooftop greenhouse, 600m^2 and a rooftop farm, 350m^2 to produce the food for to sell to customers and to use in their own restaurant located in the greenhouse. Their vision is to provide a recreation platform to the Copenhagers and knowledge about urban farming. The farm uses a community supported agriuculture and provides vegetables for 40 members every week (Delshammar, Brincker & Skaarup in: Orsini, Dubbeling & de Zeeuw et al. 2017, p.34).

4.3.1 Benefits and constraints of commercial rooftop greenhouses

One of the major benefits with rooftop greenhouses is that they are expected to be implemented on already existing buildings, mostly on surfaces that are unused which makes this area more productive and lead to further making urban environments more multifunctional by the integration of food production (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015).
In the Mediterranean area according to the authors Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015), rooftop greenhouses has shown environmental, social and economic benefits. Rooftop greenhouses works as isolation and reduces the energy required to heat and cool the building by up to 40%. Furthermore future RTG are expected to be better integrated with the building and use the metabolism that could be obtained for to optimize the otherwise unutilized resources such as the residual heat, energy, carbon dioxide and water waste (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015).
Studying the environmental aspects, greenhouses do not have the same environmental benefits as green roofs or open farms, in terms of mitigating stormwater run-off, reduce the urban heat island effect nor reduce the air pollution (Berger 2013).

In Berger (2013) it was revealed that greenhouses have a larger crop yield than conventional agriculture, and the same compared to green roofs. Though compared to the latter, greenhouses does not bring the same environmental effects as reducing heat stress, reduce air pollution nor reduce stormwater runoff. Nevertheless, greenhouses have the capability of producing crops all year round, which green roofs would not be able to do. A large amount of energy could also be saved. By using the residual heat of the underlying building, a significant amount of energy can be saved. In the study of Meijer (2015) it was found that Lufa Farms in Kanada, one of the largest commercial rooftop greenhouses in the world, saved 50% of the energy needed compared to land built greenhouses. In addition, the energy demand of the building minimized by 25% as the greenhouse provides an insulating effect (Meijer 2015).

Greenhouse urban agriculture avoids one of the most common risks within urban agriculture, bioaccumulation of heavy metals and the risk of contamination of soil (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). Moreover, several studies suggests that the transportation of food miles is beneficial to the climate (Moglia 2014; Freisinger, Specht, Sawicka et al. 2015; Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015), though how the greenhouse production affects the climate could though be questioned.

4.3.2 Urban agriculture in Sweden and Stockholm

In the case of Sweden, a few commercial urban agriculture companies have emerged or are emerging in forms of vertical greenhouses, indoor Z-farming and more. Various researches about for-profit urban agriculture have been conducted, but mostly in the southern parts of Sweden.

Looking more into the Stockholm region, applying urban agriculture for commercial purposes in the city of Stockholm does de Brun Skantz (interview 2017) consider to be only positive. At present we as a nation are highly dependent on our imports of food. A superior example is from the winter of 2016, when the supplies of vegetables were very sparse in the grocery stores in the city of Stockholm. The winter in south of Europe had been very cold and this resulted in lower import volumes than Sweden usually receive. This in turn influenced the prices and they were higher than normal. In addition, given our climate, it is not possible to grow plants during the whole year. Greenhouse urban agriculture could replace traditional agriculture in the months it can not grow crops, thus giving us a production all year round according to de Brun Skantz (interview 2017).

Regarding implementation of urban agriculture in the city of Stockholm it is suggested by André and Jonsson (2013) to use site-specific solutions and evaluate which kind of urban agriculture technology that could be best suited within an area rather than focusing on one specific type for all sites. Further on, the authors also elaborated on greenhouses and due to the economic viability of using urban greenhouses this was questioned in consideration to the resource demanded of energy and material flows (André & Jonsson 2013). In the study of Meijer the results showed that there were also some uncertainties about the potential development of commercial urban agriculture greenhouses.

The results shown in Meijer (2015) also revealed that if a commercial greenhouse operation sells directly to the consumer, uses industrial symbiosis and rainwater, a commercial greenhouse would seem to have more potential to be able to operate in Sweden than not using these resources and advantages that comes with producing food in urban areas. Furthermore, the research of Mejier (2015) also concluded that the consumer price of salads and tomatoes can be double as high as the production price. A business model where the farmer can receive a higher margin, i.e. more money, as within the *community supported agriculture* was further a suggestion (Meijer 2015).

Further research on how commercial rooftop greenhouses could influence the food production in south of Sweden and which role it could have in the integration of food production was conducted by Wedeberg (2016). The interviewees, (various people from the food sector), were positive and where the majority considered the private sector to have the best chances of implementing a commercial greenhouse compared to public owned due to the economic

perspective of the operation. How much the potential greenhouse could influence the food supply depends on what kind of operation are chosen. A small pilot project is suggested to start off with to see the potential of how it could evolve (Wedeberg 2016).
Ivarsson (2016) elaborated on the potential food supply self-sufficiency in Malmö and found that commercial urban agriculture might not give the high social values as other types of urban agriculture, e.g. educational or community, though it was interpreted to boost the ecological values of the sustainability perspective. Further more, UA was especially considered to contribute to the food self-sufficiency and thereby also lower the ecological footprints of the city (Ivarsson 2016).

Further studies than André and Jonssons on commercial urban agriculture or RTG in Stockholm has not been conducted.

4.4 Business models and the market

In contrast to conventional agriculture, the production of commercial urban agriculture differs from the larger scale and requires more labour, causes higher rents and for that reason also a higher price. Moreover, the crops produced also differ from conventional agriculture in terms of nutrients and production methods. They therefore has another type of demand (Hedin 2015). Ruehl & Goldblatt (2013) conducted a study in US. In their survey they found 70 % of the respondents, which backgrounds were both from low- and high-income earners, were willing to pay a higher price for locally produced crops. The higher price they were agreeable to pay included the contribution to the local economy, the benefits of locally produced food such as lower impact on the climate and the health aspect (Ruehl & Goldblatt 2013). Further literature reveals similar results in other developed countries (Wedberg 2016). Andersson (2015) in Wedeberg (2016) identified that the general consumer trends for food in high-income countries were factors such as price, quality, and the production process in terms of environmental and social influence. Furthermore, convenience were also one of the factors identified. Urban agriculture products offers direct value in terms of providing fresh produce (Hedin 2015).

Research made by Pölling, Prados and Torquati et al. (2017) reveals that very little research on business models used within commercial urban agriculture has been made, and classification of the models are still developing.
In 2006, Gliessman (2007, p.18) managed to identify a new sort of movement within food production that slowly has been emerging and where he recognized an alternative type of business model compared to the traditional agriculture. Gliessman (2007, p.334) elaborated on the concept alternative food networks and its origins. He concluded that it to have the purpose of empower the eating public and the people who produce the food.
Different combinations of sales channels have developed such as farmer's markets, stores, programs and other types of businesses to enhance the ability for farmers and consumers to use a different alternative to food compared to the global food system (Gliessman 2007, p.334). Furthermore, the alternative food networks are diverse and varying in scope, intent and size of the production. From alternative food networks other types of food businesses has emerged as,

community supported agriculture schemes, direct marketing purposes, restaurants with focus on local food. These types of niches operate very strictly and only locally, build shorter food supply chains and create food based communities. Many of these businesses are using face-to-face interaction between the suppliers and consumers (Gliessman 2007, p.334).

One of the models that evolved from alternative food networks, the community supported agriculture, is a more modern and innovative model in contrast to the farmer's market model according to Gliessman (2007, pp. 334-337). It consists of several individuals in a community that together support the farm, providing reciprocal support between the farmer and consumer and divide the risks and production of food it generates. Members or "shareholders" pay either in advance or using a subscription throughout the season. In return the customer receives a basket or box of food occasionally during the growing season (Gliessman 2007, p.336).

Further more, looking at a global scale, a more current research conducted by Hedin on commercial urban agriculture and its business models in developed countries was found. Hedin (2015) managed to identify in his study of for-profit UA companies in developed countries worldwide, that there are three major clusters of business models being used. The three common types of businesses models were large producers selling directly to retailers, secondary purpose farms, and a third, where the urban agriculture is mostly seen as a marketing purpose (Hedin 2015). What the study also revealed were that many of these companies had similar business models as community farms and were using similar value propositions (Hedin 2015).

Van der Schans conducted two research studies on business strategies used within commercial urban farming. In both studies a large selection of urban farms within the Netherlands were studied. The research managed to identify in total five different strategies used among the farms, 'low cost' (minimizing all cost to provide a lower price product), 'differentiation' (an alternative product compared to the existing ones on the market, 'diversification' (providing several products), 'reclaiming the commons' and 'experience' (using other activities where the customer has more or less infleunce in the production) (Van der Schans 2010; Van der Schans 2015). These strategies are according to Pröding, Prados and Torquati et al. (2017) also representative for the European market, and were further used as a basis in their research of European countries.

On the European market, Pölling, Prados, Torquati et al. (2017) compared commercial urban agriculture companies in three different countries Germany, Spain and Italy. They found three business model (in this thesis they are interpreted as strategies) that were mostly common (developed from Van der Schans strategies). The companies that were using 'Low cost specialization', (try to minimize the costs as possible), were according to the authors facing a stronger competition against the larger scale agriculture in energy and logistic efficiency, compared to the other business models. The model 'Differentiation', where urban agriculture companies using other agricultural products rather than the mainstream, were not that common of the companies studied. For farmers this could be a great advantage in the urban agriculture market concluded the authors. 'Diversification' were the most common model, using several products or activiteies, and is connected with using smaller production areas and where the company specialize on high added value production. The production could be quite small but still be profitable (Pölling, Prados, Torquati et al. 2017). These strategies have similar definitions as the strategies of Van der Schans.

Focusing on the Swedish context, specific research on business models in Sweden has not been found as mentioned earlier. The literature found though contained speculations of what kind of operations that could emerge on the Swedish market, one of them was the research of Wedeberg. Wedeberg (2016) reveals in her study of what role commercial rooftop greenhouses can have in Sweden, that the respondents, (various people from the food sector) considered private commercial urban agriculture companies to have greater chance of gaining profitability and therefore better conditions compared to publicly owned. Using a niche profile or a combined usage as a business model were many of the suggestions. Among the proposals were selling to larger distributors such as supermarkets, or supplier to bigger customers in the public sphere such as schools. Further suggestions were commercial niche companies, with a restaurant, trade or marketing purpose. Lastly, concept enterprises were also suggested such as social business model, e.g. production and pedagogic product concept (Wedeberg 2016).

4.4.1 Supply chain

In contrast to commercial urban agriculture, when working with conventional agriculture, to the producer the conventional agriculture contains high production costs and long repayment periods but also low profit margins, i.e. the remaining profit after all costs been payed. The reason to the low margin according to Gliessman (2007) are the intermediaries in the conventional agriculture distribution chain, the more, the higher the costs gets, and the farmer get less money for its work. According to Swedish Board of Agriculture (2011) the distribution line of conventional agriculture in Sweden mostly consist of producers that largely sell to further producer organizations. In total, the Swedish conventional agriculture uses about seven intermediaries before it reaches the end customer Mousavi (2017).

Compared to the conventional agriculture, urban agriculture is already where the demand is, and several intermediaries are therefore not needed. Food produced in urban areas can therefor reach the customer much faster (Gliessman 2007). This is also in line with the findings from the research of Hedin (2015). Further more, most of the commercial UA only uses a few links in the distribution chain before their crops reaches the customer (Grewal & Grewal 2012). Positive aspects of using shorter food supply chains are e.g. that it highlight the transparency and the producer could receive more money compared to using several intermediaries (Wubben et al. 2013). Moreover, in the research by Pölling, Prados & Torquati et al. (2017), they revealed in their study of Spain, Germany and Italy, that in most cases of the countries studied, focused on local customers and short supply chains, regardless on which business model that were used.

Since the millennium an increased interest in short food supply chains has been seen all over the world. The development seem to come from pressure on farmers income and changes in consumer behavior in food products. This trend has especially emerged in Europe and the US, with the purpose to replace the invisible hand in the global market (Wubben, Fondse & Pascucci 2013).

Literature on supply chains within urban agriculture has rarely been addressed and studied from a business perspective according to Wubben et al. (2013). Furthermore, alternative food networks or non conventional food networks as it also has been defined, has mostly been studied as separate cases in Europe (Venn, Keafsey, Holloway et al., 2006; Holloway, Kneafsey, Venn et al., 2007). To upscale the research within this field, Wubben et al. (2013) identified, by studying the supply chain of 57 different commercial urban farms, three different categories of short food supply chains, where these categories have different producer support or relationship to its customer. The categories vary from using only a few intermadiaries to have a strong relationship to its customer (the categories are used in Chapter 3, 'Theoretical framework'). The majority of the short food supply chains seeks to increase the economic profitability and use the market as a governance structure. Further findings from the study revealed the important impact of the three key stakeholders; producer, distributor and buyer. The importance of a strong connection between producer and consumer, and the collaboration between different actors, producer and distributor. The latter, compared to the first case, uses a more integrated governance structure than the market in forms of contracts and relations-based alliances (Wubben et al. 2013).
According to the authors, if including a few intermediaries and a collaboration strategy could increase the chance to survive on the market and generate higher profit. A strategic collaboration involves interests that are placed above the individual interests and where long term agreements are made (Wubben et al. 2013).

Global and regional literature on commercial urban agriculture in developed countries are not precise enough as many of the developed countries differ in demographics, population and have different purposes of commercial UA, and therefore there is insufficient evidence to draw firm conclusions on how commercial companies could operate in Stockholm. Specific literature on the established UA operators, or on commercial rooftop greenhouse in Stockholm on how they operate, their business models and strategies, was not found which means that there is still a lack in clarity regarding how it could be operationalized. The knowledge gap on what kind of commercial operations that could emerge on the Swedish market and what their distribution channels could look like, therefore leaves space and need for this area of research.

4.5 Suitable buildings and areas for commercial RTG

Area

The research of Svännel & Sang (unpublished report) states that it is less expensive to use one larger building to installment of a commercial greenhouse than several smaller and it could also minimize the amount of property owners agreement and investment that could be required. Berger (2013) suggested the larger rooftop area is the better for commercial greenhouse purposes. This was also claimed by the authors Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015) in their study that larger rooftop greenhouse, RTG, projects has been installed on larger roofs, Gotham Greens 1400m^2 and Lufa Farms 2900m^2. It may further decrease economic barriers, reduce the payback time, the time it takes to gain all money invested in the beginning of the project, and larger production volumes could also be obtained.

Furthermore to be economically viable, the size of the roof needs to be around a minimum of 1000 square metres, it could be less depending on yields, sales planning, and the height of the greenhouse (Freisinger, Specht, Sawicka et al. 2015).

Inner city areas - rent

Berger (2013) also pointed on the rents of buildings that are more attractive to other types urban planning. For example, roofstacking, which can drives upp the rent, and furher need to take in to consideration (Berger 2013).

Suitable places and buildings

Meijers (2015) suggested implementing rooftop greenhouses on parking houses since they are easily identified, may be central to the city and are already constructed to carry large weights. Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015) proposed a further alternative, industrial areas, since the roofs are more homogenous, large and in most cases flat. In addition Freisinger, Specht, Sawicka et al. (2015) argues that larger and more homogenous roofs increases the possibilities for economies of scale and a shorter payback could be received for the urban agriculture company. It is also beneficial to smaller greenhouse producer companies who could get financial difficulties with designing a less homogenous greenhouse (Freisinger, Specht, Sawicka et al. 2015).

Finally, to more easily install a rooftop greenhouse, Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015) suggested solely owned properties than a building with several owners such as the case of residential buildings, in order to overcome potential management barriers, further on to also overcome economic and social barriers. The latter is interpreted to be referred to the public and neighbours agreement of an implementation of a greenhouse.

Localisation of the building

According to Gorgolewski & Straka in Orsini, Dubbelling, de Zeeuw et al. (2017, p. 114) all cities are unique and have their own local planning requirements and building codes. Due to the zooning in cities, some areas will be more or less appropriate for food trucks, since a larger food production may require many transports and movements of trucks and therefore also require an area that is more suitable. For example, residential areas may be less suitable if they do not have appropriate trasport infrastructure (Gorgolewski & Straka in Orsini, Dubbeling & de Zeeuw et al. 2017, p. 114).

Industrial areas

Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015) argue for using the industrial parks that are commonly found near cities. These are normally well connected to infrastructure. Further more, these are usually public owned and typically contain food distribution centres. Moreover, as greenhouses consumes a large amount of energy, implementation of greenhouses in industrial areas could lead to a large reduction of heating and cooling costs due to the symbiosis that can be created by a greenhouse.

Energy and resource efficiency

Freisinger, Specht, Sawicka et al. (2015) claims that deployed resources such as water, energy and heat in buildings can be transferred to greenhouses. Integrated heating systems for rooftop greenhouses is possible, both for heating and cooling. By using the integrated system, the greenhouse could both change the temperature within the greenhouse and also regulate the temperature within the building. During the winter the greenhouse works as an insulation for heat loss and in the summer the impact of heat as the greenhouse works as an additional layer "thermal buffer element". Through circulation of water-based ventilation and dehumidification systems the greenhouse and building can be cooled (Freisinger, Specht, Sawicka et al. 2015).

To heat the greenhouse different sources can be used such as waste heat, such as water waste heat from swimming pools or local sources as a bakery (Freisinger, Specht, Sawicka et al. 2015). The crops that are used within the greenhouse could also influence the temperature, such as certain products need a higher temperature and other can manage to grow in lower degrees, therefore further energy savings could be obtained (Meijer 2015).

Organic waste cycles could be obtained by either using the compost occurring in the building or nearby. The use of compost makes it possible to reduce nutrient losses and it minimizes the need of using artificial fertilizers in the greenhouse (Freisinger, Specht, Sawicka et al. 2015). The rainwater, treatment of waste water from the underlying building or nearby or use of the evaporation water from the greenhouse are several ways the of using the water deployed (Freisinger, Specht, Sawicka et al. 2015).

5 Results

In this chapter the results of the interviews and additional data collection of the companies will be presented in alphabethical order in section 5.1. The results of the GIS study will be presented in 5.2.

5.1 Presentation of empirical data

5.1.1 Bee Urban

Bee Urban was established in 2010 in Stockholm. In 2016 their turnover was around 6.3 million Swedish krona. The company has seven employees (Allabolag 2017b). The interview was conducted with Josefina Oddsberg, acting CEO and Research & Developer at Bee Urban (Bee Urban 2017c).

Their vision is to create a sustainable city, where the citizens are aware of the processes of nature and to green the city, with a purpose to higher the social and ecological values and to transform the city into a living environment (Bee Urban 2018).
Bee Urban’s business model is selling bee hives to organizations. Their product line consists of several other services and products such as honey, installation of gardens, education and more (Bee Urban 2017b).
The company acts like a sponsor or host, as they are letting the bees. The beehives are placed on the renting company´s or consumer´s property, facility, garden or similar. Bee Urban takes care of the bees and the garden. They charge for the design, the facility and the gardening (Bee Urban 2017b; interview with Oddsberg 2017). Bee Urban fills the honey produced in jars with the company´s logo (directed to the customer) (interview with Oddsberg 2017), and leave some of it left in the hive to make sure that the bees have enough honey for the winter season (Bee Urban 2017b). For the renting company, its work with CSR, corporate social responsibility and environmental work both benefits and evolves in a new interactive way as the beehives and garden implementation stimulate participation and other soft values (Bee Urban 2017a; interview with Oddsberg 2017).
Additionally, Bee Urban also works with education, hold lectures on bees, biodiversity, and ecosystem services. They educate people in all ages and collaborate with schools and companies. They also produce their own honey and sell it in different grocery stores (Bee Urban 2017b).
Bee Urban’s aims to be the most up to date company in the market regarding trends and development and to use it to make good effort for the environment. They conduct a lobbying work and research within these issues. Furthermore, Bee Urban renew their services dynamically (interview with Oddsberg 2017).

5.1.2 Coop

The Cooperative Association was founded in 1899 with a vision of providing good food sold at good prices in their own stores. Furthermore, to create economic benefits and enable members to contribute to a sustainable development for both humans and the environment through their consumption (Coop 2017b). Their turnover in 2017, was 26.9 million Swedish krona with 354 employees (Allabolag 2017c). Coop Sverige AB constantly strives to find new ways to contribute to a better environment (Coop 2017a)

In the city of Stockholm, Coop has together with Bee Urban developed rooftop urban agriculture with a purpose of to gain a greener corporate profile and to gain valuable knowledge about biodiversity in the urban sphere and which later can be spread to their members. It is a pilot project and which can improve the future for more rooftop urban agriculture according to Coop (2016). The project, Garnisonen, will consist of a multifunctional usage and will function as a showroom. The aim is to exhibit the latest within urban sustainability and where property owners, companies and schools can come and learn about biodiversity (Konsumentföreningen Stockholm 2017).

The roof will contain of beehives, solar panels, a greenhouse, a rooftop farmland and an indoor cultivation (Mynewsdesk 2016). The products produced will later be sold in the same building at Coop (Jordbruksaktuellt 2016)

In the future, the building will be upgraded with vertical indoor farming, greenhouse agriculture, cooking, education, music and other cultural activities. Some sustainable urban technology will also be shown as solar panels, water treatment and rainwater harvesting (Jakobsson Törmä 2017; Konsumentföreningen Stockholm 2017).

5.1.3 Grönska

Grönska was founded in 2014 which de Brun Skantz started together with two partners, an architect and a growing expert. In 2016 they did have a small turnover (interview with de Brun Skantz 2017). The interview was conducted with Natalie de Brun Skantz at Grönska.

According to de Brun Skantz (interview 2017) their aim to start Grönska was to work with sustainability and urban agriculture. Their vision is to live in symbiosis with the city and use the existing grid in the city. This means using the resources the city provides as residual heat waste or energy waste or ecological compost the city produces. Their goal is to offer a sustainable, near-produced alternative to imported vegetables and herbs (Grönska 2017).

Grönska are focusing on providing locally produced crops to Swedish city dwellers and to only sell products to well established operators. At present Grönska have a zero-acre farming production in a cellar in the city of Stockholm and are selling their products to a restaurant and a grocery store, Paradiset, with no intermediaries (interview with de Brun Skantz 2018).

In the future, they plan to upscale their production and have facilities in other cities in the Nordic region and also to be able to sell to larger operators such as grocery stores (interview with de Brun Skantz 2017) and where the average consumer get their ordinary food (Kronbrink 2016)

Today their main production consist of basil and it will always be offered. Different types of herbs and other crops are being tested such as coriander. In the future berries might also be produced. Another idea is to produce strawberries all year round (Alexandersson 2016).

5.1.4 Plantagon

Plantagon International AB was founded in 2008, and has a vision to be the leading international clean tech company as well as global (interview with Mousavi 2017). In 2016, they achieved a turnover of 0.49 Swedish million krona with four employees (Allabolag 2017a). The interview was conducted with Sepehr Mousavi, sustainability strategist at Plantagon and member of the Plantagon International Association Board.

Plantagon is focusing on vertical greenhouses and indoor zero-acre farming. Their vision to start Plantagon was to provide sustainable solutions which solve global challenges within the categories of food, energy and water. They started with vertical farming to provide food to as many people as possible and by producing it in a sustainable way as well as to minimize the land footprints (interview with Mousavi 2017).

According to Mousavi (interview 2017) Plantagon's business model focusing on three types of customers, which are dependent of the size of the project. One of the projects will be in their cleantech park in Linköping in Sweden and where the aim is to farm several different perishable products. The products produced will be sold through a farmer's market located in the same building as the vertical greenhouse is implemented. The farmer's market is owned and organized by Plantagon, but there will be space for other producer or farmers to sell their products (interview with Mousavi 2017).

For the second project, located in the city of Stockholm, their vision is to have ten facilities for zero-acre farming and to produce all kinds of leafy salads, herbs and other vegetables. The facilities for the production are unused cellars in buildings in order to maximise the usage of the building and lower the costs (interview with Mousavi 2017). They also plan to use the residual heat waste product to reheat the building and implement good water management in order to reduce the supply of water (Thander 2017). For this project, the objective will be to sell to larger operators such as supermarkets (interview with Mousavi 2017).

The third project will use a subscription model for private customers where the customers receive a composition of several different products.

The supply chain will only consist of one or maximum two intermediaries before the product reaches the customer. It is also through this the profitability occurs in this type of industry compared to the conventional agriculture Mousavi (interview 2017) adds.

5.2 Presentation of GIS study

In total, 2885 buildings with a rooftop area of 1000m^2 or more were identified in the studied areas of the city of Stockholm. Among these 490 buildings offered a flat rooftop surface. Of these 490 building 376 had a rooftop with a different shape or obstructions such as ventilation or similar and was given value '1'. The remaining 114 buildings that had a square or rectangular

rooftop area or a more suitable rooftop for greenhouse implementation where most of the roof was clear from obstructions, was given value ‘2’.
The table below present a summary of all the buildings with a flat rooftop and an area of 1000m^2 or larger.

5.2.1 Presentation of all areas

The table presents a summary of all buildings, how many buildings that were valued ‘1’ and ‘2’, how many of which type and the number of buildings with different building footprint area in respectively city area. The blue marking shows the highest number in each column. The column “4000m^2≤” lists buildings that have a building footprint area of 4000m^2 or larger.

Table 4: *Presentation and summary of buildings*

Area	Buildings	Total	Value 1	Value 2	Industrial buildings	Operational buildings	Public buildings	Parking houses	Residential buildings	Area 1000-2000m2	Area 2000-4000m2	Area 4000m2≤
Bromma	Total	48			27	17	1	1	4	20	16	12
	Value 1	30	30		24	5	0	1	4	10	14	6
	Value 2	18		18	3	12	1	0	0	10	2	6
Enskede Årsta Vantör	Total	68			43	9	9	1	14	28	14	26
	Value 1	54	54		30	9	8	1	14	27	11	16
	Value 2	14		14	13	0	1	0	0	1	3	10
Hägersten Liljeholmen	Total	67			36	14	3	3	12	21	28	18
	Value 1	54	54		26	13	3	2	12	20	22	12
	Value 2	13		13	10	1	0	1	0	1	6	6
Kungsholmen	Total	37			4	12	13	0	7	11	19	7
	Value 1	28	28		2	6	12	0	7	10	14	4
	Value 2	9		9	2	6	1	0	0	1	5	3
Norrmalm	Total	28			0	15	1	0	9	6	12	10
	Value 1	21	21		0	10	1	0	8	5	8	8
	Value 2	7		7	0	5	0	0	1	1	4	2
Rinkeby Kista	Total	45			29	6	3	3	14	16	10	19
	Value 1	32	32		20	5	2	2	11	11	7	14
	Value 2	13		13	9	1	1	1	3	5	3	5
Skärholmen	Total	51			27	9	8	2	11	22	17	12
	Value 1	39	39		17	8	8	2	11	19	12	8
	Value 2	12		12	10	1	0	0	0	3	5	4
Spånga Tensta	Total	41			16	0	3	0	18	21	7	13
	Value 1	32	32		9	0	2	0	18	20	2	10
	Value 2	9		9	7	0	1	0		1	5	3
Södermalm	Total	69			20	7	9	1	39	43	21	5
	Value 1	64	64		17	7	8	1	38	41	20	3
	Value 2	5		5	3	0	1	0	1	2	1	2
Östermalm	Total	36			14	2	13	0	5	11	16	9
	Value 1	22	22		8	1	9	0	4	5	13	4
	Value 2	14		14	6	1	4	0	1	6	3	5
All areas	Total	490	376	114	216	91	63	11	133	199	160	131

Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

The columns have been grouped together to categories, *Value, All building types* and *Area.* Respectively category, will be presented in the next session, additionally, also respectively building type, *Industrial-, Operational-, Public buildings, Parking houses and Residential buildings*, will be presented.
In order not to be misleading or create confusion, the results only refer to the buildings found in this study, all the buildings with an area of 1000m^2 or larger, not all buildings in respectively city district.

Definitions:
"Building footprint area" means the rooftop area of the building (all area is included in both terms).
"$4000m^2\leq$" means buildings that have a building footprint area of $4000m^2$ or larger.

5.2.1.1 Presentation of each category

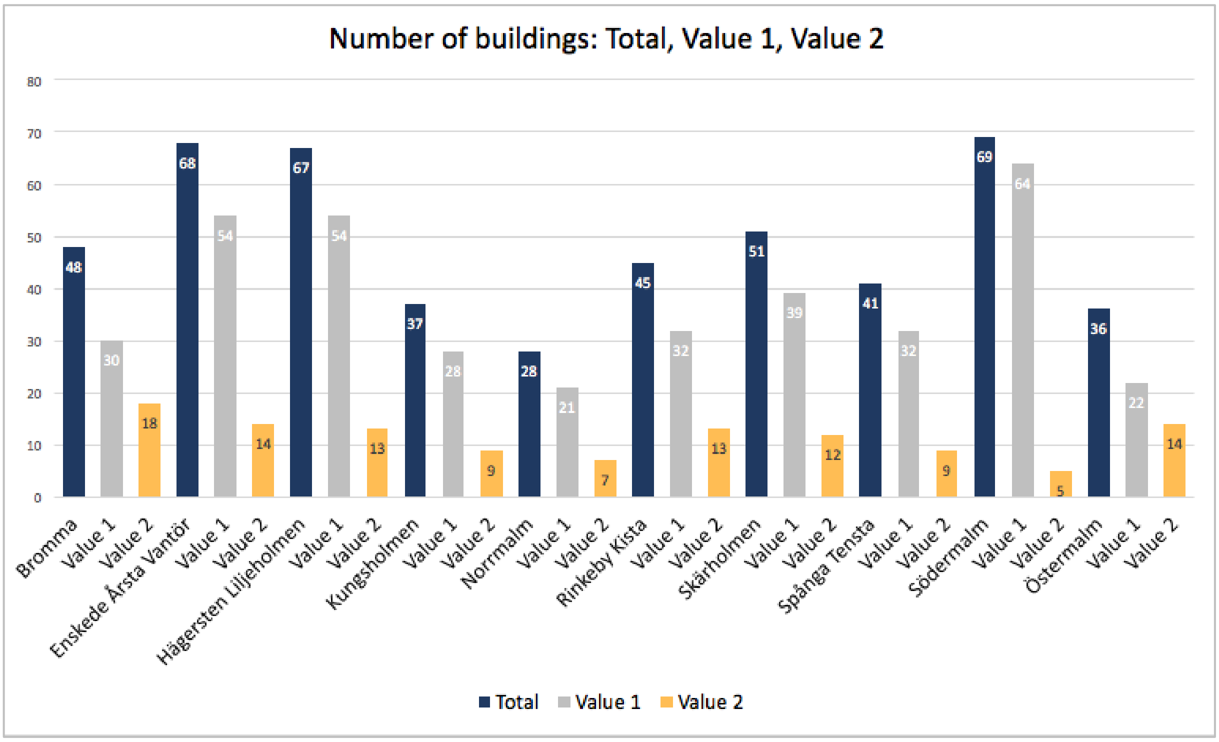


Figure 1. Presentation of number of buildings: Total, Value 1, Value 2
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

Södermalm has the greatest number of buildings in total (69) This district also have the greatest number that were given 'Value 1', 64 buildings. Bromma has the largest number of buildings with 'Value 2', 18 buildings.

Normalm has the lowest number of total buildings, 28 buildings and also the lowest number of buildings, 21, which were given value '1. Södermalm and Normalm are also the city districts with least amount of buildings given value '2'.

Most of the buildings are located in Södermalm, Enskede-Årsta and Hägersten-Liljeholmen and where these also received the highest values of buildings valued '1', all in respectively order from highest to lowest.

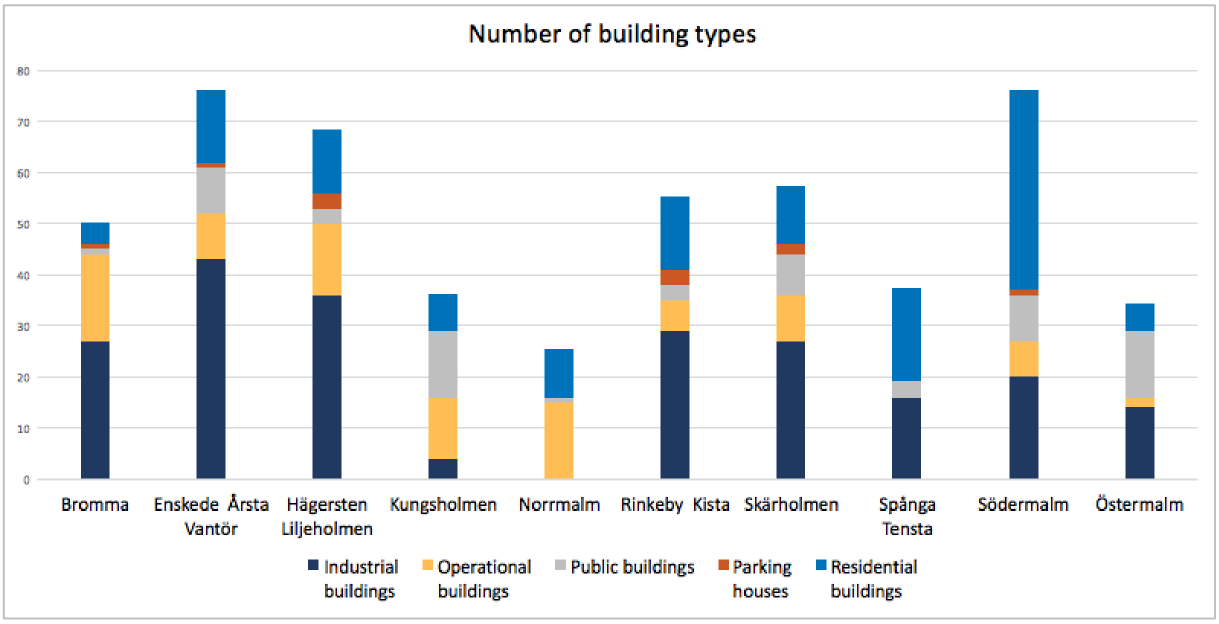


Figure 2. Presentation of number of building types in respectively area
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

N.B. In this specific figure, the parkinghouses are included. They belong to one of the other building types, therefore the real value of the staples are not equal to the y-value, number of buildings (for those staples that includes parkinghouses, the rest are correct).

Enskede-Årsta-Vantör containes the highest amount of the industrial buildings, 43 in total. Bromma has the highest amount of the operational buildings, 17 in total. Kungsholmen and Östermalm have the largest amount of the public buildings, 13 in each district. Hägersten-Liljeholmen and Rinkeby Kista, containes 3 parking houses each. Södermalm contained most of the residential buildings, 69 buildings.

Norrmalm does not have any industrial buildings, Spånga-Tensta does not have any operational buildings and four districts out of ten, Kungsholmen, Norrmalm, Spånga-Tensta and Östermalm do not have any parking houses. Finally, Bromma containes the smallest number of residential buildings, 4 units.

In total, most of the buildings identified are industrial buildings with 216 unit or 44% of the total. The 2nd largest category is residential buildings with 133 unit (27%).

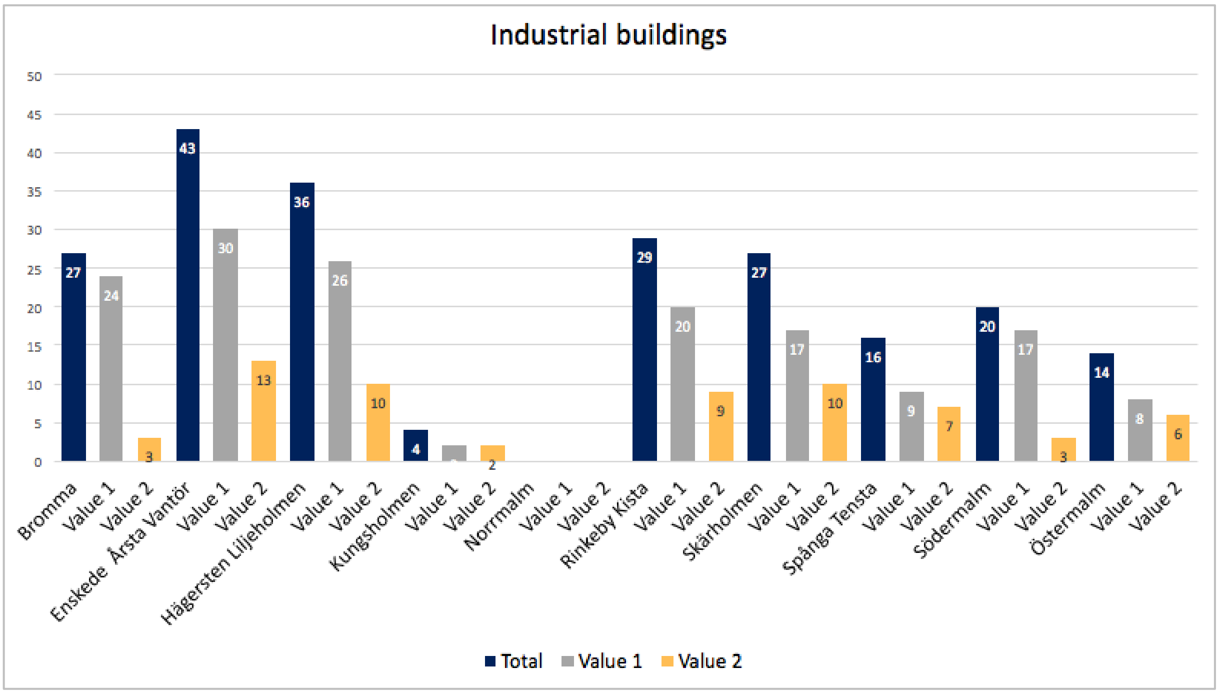


Figure 3: Presentation of industrial buildings in respectively area
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

In total there are 216 industrial buildings. Enskede-Årsta-Vantör containes most of the industrial buildings (43) and this district also has the highest number of buildings given value ‘2’, 13 units.
Finally, Kungsholmen has the lowest number of industrial buildings (4), valued ‘1’. This district has 2 buildings valued ‘2’.
In general, most of the industrial buildings are located in Enskede-Årsta-Vantör, Hägersten-Liljeholmen, Rinkeby-Kista, Skärholmen and Bromma in respectively order from highest to lowest.

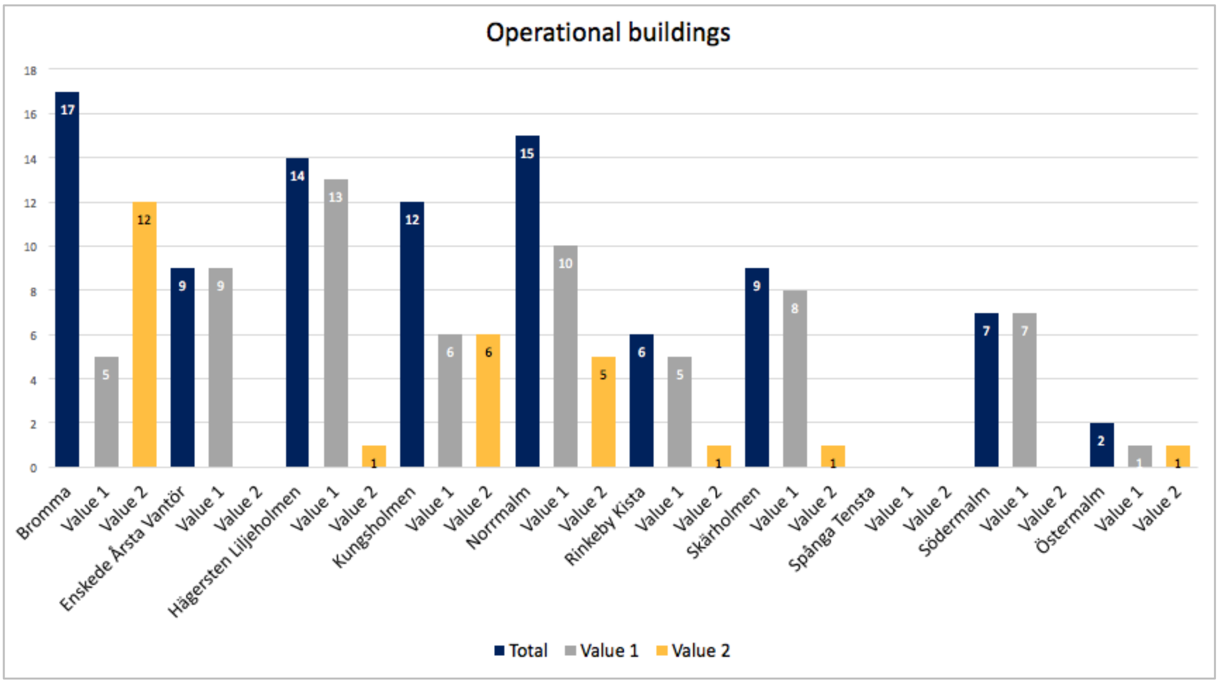


Figure 4: Presentation of operational buildings in respectively area
Based on data set provided by: Stadsbyggnadskontoret (2017)

There are in total 91 operational buildings where Bromma had the highest amount, 17 buildings. Bromma did also have the highest amount of the buildings valued ‘2’, 12 buildings. Hägersten-Liljeholmen had the highest number of buildings, 13, that were valued ‘1’. Spånga-Tensta did not have any operational buildings.

What can be further said, most of the operational buildings given value ‘2’ are located in the areas, Bromma, Kungsholmen and Norrmalm.

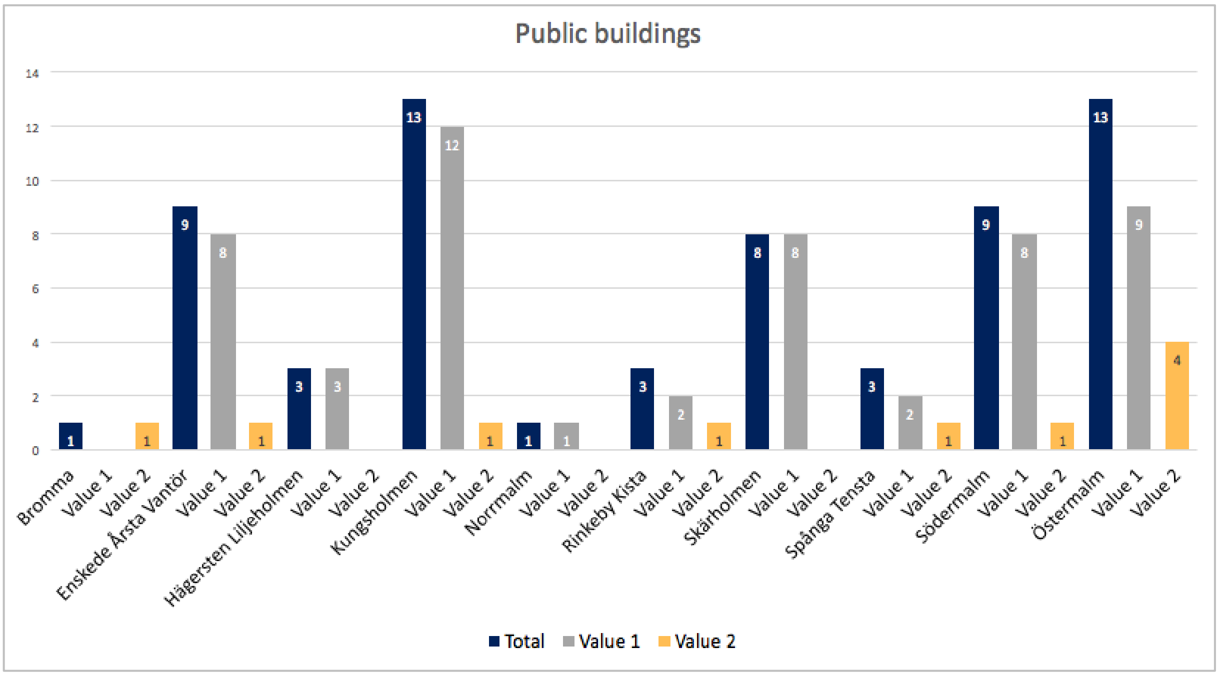


Figure 5: Presentation of public buildings in respectively area
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

There were 63 public buildings in total. Kungsholmen and Östermalm had the largest amount of the public buildings with a number of 13 each. Östermalm did further have the highest amount of buildings valued ‘2’, 4 buildings.
Bromma and Norrmalm had the smallest amount of public buildings, 1 each, and where the latter, the buildings in Norrmalm received value ‘1’. Six areas consisted of only one building that were valued ‘2’.

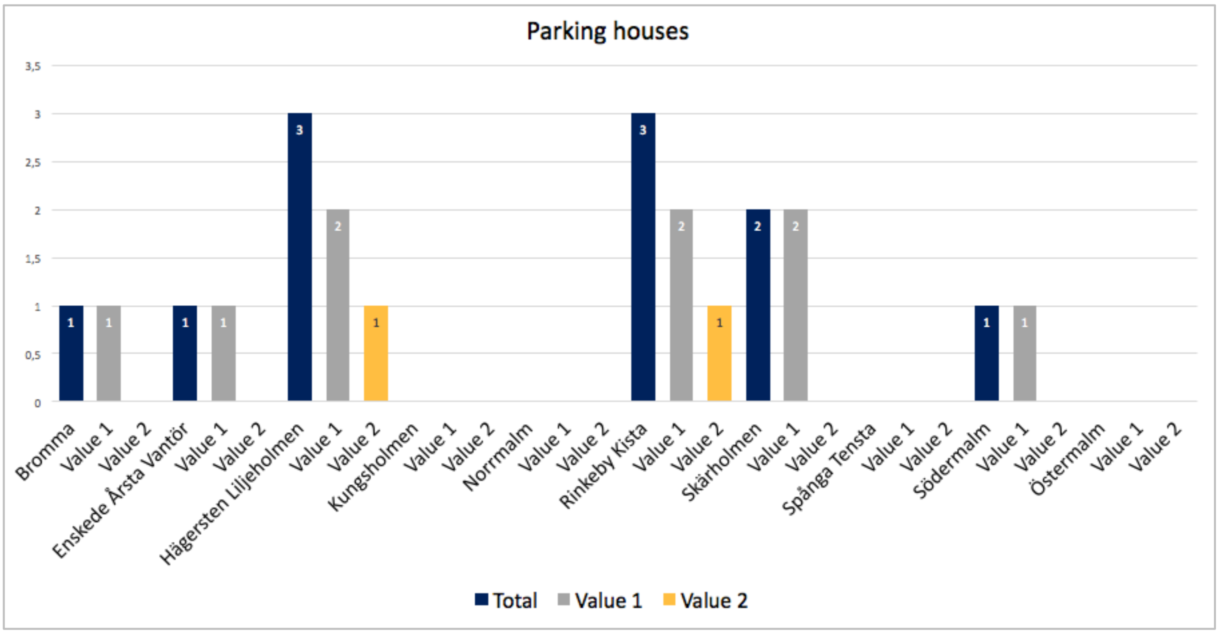


Figure 6: Presentation of parking houses in respectively area
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

In total there were 11 parkinghouses. Hägersten-Liljeholmen and Rinkeby-Kista, contained 3 parking houses each. Furthermore, were there only four more areas of ten in total, Bromma, Enskede-Årsta-Vantör, Skärholmen and Södermalm that also contained parking houses, between 1 to 2 each. Lastly, only Hägersten-Liljeholmen and Rinkeby-Kista had one parking house each that were valued ‘2’.

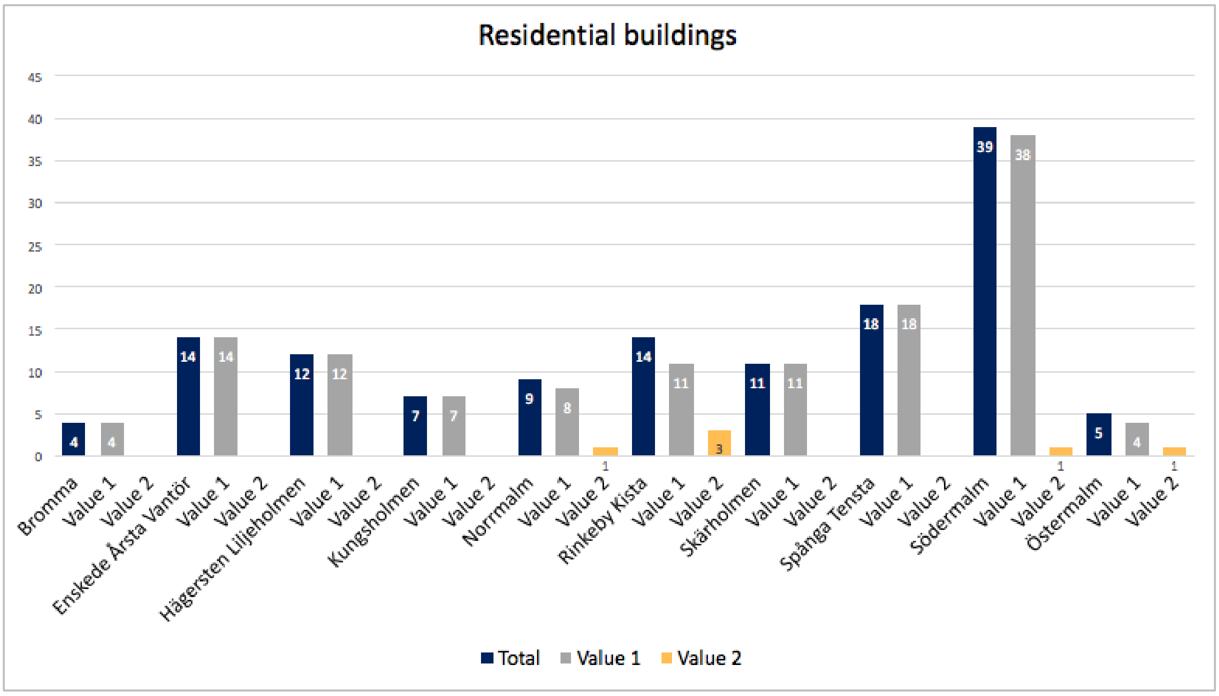


Figure 7: Presentation of residential buildings in respectively area
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

In total there were 133 residential buildings. Södermalm contained the most, 39 buildings. Rinkeby-Kista contained 3 buildings that were valued '2'.
Bromma contained the smallest number, 4 buildings and the smallest of value '1', 4 buildings.

In general, the majority of the residential buildings are valued '1'.

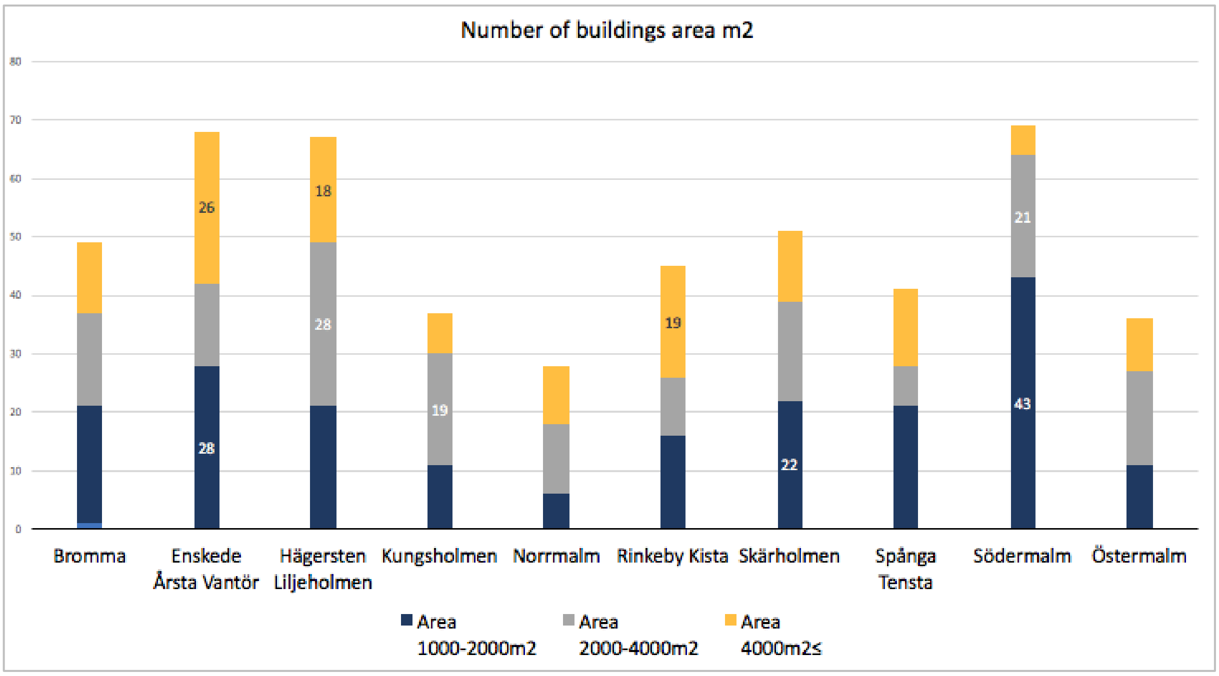


Figure 8: Presentation of number of buildings area m^2
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

Södermalm consists of most of the buildings with an area of $1000m^2$, 43 buildings. Hägersten-Liljeholmen had the greater number of buildings with an area of $2000\text{-}4000m^2$. Enskede-Årsta-Vantör contained most of the buildings with an area of $4000m^2$ or larger.
Normalm had the smallest amount of buildings with and area of $1000m^2$, 6 buildings. Spånga-Tensta did further have the smallest amount of buildings with and area of $2000\text{-}4000m^2$, 7 in total. Lastly, Södermalm had the smallest amount of buildings with an area of $4000m^2$ or larger.

Hägersten-Liljeholmen, Södermalm and Kungsholmen contained most of the buildings with an area of $2000\text{-}4000m^2$. Enskede-Årsta-Vantör, Rinkeby-Kista and Hägersten-Liljeholmen had most of the larger buildings, $4000m^2$ or larger. All city areas presented from highest to lowest respectively.

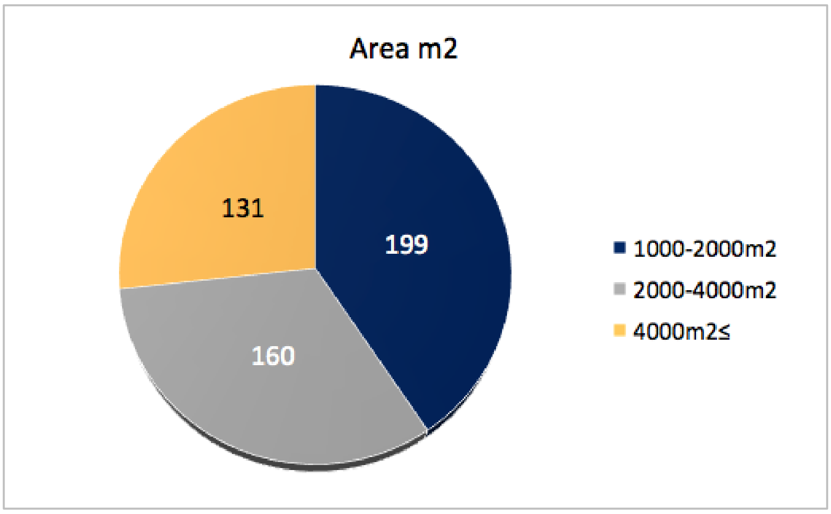


Figure 9: Presentation of building footprint area
Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

In total, 40%, a number of 199 of the buildings had a building footprint area of 1000-2000m^2, 33%, number of 160 consisted of an area of 2000-4000m^2 and lastly 27%, a number of 131 of the buildings had an area of 4000m^2 or more.

In summary, all categories and building types with the highest number, and a smaller general summary:

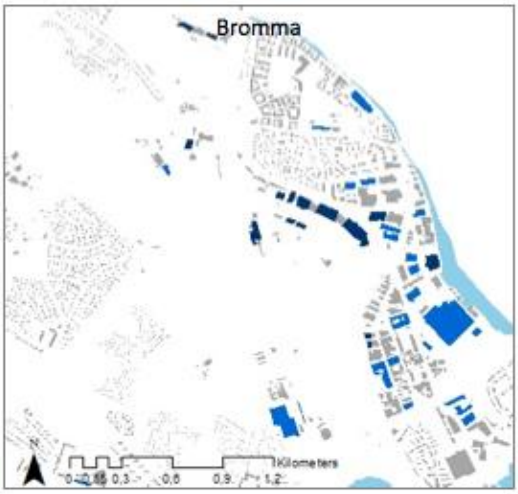
Södermalm had the greatest number of buildings in total, 69 buildings, and the ones that were given ‘Value 1’, 64 buildings. Furthermore, Södermalm did also consist of most of the residential buildings and the ones with an area of 1000m^2, 39 respectively 43 buildings. Bromma had the largest number of the buildings with ‘Value 2’, 18 buildings. They did also have the highest number of operational buildings, 17.
Enskede-Årsta-Vantör contained most of the industrial buildings, 43 buildings, and also the ones that had the most buildings that were larger than 4000m^2, 26 buildings in total. Kungsholmen and Östermalm had the largest amount of the public buildings with a number of 13 each. Hägersten-Liljeholmen and Rinkeby-Kista contained 3 parking houses each. Hägersten-Liljeholmen had the greater number of buildings with an area of 2000-4000m^2.

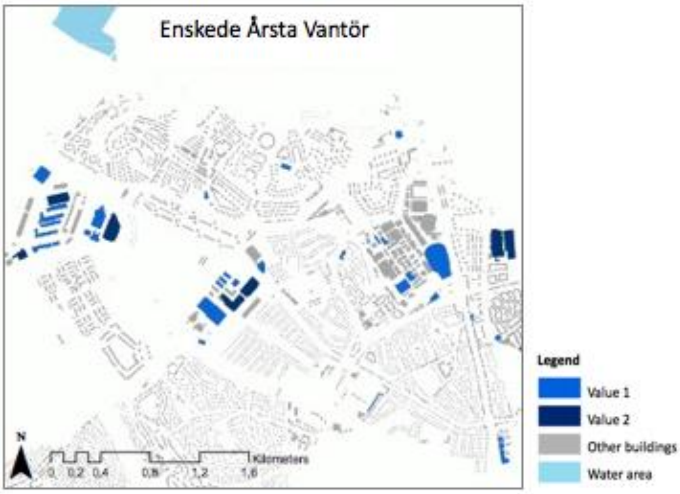
In total, most of the buildings identified were industrial buildings with an amount of 216, 44%, second most were residential buildings of 133, 27%. Furthermore, 40%, 199, of the buildings had a building footprint area of 1000-2000m^2, 33%, 160, consisted of an area of 2000-4000m^2 and lastly 27%, 131, of the buildings had an area of 4000m^2 or more.

5.2.2 Presentation of respectively area

Down below all the city areas are presented with a map included. For a full map of the area, displaying all the buildings, the identified buildings, and with an inclusion of roads, infrastructure and water area please see the ‘Appendix 4’. The appendix further includes a separate table for each of the city areas, respectively footprint area of each building and more.

The buildings given value ‘1’ consisted of a rooftop with a different shape or obstructions such as ventilation or similar. The buildings given value ‘2’ consisted of a square or rectangular rooftop area, or a more suitable rooftop for greenhouse implementation and where most of the roof was clear from obstructions.
The blue markings in the table indicates that the number was the highest in that specific column compared to the rest of the city areas.





Map 2: Bromma

Map 3: Enskede-Årsta-Vantör

Maps 2&3: Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

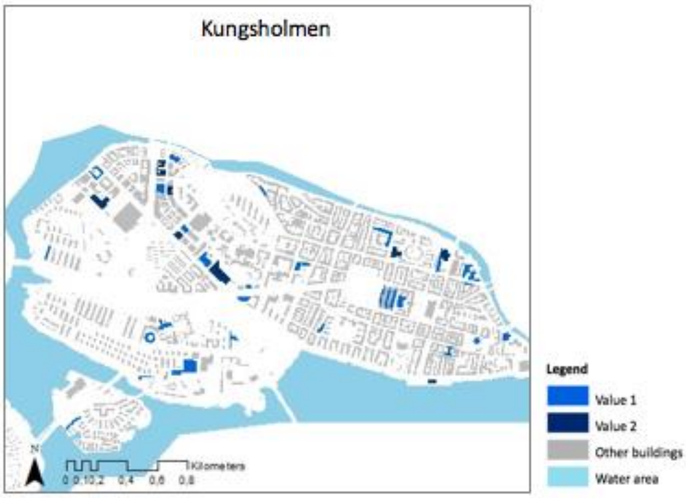
Table 5: *Presentation of Bromma and Enskede-Årsta-Vantör*

Area	Buildings	Total	Value 1	Value 2	Industrial buildings	Operational buildings	Public buildings	Parking houses	Residential buildings	Area 1000-2000m2	Area 2000-4000m2	Area 4000m2≤
Bromma	Total	48			27	17	1	1	4	20	16	12
	Value 1	30	30		24	5	0	1	4	10	14	6
	Value 2	18		18	3	12	1	0	0	10	2	6
Enskede Årsta Vantör	Total	68			43	9	9	1	14	28	14	26
	Value 1	54	54		30	9	8	1	14	27	11	16
	Value 2	14		14	13	0	1	0	0	1	3	10

Based on dataset provided by: Stockholms Stadsbyggnadskontor (2017)

Bromma had the largest amount of operational buildings, 17. Bromma did also have the highest number of buildings given value ‘2’, 18 buildings. In Bromma 58% of the studied buildings contains a building footprint area larger than $2000m^2$.
Further on, it had the lowest amount, 4, of residential buildings. A larger number of the buildings are industrial or operational buildings, and where 12 of 17 in total, 71%, of the operational buildings received value ‘2’. Finally most of the identified buildings are located in the same district and close to infrastructure with larger roads.

Enskede-Årsta-Vantör had the second most buildings, 68 buildings, after Södermalm with 69 buildings. It was also the one with most industrial buildings, 43, and the one with most buildings with an area of 4000m^2 or more. Enskede-Årsta-Vantör was also the one with most of the largest buildings. 7 buildings that had an area of more than 12000m^2, and where 6 of these contained a value ‘2’, furthermore were all of these categorized as industrial buildings. The greatest consisted of over 41000m^2, second largest among the identified buildings and was given value ‘1’. The building is a public building intended for sports and athletics. Furthermore, Enskede-Årsta-Vantör did also have the highest number 10 buildings given ‘Value 2’ of roofs with an area of 4000m^2 or more. Finally, a greater number of the buildings are located near bigger roads.



Map 4: Hägersten-Liljeholmen Map 5: Kungsholmen
Maps 4&5: Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

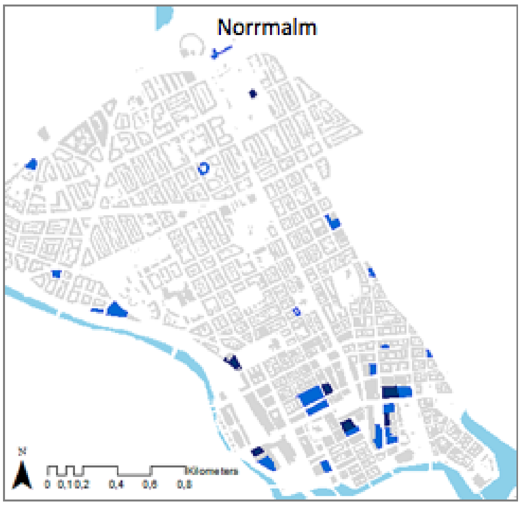
Table 6: *Presentation of Hägersten-Liljeholmen and Kungsholmen*

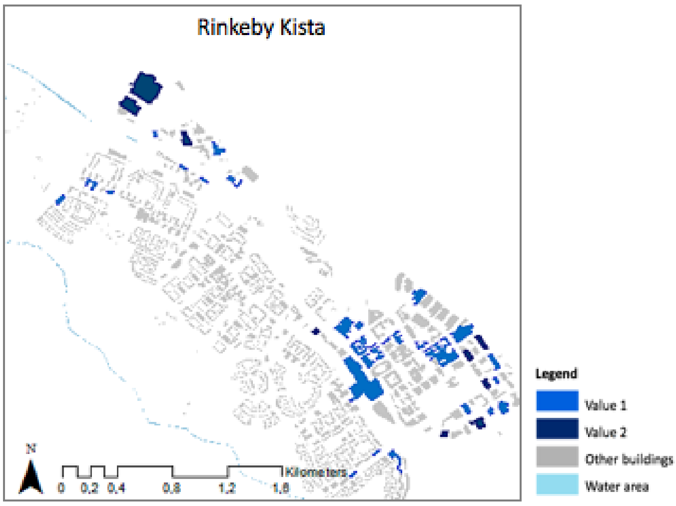
Area	Buildings	Total	Industrial buildings	Operational buildings	Public buildings	Parking houses	Residential buildings	Area 1000-2000m2	Area 2000-4000m2	Area 4000m2<
Hägersten	Total	67	36	14	3	3	12	21	28	18
Liljeholmen	Value 1	54	26	13	3	2	12	20	22	12
	Value 2	13	10	1		1		1	6	6
Kungsholmen	Total	37	4	12	13	0	7	11	19	7
	Value 1	28	2	6	12		7	10	14	4
	Value 2	9	2	6	1			1	5	3

Based on dataset provided by: Stockholms Stadsbyggnadskontor (2017)

Hägersten-Liljeholmen contains mostly of industrial buildings, 54%, and had the second largest amount of industrial buildings after Enskede-Årsta-Vantör. Furthermore, it was also the one with the greatest number of buildings with an area of 2000-4000m^2, 28 buildings. Further on, Hägersten-Liljeholmen was one of two areas containing a parking house given value ‘2’. It also contained the largest parking house with an area of approximately 4200m^2. Greater roads are close to most of the buildings.

Kungsholmen had the largest number of public buildings 13, and second most on Kungsholmen consists of operational buildings, 12 in total. 51% of the buildings contains an area of 2000-4000m^2. Moreover, Kungsholmen 2 of 4 industrial buildings received ‘Value 2’. Finally, a greater number of the buildings are located closely to bigger roads.





Map 6: Norrmalm Map 7: Rinkeby-Kista

Maps 6&7: Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

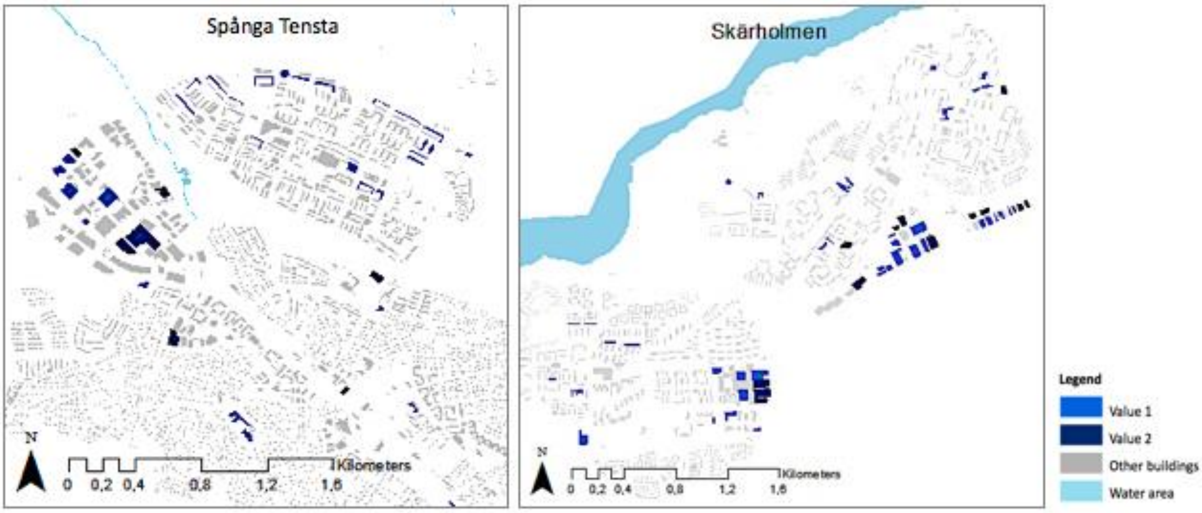
Table 7: *Presentation of Norrmalm and Rinkeby-Kista*

Area	Buildings	Total	Industrial buildings	Operational buildings	Public buildings	Parking houses	Residential buildings	Area 1000-2000m2	Area 2000-4000m2	Area 4000m2<
Norrmalm	Total	28	0	15	1	0	9	6	12	10
	Value 1	21		10	1		8	5	8	8
	Value 2	7		5			1	1	4	2
Rinkeby	Total	45	29	6	3	3	14	16	10	19
Kista	Value 1	32	20	5	2	2	11	11	7	14
	Value 2	13	9	1	1	1	3	5	3	5

Based on dataset provided by: Stockholms Stadsbyggnadskontor (2017)

Norrmalm had the smallest number of buildings, in total 28. It had the second most highest of the operational buildings, 15 buildings. Furthermore, the majority of the buildings, 76%, had an area larger than 2000m^2. Norrmalm did not have any industrial buildings nor parking houses. All the buildings are close to bigger roads.

Rinkeby-Kista consist mainly of industrial buildings, 64%. It also has the largest building, an operational building for offices, with a building footprint area of approximately 43500m^2, given value ‘1’. Furthermore, it was one of two areas consisting of three parking houses. Finally, most of the buildings are near greater roads.



Map 8: Skärholmen Map 9: Spånga-Tensta

Maps 8&9: Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

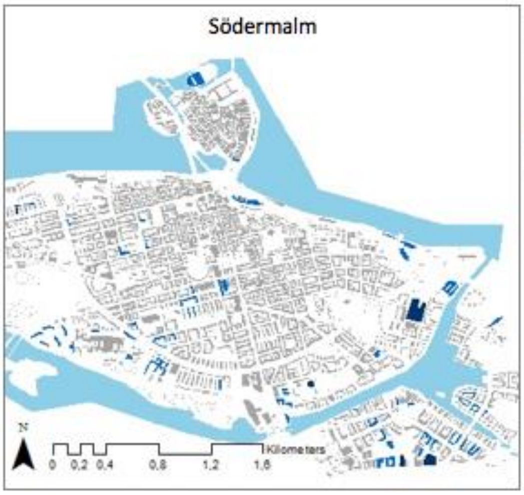
Table 8: *Presentation of Skärholmen and Spånga-Tensta*

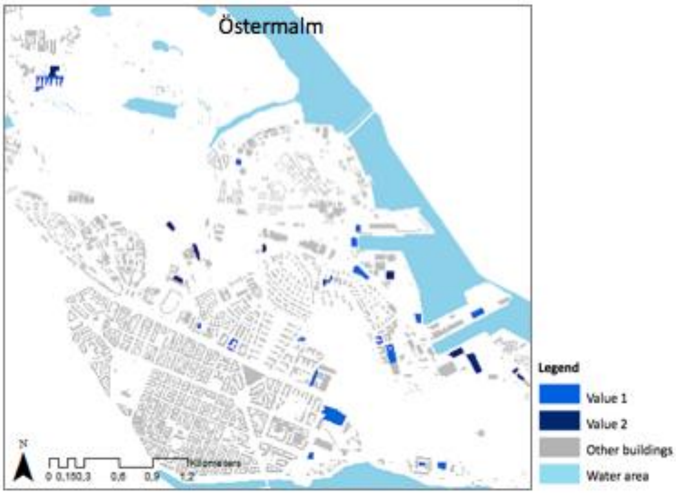
Area	Buildings	Total	Industrial buildings	Operational buildings	Public buildings	Parking houses	Residential buildings	Area 1000-2000m2	Area 2000-4000m2	Area 4000m2<
Skärholmen	Total	51	27	9	8	2	11	22	17	12
	Value 1	39	17	8	8	2	11	19	12	8
	Value 2	12	10	1				3	5	4
Spånga	Total	41	16	0	3	0	18	21	7	13
Tensta	Value 1	32	9		2		18	20	2	10
	Value 2	9	7		1			1	5	3

Based on dataset provided by: Stockholms Stadsbyggnadskontor (2017)

Skärholmen contained the third largest of all buildings of nearly 22000m^2. The building did further receive value ‘2’ and is categorized as an operational building for retail. Skärholmen had a large amount of industrial buildings of the total amount of buildings and more than half of the buildings contained an area larger than 2000m^2., 57%. Moreover, the majority of the buildings are connected to bigger roads.

Spånga-Tensta were the second city area consisting of a greater amount of residential buildings than industrial, 43% of the buildings in total within the city area. Further on, 50% of the buildings had an area of 1000-2000m^2. After Södermalm, this city area is the one with second most “smaller” buildings, 1000-2000m^2, compared to rest of the city areas studied. Many of the buildings are close to greater ways.





Map 10: Södermalm Map 11: Östermalm
Maps 10&11: Based on data set provided by: Stockholms Stadsbyggnadskontor (2017)

Table 9: *Presentation of Södermalm and Östermalm*

Area	Buildings	Total	Industrial buildings	Operational buildings	Public buildings	Parking houses	Residential buildings	Area 1000-2000m2	Area 2000-4000m2	Area 4000m2<
Södermalm	**Total**	69	20	7	9	1	39	43	21	5
	Value 1	64	17	7	8	1	38	41	20	3
	Value 2	5	3		1		1	2	1	2
Östermalm	**Total**	36	14	2	13	0	5	11	16	9
	Value 1	22	8	1	9		4	5	13	4
	Value 2	14	6	1	4		1	6	3	5

Based on dataset provided by: Stockholms Stadsbyggnadskontor (2017)

Södermalm had the greatest number of total buildings, 69 buildings, of residential buildings, 39 buildings, and buildings consisting of an area between 1000-2000m^2, 43 buildings. More that half of the buildings at Södermalm consist of an area of 1000-2000m^2. Furthermore, it also has the largest number of buildings with 'Value 1', 64, but also the smallest number of buildings given 'Value 2', with merely 5. All buildings are close to bigger ways.

The results show that Östermalm consists of 75% of industrial and operational buildings. Nearly half of the industrial buildings was given value '2'. Almost 70% of the buildings have an area larger than 2000m^2. Lastly it has the second least amount of residential buildings.
Östermalm is the only one where the buildings are widely spread over the whole city area compared to the other city areas where the buildings are mostly grouped or clustered. Finally, all the buildings are connected to larger roads.

6 Discussion

This thesis provided three research questions. The first two research questions were to investigate how the commercial urban agriculture operate: *What are the current business models and strategies of the commercial urban agriculture companies in Stockholm?* and *What* *are the supply chains of the for-profit urban agriculture firms in Stockholm?.* The third question was to explore how many roofs in the city of Stockholm has potential for commercial rooftop greenhouse implementation: *How many roofs are potentially suitable for a greenhouse in the city of Stockholm?*

6.1 will discuss the empirical data of the companies and where the first research question of this thesis will be answered in 6.1.1 and 6.1.2, and the second will be answered in 6.1.3. A short summary will be presented in 6.1.4
6.2 will discuss the results from the GIS study including literature review part II and where the third research question will be answered. Limitations of research will be provided in 6.3.

6.1 Business models, strategies and supply changes

6.1.1 Business model

The business model of Bee Urban could be best explained by the model of Gliessman (2007, pp.334-337), *community supported agriculture,* where the customer to Bee Urban hosts the beehives and pay a subscription, an annual cost for to have the production at their place. In other words, they buy a part and the final production as Gliessman (2007, p.334-337) described it as. The model also indicates Bee Urban harvest the products and the customer receives honey. Bee Urban also uses a diversity of products as this business model also implies.

Coop suits best with the *secondary purpose farm* of Hedin's (2015) models. The urban agriculture activity could be interpreted as a marketing activity, which this business model also implies, that it is supported by another main business (Hedin 2015). Further on, the main business of Coop, how they earn profit, is by their grocery stores and supermarkets.

Grönska can be best explained (at present) by the model *small production* of Hedin (2015), where the products the company produces are being directly sold to a restaurant and a grocery shop which is in line with the description of small production selling directly to a restaurant or farmers market (Hedin 2015), the latter in this case, a grocery store. The production is further very specialized with only a few products, basil and a few other herbs, which this *small production* model is also characterized as.

Plantagon, looking at the whole company and not the specific projects, Plantagon's business model fits best with the description of the business model *large production* of Hedin (2015). The ten planned facilities, their scale production of leafy salads and herbs, the narrow product line inclusive the two other projects in Sweden. Further on they plan to sell through retail, larger supermarkets, which is further align with the business model *large production. Small production* could have fitted with two of three of the projects where the aim in one of them was to use a subscription model and the second to sell to farmer's market. Yet, as previously mentioned in the beginning of this paragraph, if studying whole Plantagon, it is interpreted to be better suited with the description of a *large production.*

The majority of the companies, 3 of 4, used the models of Hedin. The company Grönska was using *small production* at present and had an intention to later develop into a larger business, by expanding in cities of Sweden and in the Nordic region. Their current business model *small production* will thus develop into a *large production* business model. In the terms of their low-cost facilities, the amount of facilities and their narrow product line which characterizes the *large production* business model. Furthermore, this is also in line with Hedin's (2015) statement that a *small production* further needs to develop into a *large production.*

6.1.2 Strategies

Bee Urban's strategy fits best with the strategy *diversification* (Van der Schans 2015). The activities of the company is divided between its customers and partnerships and where the latter is where the production of the honey also occurs. Different activities as suggested in Van der Schans model, as education, is also within Bee Urban's strategy. Furthermore, the synergy between the different activities as Van der Schans (2015) suggests could clearly be seen in Bee Urban's strategy such as the production of honey, education and the soft values it brings to the customer.
Lastly in the *diversification strategy*, the business-consumer activity and the business-to-business activity is also identified in Bee Urban's strategy as the production that further is sold through different food groceries to the consumers, and the education or lecturing, business-to-business is also within Bee Urban's strategy.

The interpreted marketing activity of Coop, the commercial urban agriculture, could not be placed within any of the suggested strategies developed by Van der Schans. A reason for this is as they are not using their activity as their main part of their operation to be profitable. Furthermore, the proposed strategies are strategies that are used within operations that specifically working with commercial urban agriculture as their main business.

The strategy of Grönska is best described as a *low-cost strategy* (Van der Schans 2015). Grönska is focusing on using one type of zero-acre farming located in empty or unused buildings, or as Van der Schans (2015) describes it, using resources that are not fully utilized. By using those as facilities for their production they can in such way be able to minimize the external input, production cost, which is typically characterized for this strategy.

In the case with Plantagon, they use the strategy *low cost strategy* in Van der Schans (2015) model. Aiming to offer a larger selection of leafy salads and use unused facilities in the city. Furthermore, using waste heat and wastewater as minimizing the costs, or in Plantagon's case being environmentally friendly, is also within the business model of Van der Schans (2015).

In summary, two of five of the proposed strategies by Van der Schans were used among the four companies. Furthermore, as Van der Schans (2015) suggests that more than one strategy is normally used within commercial urban agriculture, a third strategy, *differentiation,* could also be counted as one of the strategies for Plantagon since it provide products that are not produced from the conventional agriculture. However, as Hedin (2015) stated that the product itself already creates value, it is therefore difficult to analyze further if *differentiation* is an intended strategy or not for the company.
In the case of Grönska, a similar confusion occurs. The strategy *differentiation* could also be interpreted to be used within the company. For example, aiming to provide swedish strawberries all year round compared to otherwise being a summer product. Though, the strategy *differentiation* is not clear whether or not if it is valid for only products that are distinguished from the conventional agriculture, or if it is valid for all urban agriculture products.

6.1.3 Supply chain

Bee Urban's supply chain could be best explained by the *third category* of the supply chain models of Wubben et al. (2013). Since their business model are focusing on a direct relationship with its customer and the importance of having a strong connection to them. The value creation and capture is a bit vague in this category (Wubben et al. 2013) and also in line with Bee Urbans offering. To the customer of Bee Urban, it is not a direct value to the company but rather indirect as it influences it CSR and environmental work. Furthermore, Bee Urban's other services such as the education or the gardens provide similar results, enhancing the soft values at the customer rather than directly creating value.

The urban agriculture activity of Coop could not be suited within any of the proposed categories. As previously mentioned in the last section, this could be explained by as Coop is not using urban agriculture as their main business, it is rather one of their activities used within the company, for a marketing purpose. The presented models of Wubben et al. (2013) are the most central in the commercial urban agriculture business model (and commercial urban farms) according to the authors, and since the urban agriculture practice or activity is not the initial business of Coop (supermarket), it could for that reason explain why these models can not be suited in Coop's urban agriculture.

Grönska is best suited with the *second category* of Wubben et al. (2013). The company is only focusing on selling to well established operators, restaurant and grocery store, and could be interpreted as the support to the producer in this category of Wubben et al. (2013). The customers of Grönska could be the strategic collaboration that Wubben et al. (2013) refers to in this category. Through this way Grönska uses another structure then the market as this category also implies. Furthermore, this is also how the company reduces the food miles of the products produced which is also characterized for the *second category*.

Since Plantagon having three different projects and where the products are distributed in different ways, one category have been identified being used more frequently and to be better suited in their business model, the *second category* of Wubben's et al. (2013) models. The second category refers to the first project, the vertical greenhouse production in Linköping, selling through a farmer's market where this could also be interpreted to be an intermediarie before the prodcuts reaches the customer. The reason to why it could be seen as an intermediarie is because of the opportunity for other producers or farmers to sell their products in the facility of Plantagon. The second project where a collaboration with larger operators is being held, the supermarkets are analysed to be the support to the producer as the second category of Wubben et al. (2013) implies. In both projects the transportation food miles is shortened by selling directly to the distributor as this category is further characterized of (Wubben et al. 2013). The last, the third projct that will be a substricption model is unclear if it will be received directly from the company. But overall, this category is interpreted to be best suited when analysing Plantagon as a whole.

In conclusion, the presented companies within this thesis further uses very few or none intermediaries compared to the conventional agriculture, which was also stated by the researchers Wubben, Fondse and Pascucci (2013) to be the most crucial for commercial urban agriculture to be economically viable.

Synthesis

The table below presents a summary of all four companies.

Company/model	Business model	Strategy	Supply chain model
Bee Urban	Community supported agriculture	Diversification	Third category
Coop	Secondary purpose	-	-
Grönska	Small production	Low cost	Second category
Plantagon	Large production	Low cost	Second category

Table 10: *A summary of all four companies business models, strategies and supply chain models*

Grönska are using a *Small production* business model at present but are interpreted to be aiming towards a *Large production* business model. Plantagon uses *Large production* and the same strategy and supply chain model as Grönska. This could be interpreted to be better suited for larger operations, using *large production, low cost* strategy and *second category.*

Coop uses a *Secondary purpose* business model and their urban agriculture practice is interpreted as a marketing purpose of the company. For that reason, the models of Van der Schans and Wubben et al. could not be fitted within Coops business since these researchers' models are referrering to for-profit urban agriculture that uses urban agricutlture as their main business.

Bee Urban is using the *Third category,* a strong relationship with its customers which seems to be crucial when using a *Community supported agriculture* model.

In conclusion, in the contesxt of the city of Stockholm and what kind of operations that could emerge, for larger operations a large production, a low cost strategy and secondary purpose supply chain seem to be the better option for to be profitable. For smaller operations, or other kinds of operations, a community supported business model and the third category, a strong relationship, seems to be a good alternative as this was the only business model used among the propsed models by Gliessman. Furthermore, several researchers mentioned in this thesis has also suggested this model, e.g. Meijer, or it is used in other for-profit companies such as Östergro using a CSA model. Since it is more difficult for smaller operations to take advantage of scale production as larger operations, it has also been pointed out in this thesis that people are willing to pay a higher price, both low incomers as high incomers according to Ruehl and Goldblatt (2013), and therefore it could be possible to take a higher price to cover the costs as a small operation.

Finally, if implementing for-profit urban agriculture as a secondary purpose, it needs to be supported by the initial company as the case of Coop and give value for both its customers and to Coop. The value for its customers in this case is the educational and inspiring urban agriculture.

6.2 Roofs suitable for RTG in the city of Stockholm

All city districts studied contains good infrastructure when looking at their roads which was also stated by Mousavi (2017). The accessibility, in consideration to access of the buildings, could therefore be considered possible and which was also a suggested criterion by Freisinger, Specht, Sawicka et al. (2015) when determining where a greenhouse could be placed.

Of the top three largest buildings, in Skärholmen, with the third largest building footprint area, was considered to have the best potential for a larger production. Since this building was valued '2' and was used for retail, theoretically the building might contain actors with high resource waste such as energy waste, which could enhance the possibility of using larger operations (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). The two other buildings seemed to have less potential for the reasons that the greatest building in Rinkeby-Kista had the purpose of a operational building and was only given value '1' which therefore was considered to have less potential. The second largest building, located in Enskede-Årsta-Vantör, was also valued '1' and used for sports. The latter might be advantageous depending on what kinds of sport it is used for. As Freisinger, Specht, Sawicka et al. (2015) suggested that implementing a commercial greenhouse on a building containing a swimming pool is a good strategy to minimize the need of resources to heat a greenhouse.

Enskede-Årsta-Vantör, Bromma, Hägersten-Liljeholmen, Rinkeby-Kista and Skärholmen, were the city districts identified most suitable for installing a commercial greenhouse with a large production, in respectively order from highest to lowest, since these type of areas are considered to have good potential for larger operations according to the authors Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015). Enskede-Årsta-Vantör had the greatest amount of large buildings, had a high amount of more suitable buildings, value ‘2’, and where these were all industrial buildings. Given this, industrial symbiosis (André & Jonsson 2013) and a larger production (Berger 2013; Freisinger, Specht, Sawicka et al. 2015) which all lower the production costs could be suitable and preferable (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). Bromma, Hägersten-Liljeholmen, Rinkeby-Kista and Skärholmen did also consists of a large amount of industrial buildings and buildings with value ‘2’, and where the greater amount of these areas had buildings larger than 2000m^2. For these reasons these city areas are considered to be the greater alternatives for implementing larger operations which the authors Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015) also suggests for these kinds of areas. Lastly, two of the identified parkinghouses with a value ‘2’, were within these areas, which Meijer (2015) stated would be an easier option to install a greenhouse since they already are constructed to carry large weights.
That these areas also are located in industrial areas also higher the possibility for many food trucks to get through (Gorgolewski & Straka in Orsini, Dubbeling & de Zeeuw et al. 2017, p. 114).
The results of Östermalm and Kungsholmen indicates that these inner city areas are better suited for implementation of a commercial rooftop greenhouse in contrast to Södermalm and Norrmalm. These areas consisted of a larger amount of industrial, operational and public buildings which therefore might be easier to receive an agreement by the owner of the property, since these are not residential buildings that according to the authors Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. (2015) have more property owners compared to other buildings.
Östermalm did further consist of several larger industrial buildings compared to the other inner city areas which are according to Berger (2013) more commercially viable to implement a commercial RTG on. A larger production could in this place be more of interest and further on using the buildings waste heat could also minimize the production costs as suggested by André and Jonsson (2013). Furthermore, economies of scale can thus be obtained (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). On Kungsholmen, two larger industrial buildings given value ‘2’ was also identified and had potential for a larger operation (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015).

Norrmalm, one of the four inner city areas, did also consists of a few larger buildings and where some of them might have potential for a commercial greenhouse and also a larger operation as 76% of them were identified having an area larger than 2000m^2. Since neither of them are industrial buildings, creating large amount of waste resources (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015), the chances of low cost production might be reduced. Furthermore, non-industrial buildings are considered more expensive and attractive to use for other purposes which might also increase the rent of the building (Berger 2013).

Södermalm and Spånga-Tensta consisted mostly of “smaller” buildings, an area of 1000-2000m^2, and most residential buildings, these areas may for these reasons be the least suitable areas for installing a for-profit greenhouse. Moreover, as the city districts consisted mainly of residential buildings, an assumption is made that this might be representative for these areas in general. For these reasons it might be harder to receive the property owners and neighbors agreement to install a for-profit greenhouse.
If implementing a greenhouse, a smaller commercial greenhouse would be feasible as Freisinger, Specht, Sawicka et al. (2015) argued that the minimum area of a roof is approximately 1000m^2 to be commercially viable unless if building a higher greenhouse. Though Hedin (2015) claimed that smaller productions need to be developed into larger productions to be profitable this would require several buildings or as Freisinger, Specht, Sawicka et al. (2015) suggested a higher greenhouse. Further reasons are high production costs and longer payback time with smaller productions (Sanyé-Mengal, Cerón-Palma, Oliver-Solà et al. 2015). However, these areas seems to have the least potential to place a commercial greenhouse.

In conclusion, the districts within the municipality of Stockholm contain many large buidings, more than 50% had an larger area than 2000m^2, and where more than 25% of the buildings in total had an area greater than 4000m^2. This means that the city of Stockholm could have potential for both smaller and larger operations but also operations such as Lufa farm (2900m^2), Gotham Greens (1400m2 aim towards 18000m2) and more considering the large amount of greater roofs.

6.3 Limitations of research

It is of importance to notify that this research does not represent the real value of potential greenhouse implementation, only the hypothetical potential of greenhouse implementation on the basis of the findings in this study. As previously pointed out, it does not take into account the acceptability of property owners and nearby residents, or if the roof can bear a potential roof etcetera. Other limitations were gaps of information about the commercial urban agriculture activity of the company Coop and an interview was not possible to be conducted due to the time constraints for this thesis.
Finally, three of four companies are still in the startup phase, or their urban agriculture activity (Coop), and it may take further time for them to mature. Yet, what these four samples provided was what kind of commercial urban agriculture operations that could evolve on the market in the city of Stockholm.
In consider to Grönska,regarding their vision of maybe expanding their business, it has been a question of interpretation whether it would be considered as a small or a large company. But what whas interpreted during the interview and by studying their website, a smaller operation seemed to most suitable.

7 Conclusion

7.1 Conclusions

By using a triangular approach this thesis demonstrate which potential the city of Stockholm has for commercial rooftop greenhouse urban agriculture. The empirical study showed what kind of operations there are at current and the case study demonstrated where a commercial greenhouse could be implemented.
By the results from the used methods, this research shows that the city of Stockholm has great potential for commercial rooftop greenhouses, for the reason that eight of ten areas had suitable buildings for an implementation of a commercial RTG and the location of the buildings.
For bigger commercial rooftop greenhouse operations, by the results from this study, a *large production* using a *low-cost* strategy placed in the industrial areas in the city and some of the inner-city areas would be a suggestion. The reason for this conclusion was according to the majority of larger roofs that were placed outside the inner-city area and where these areas and industrial areas may be or are better suited for more heavy vehicles. Furthermore, many of these buildings were interpreted to have the potential for industrial symbioses, i.e. reuse of waste resources. Östermalm and Kungsholmen, the two inner city areas that seemed to have similar possibilities due to the large few operational and industrial buildings found in these districts.

Spånga-Tensta and Södermalm were the least suited city areas for implementing a for-profit rooftop greenhouse in consideration to the smaller rooftop areas and the residential buildings. If planning a commercial greenhouse in either of the two areas, a *secondary purpose* or a *community supported agriculture* business model seem to be a better alternative for an operation, in consideration to the existing profitable business models in Stockholm of how they operate. Furthermore, the consideration to the infrastructure near the residential and inner city area, to not have too many or heavy trucks.
Norrmalm was considered to have better potential for a rooftop greenhouse compared to the former city districts, Södermalm and Spånga-Tensta, and for implementation of smaller operations, such as *secondary purpose* or *community supported agriculture*. The reason to this are that the buildings in Norrmalm were larger and more suitable for a greenhouse. Norrmalm might further have higher rents because of the location, type of buildings and therefore might be attractive to other actors or other uses, e.g. roof stacking. Smaller operations as suggested could set a higher price on their products and could therefore be a better alternative compared to a *large production* with a *low-cost* strategy in this specific district.

This research has shown what kind of commercial urban agriculture operation that could evolve on the market in the city of Stockholm and where it could be implemented. It also demonstrates a possibility that a large amount of commercial RTG can emerge in the city of Stockholm, which can lead to a higher self-sufficiency of food produced locally. As this thesis further show, many developed countries are practicing urban agriculture and incorporating polices of urban agriculture which indicates the importance of integrating local food production within the urban planning. The environmental benefits the urban agriculture brings, the health aspects and the use of unused spaces in the city of Stockholm are further advantages of intergrating urban agriculture. Furthermore, our global food production system is fragile and the Europe 2020 strategy further points on the importance of integrating urban agriculture. The Swedish Government also claims that we need to become more self-sufficient and where commercial rooftop greenhouses can be one solution to meet these needs, to foster a sustainable development and a sustainable urban planning.

7.2 Further research

This thesis provides a research basis for potential future operators of where a greenhouse could be placed and how it can be operated. Moreover, it could also be of interest for the municipality of Stockholm, policy makers and other actors involved or interested in commercial urban agriculture. However, what has not been researched on yet, and what this research did not have space for was the potential of urban agriculture products on the market in the city of Stockholm. To whom are the commercial urban agriculture products desirable to of the citizens in Stockholm and what are the most preferable products? In this thesis there is insufficient evidence to draw any conclusion of this aspect since Bee Urban and Grönska are the only two companies that offers commercial urban agriculture products in Stockholm at present. To carry out a survey among the citizens of Stockholm could be a suggestion.
Another aspect are the building constraints and legal constraints for suggested further research. A more in-depth study of which building requirements there are in the city of Stockholm, such as height limits of buildings in the city areas or cultural values and more that further might influence the possibility of an installment of a commercial rooftop greenhouse.
Finally, to uspcale this research, by e.g. using a GIS grashopper strategy, to identify where or in which city districts that urban agriculture will be most needed in the future in terms of population growth, transportation availabilities, public neccissities, e.g. plants for medicinal uses, and in consideration to future climate change events.

Recommended literature

Sowing seeds in the city by Elisabeth Hodges Snyder, Kristen McIvor & Sally Browns

Rooftop Urban Agriculture by Francesco Orsini, Marielle Dubbeling, Henk de Zeeuw & Giorgio Gianquinto

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Personal messages

Natalie de Brun Skantz, Grönska, 2017-10-14

Sepehr Mousavi, Plantagon, 2017-10-17

Josefina Oddsberg, Bee Urban, 2017-12-15

Maps

Energi & Klimatrådgivningen. (2017). Solkarta för Stockholmsregionen. *Eng: Energy and Climate Advice.* Available at: https://energiradgivningen.se/webbapplikation/index.html#12/59.3023/18.1163 [2017-12-14]
Eng: Energy and climate advice. Solar map for the Stockholm region

Stockholms Stads Solkarta shp-fil. CC By: Stockholms Stad
Eng: The municipality of Stockholms solar map

Stockholms Stads Statskarta shp-fil. CC By: Stockholms Stad
Eng: The municipality of Stockholms city map

Appendices

1. Questionnaire
2. Solar map of Stockholm
3. Area of Stockholm Municipality
4. Maps and tables of the studied areas

Appendix 1 - Questionnaire

Aim - To explore urban agriculture in Stockholm. Investigate in what potentials Stockholm has for commercial rooftop greenhouse urban agriculture.

I will briefly mention your rights. I use the Scientific Council's (2010) ethical guidelines for good research. The information requirement, enter information about the interview, its purpose and the rights you have. The consent requirement, your consent to participate and the possibility to interrupt the interview at any time. Confidentiality, not to allow any unauthorized person to hear what is said during the conversation. The utility requirement that I will not use the material for any other purpose than this thesis. Finally, the thesis will be sent to you in advance for approval before submission.

All these questions were not asked during the interview to the interviewees time. Furthermore, as the first two interviews with Plantagon and Grönska were conducted in person or by telephone, this opened an opportunty to ask further questions. The most significant, Hedin and forward, those questions were asked in all interviews with Plantagon, Grönska and Bee Urban.

General questions

- What was your vision to start the company?
- What were the most challenging starting up a business in Sweden?
- Which are your customers?
- What is you opinoin about commercial agriculture in Sweden?
- How could this influence the business community?
- What do you believe operators and customers think about urban agriculture?
- Do you see any obstacles for commercial urban agriculture?

Hedin (2015) & Gliessman (2007)

- What is your business model?
- What partnerships are there?

Van der Schans (2015)

- What are your strategies?

Wubben et al. (2013)

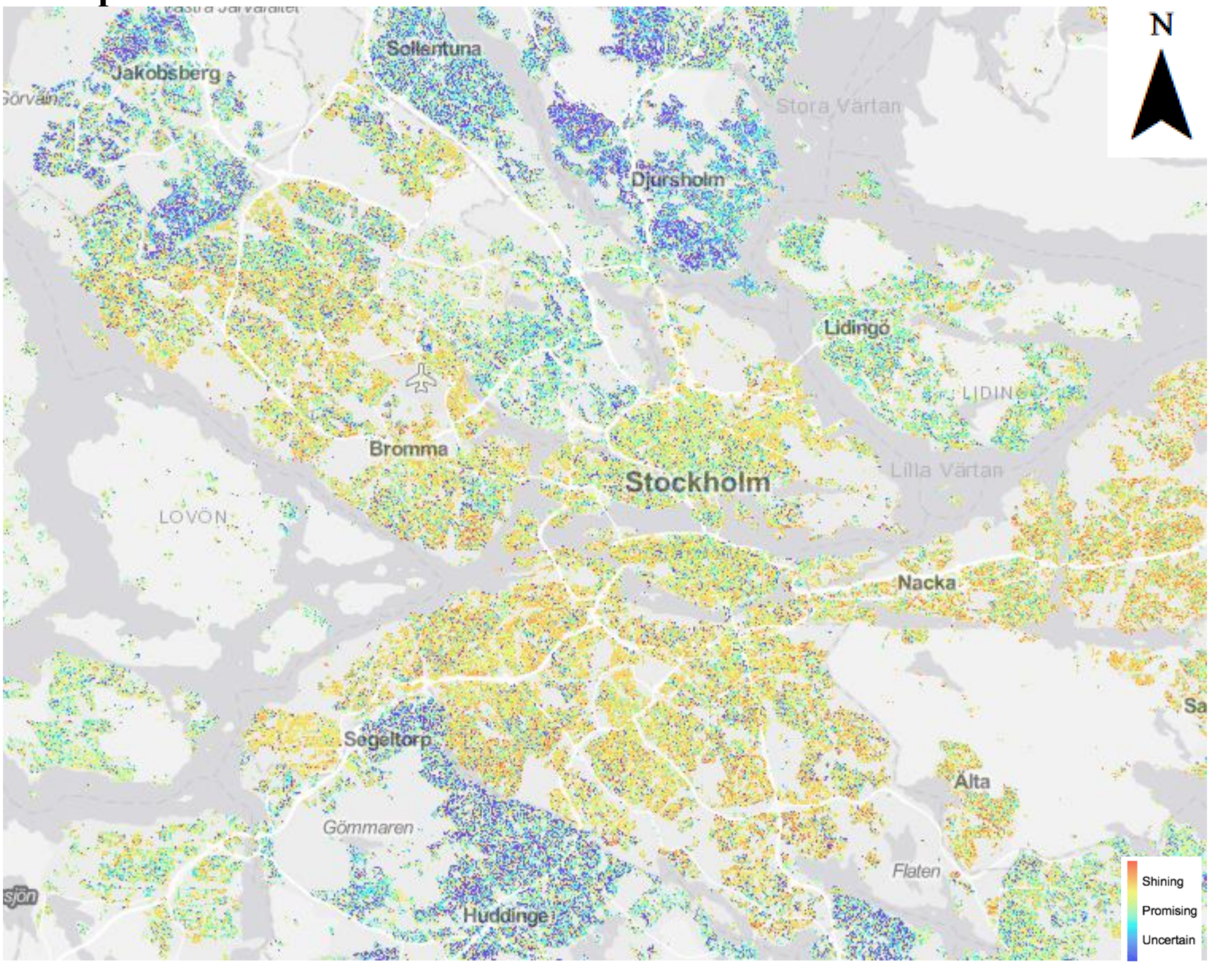
- What are the distribution channels?

Further questions

- What are the opportunities and challenges for commercial urban agriculture?

Appendix 2 - Solar map

Solar potential Stockholm



Appendix 3 - Selected areas

Table of selected areas

Roofs with an area of 1000m2 or more				
District	**All flat roofs**	**Roofs: Different shapes**	**Roofs: Rectangular or squared**	**All roofs with an area of 1000m2 or more**
Bromma	48	30	18	272
Enskde Årsta Vantör	68	54	14	371
Farsta	45		3	187
Hägersten Liljeholmen	67	54	13	355
Hässelby Vällingby	25			215
Kungsholmen	37	28	9	238
Norrmalm	28	21	7	310
Rinkeby Kista	45	32	13	257
Skarpnäck	17			165
Skärholmen	51	39	12	123
Spånga Tensta	41	32	9	168
Södermalm	69	64	5	390
Älvsjö	25			78
Östermalm	36	22	14	401
Total	490	376	114	2885

Included: Black color
Excluded: Red color (Not calculated within the total value)

Description:

The ones that are marked in red are the ones that were excluded from this research due to the small amount of flat roofs or to the small amount of squared or rectangular shapes of the roof. Älvsjö, Hässelby Vällingby and Skarpnäck was first excluded and in the second selection Farsta was excluded as it only had three types of roofs that would be suitable for greenhouse implementation. Further on, a second study on Farsta was also made to ensure that all houses had been validated.

Appendix 4 - Maps and tables

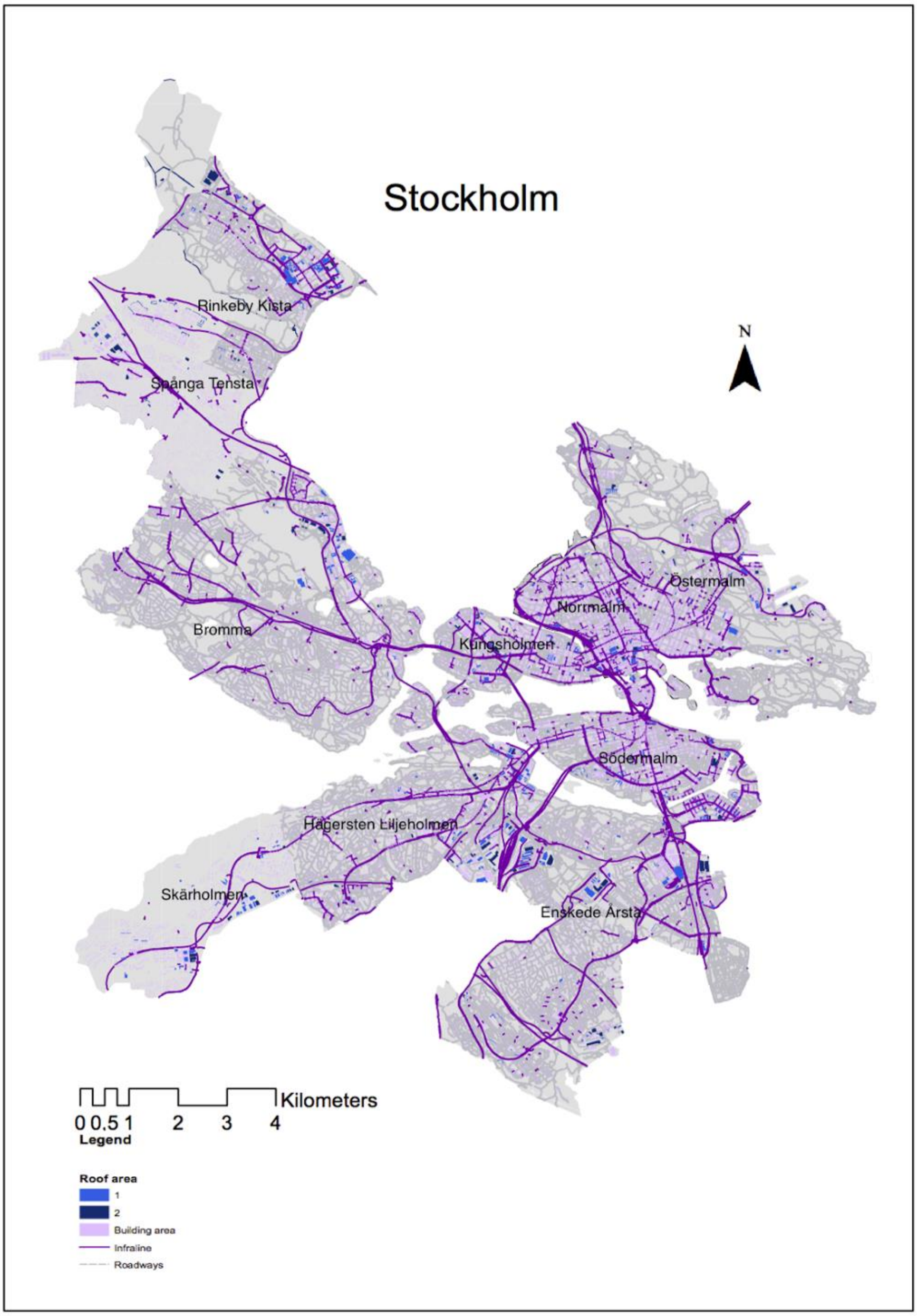
1. Map of all areas
2. Bromma
3. Enskede-Årsta-Vantör
4. Hägersten-Liljeholmen
5. Kungsholmen
6. Norrmalm
7. Rinkeby-Kista
8. Skärholmen
9. Spånga-Tensta
10. Södermalm
11. Östermalm

Translations

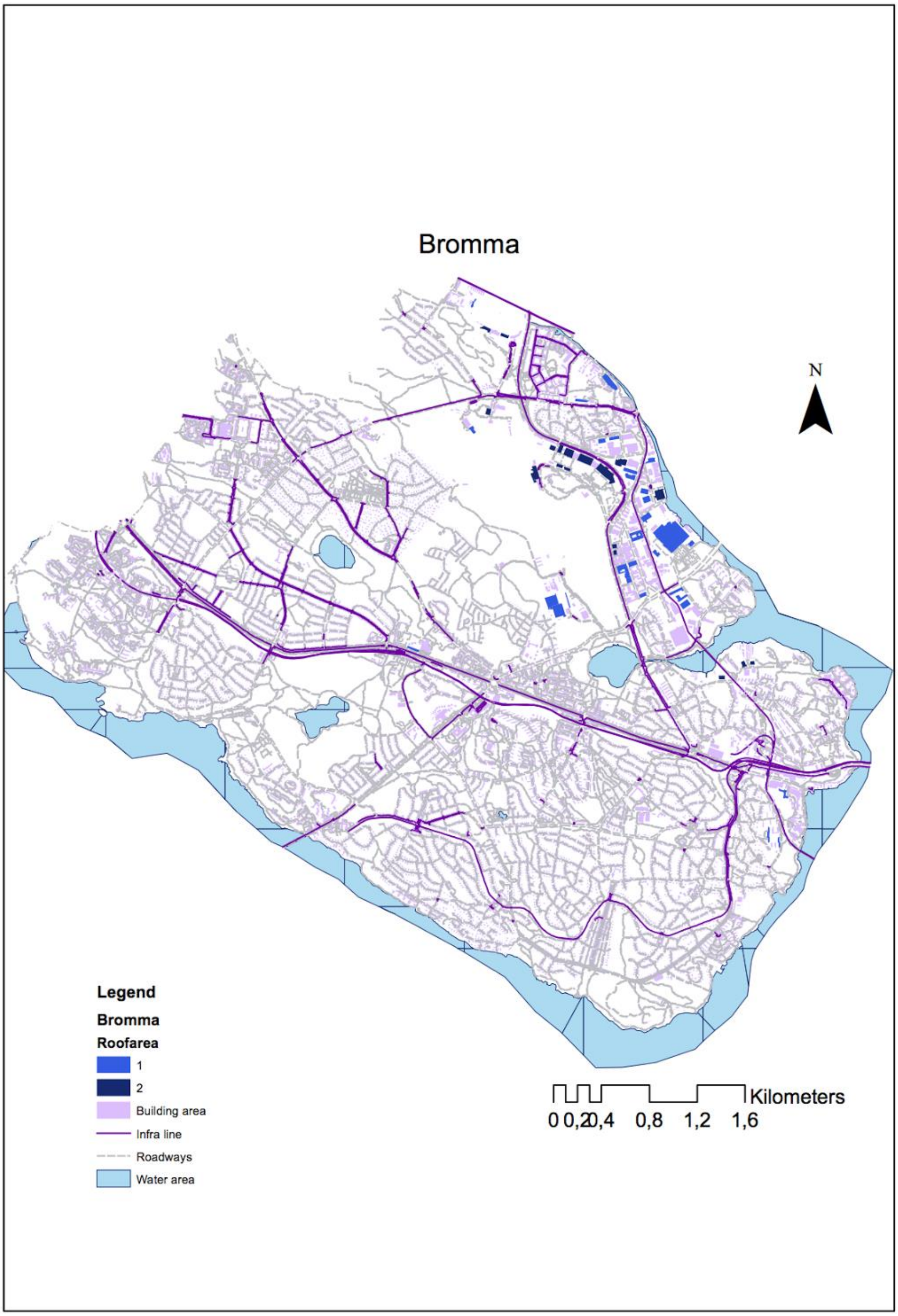
Swedish:	**English:**
Industribyggnad	Industrial building
Verksamhetsbyggnad	Operational building
Samhällsfunktionsbyggnad	Public building
Parkeringshus	Parking house
Bostadsbyggnad	Residential building
Flerbostadshus	Apartment building
Ospecificerad byggnad	Unspecified building
Handel	Retail
Kontor	Offices
Idrott	Sports

Source maps and tables:
Maps
Data sets provided by: Stockholms Stadsbyggnadskontor (2017)
Tables
CC By: Stadsbyggnadskontoret (2017)

Building number ”FID”
The address for respectively building were too time consuming to look up. But respectivey number of each building is provided and can be easily looked up at the City Bulding Offfite, (Stadsbyggnadskontoret) at Stockholm municipality, where more information can be provided.



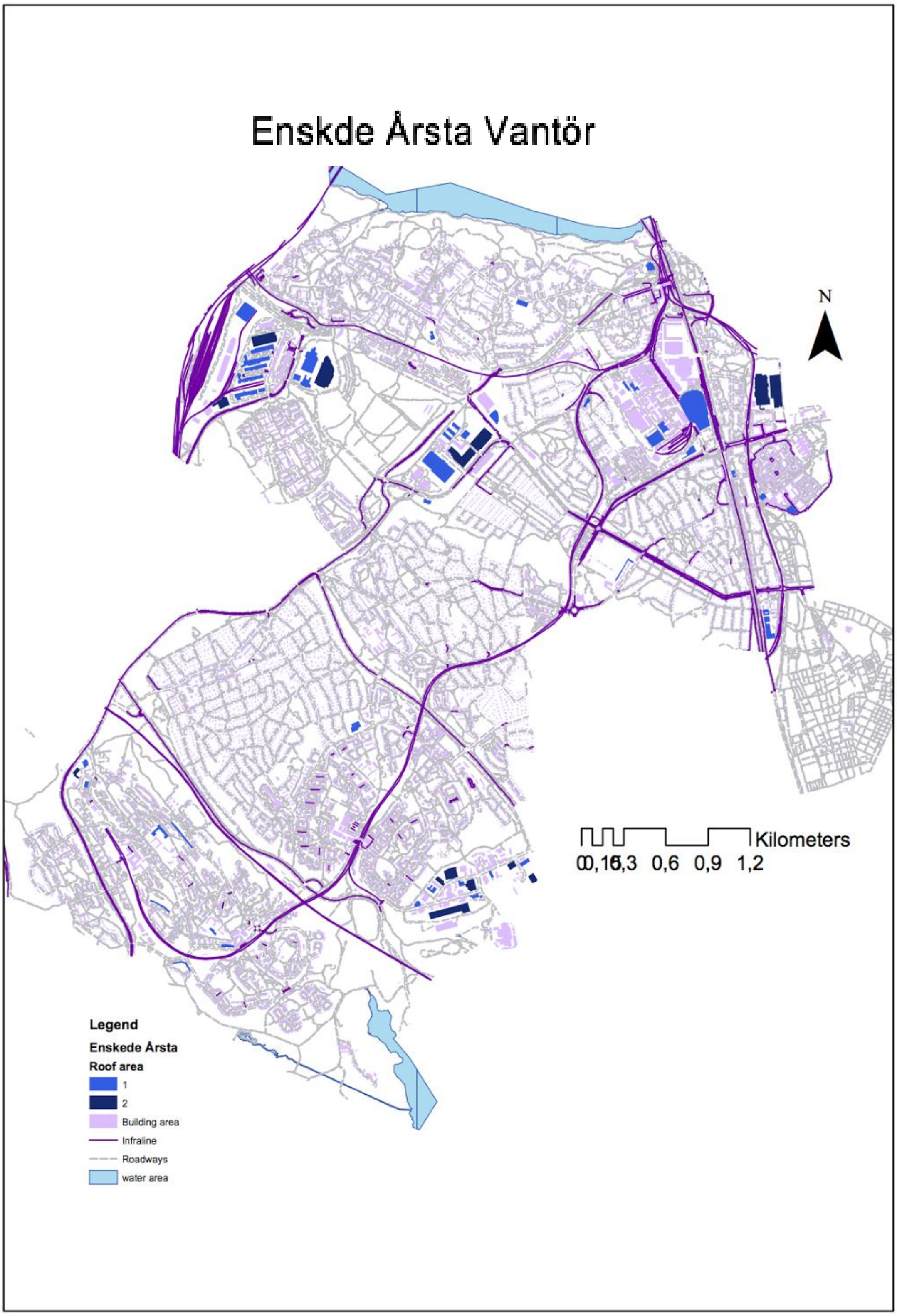
Data sets provided by: Stockholms Stadsbyggnadskontor (2017)



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Bromma

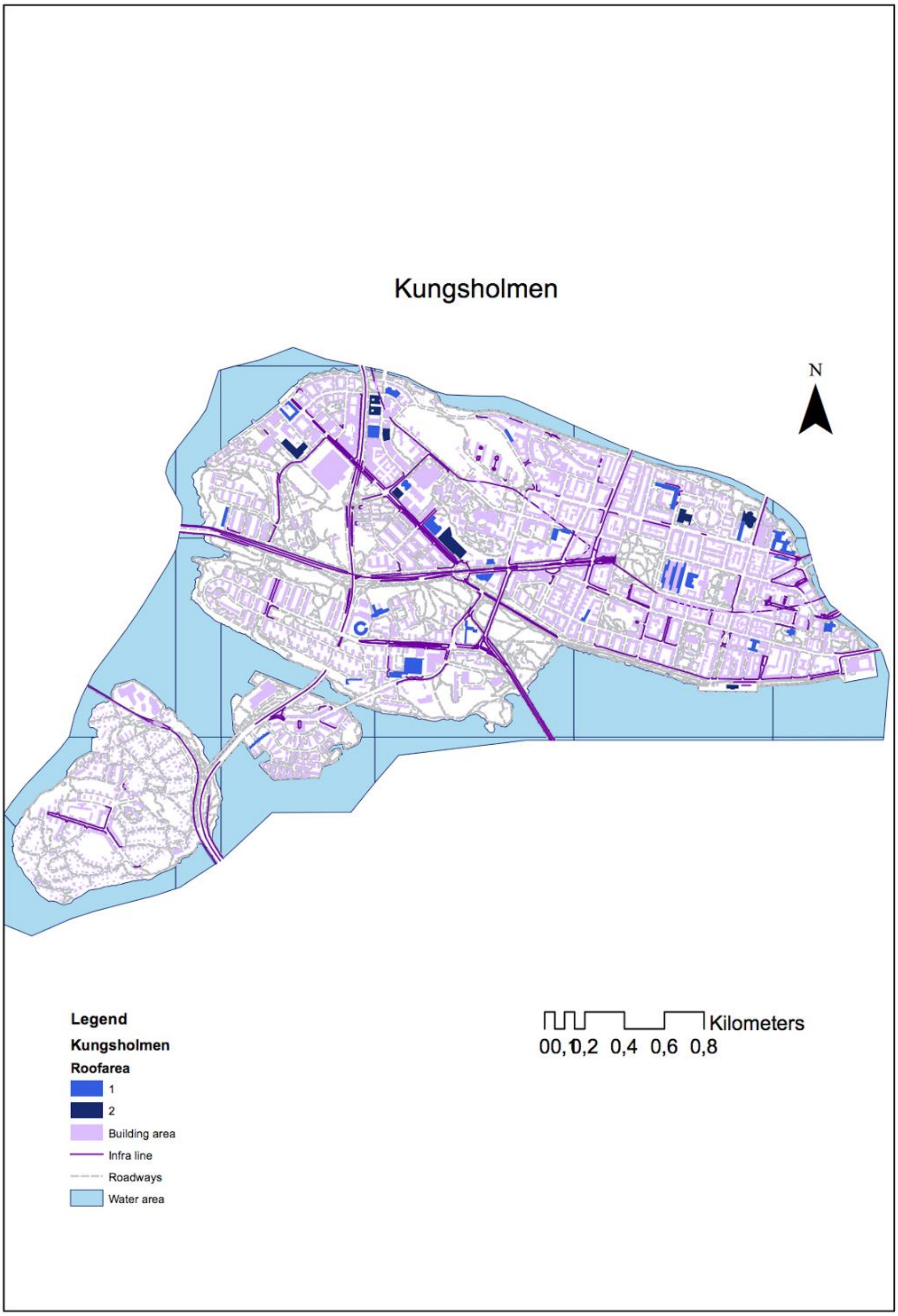
FID	GRUPP	KATEGORI	Takarea	Takyta
1	Verksamhetsbyggnad	Handel	7743,04	2
28	Industribyggnad	Industribyggnad	6518,81	2
65	Verksamhetsbyggnad	Kontor	1974,76	2
86	Verksamhetsbyggnad	Kontor	1561,38	2
93	Samhällsfunktionsbyggnad	Allmän byggnad	6096,08	2
99	Industribyggnad	Industribyggnad	1026,06	2
108	Ospecificerad byggnad	Ospecificerad byggnad	1547,62	2
155	Verksamhetsbyggnad	Kontor	1672,11	2
158	Verksamhetsbyggnad	Kontor	1046,29	2
160	Verksamhetsbyggnad	Handel	1739,36	2
184	Industribyggnad	Industribyggnad	1339,51	2
189	Verksamhetsbyggnad	Kontor	2157,89	2
192	Verksamhetsbyggnad	Kontor	4870,24	2
199	Verksamhetsbyggnad	Handel	2442,69	2
208	Verksamhetsbyggnad	Handel	11873,3	2
221	Verksamhetsbyggnad	Handel	1207,75	2
222	Industribyggnad	Industribyggnad	4878,97	2
227	Verksamhetsbyggnad	Handel	1389,24	2
2	Industribyggnad	Industribyggnad	1694,78	1
14	Industribyggnad	Industribyggnad	2735,36	1
15	Bostadsbyggnad	Flerbostadshus	1870,96	1
32	Industribyggnad	Industribyggnad	2052,64	1
33	Industribyggnad	Industribyggnad	1920,57	1
46	Industribyggnad	Industribyggnad	2983,75	1
54	Industribyggnad	Industribyggnad	3877,38	1
58	Verksamhetsbyggnad	Kontor	1054,09	1
85	Verksamhetsbyggnad	Handel	45023,6	1
89	Industribyggnad	Industribyggnad	1755,1	1
117	Bostadsbyggnad	Flerbostadshus	1132,67	1
122	Industribyggnad	Industribyggnad	6506,56	1
136	Industribyggnad	Industribyggnad	2140,79	1
144	Industribyggnad	Industribyggnad	2297,63	1
165	Industribyggnad	Industribyggnad	1299,55	1
170	Industribyggnad	Industribyggnad	4215,4	1
172	Verksamhetsbyggnad	Kontor	1888,41	1
173	Verksamhetsbyggnad	Hotell	2425,19	1
178	Industribyggnad	Industribyggnad	9010,51	1
183	Industribyggnad	Industribyggnad	9147,56	1
197	Verksamhetsbyggnad	Parkeringshus	1766,91	1
198	Industribyggnad	Industribyggnad	3028	1
204	Industribyggnad	Industribyggnad	1717,77	1
214	Industribyggnad	Industribyggnad	7220,29	1
232	Industribyggnad	Industribyggnad	7169,75	1
242	Industribyggnad	Industribyggnad	2873,56	1
248	Industribyggnad	Industribyggnad	2760,63	1
261	Industribyggnad	Industribyggnad	3127,48	1
263	Industribyggnad	Industribyggnad	2407,1	1
271	Industribyggnad	Industribyggnad	2700,18	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Enskde Årsta Vantör

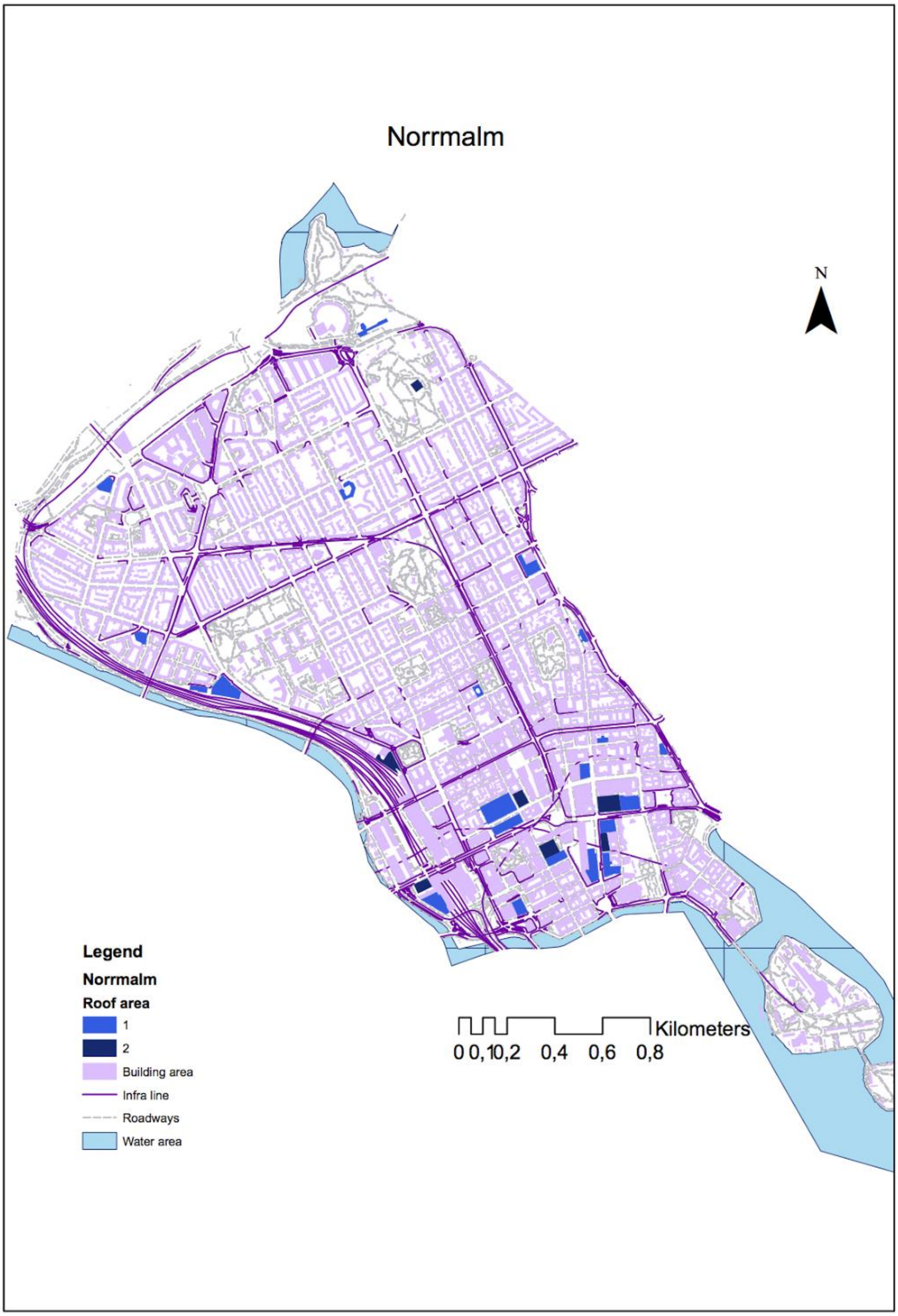
FID	GRUPP	KATEGORI	Takarea	Takytor
21	Industribyggnad	Industribyggnad	1883,69	2
57	Industribyggnad	Industribyggnad	17054,9	2
58	Industribyggnad	Industribyggnad	21181,1	2
61	Samhällsfunktionsbyggnad	Allmän byggnad	2730,19	2
65	Industribyggnad	Industribyggnad	12804,2	2
72	Industribyggnad	Industribyggnad	2036,43	2
85	Industribyggnad	Industribyggnad	4892,13	2
126	Industribyggnad	Industribyggnad	13504,7	2
146	Industribyggnad	Industribyggnad	19490,5	2
152	Industribyggnad	Industribyggnad	2392,01	2
161	Industribyggnad	Industribyggnad	5661,79	2
168	Industribyggnad	Industribyggnad	13239	2
308	Industribyggnad	Industribyggnad	14486,3	2
332	Industribyggnad	Industribyggnad	6595,2	2
14	Verksamhetsbyggnad	Kontor	1096,31	1
15	Verksamhetsbyggnad	Kontor	1579,33	1
28	Industribyggnad	Industribyggnad	3865,39	1
35	Samhällsfunktionsbyggnad	Allmän byggnad	1615,73	1
37	Industribyggnad	Industribyggnad	1127,7	1
39	Verksamhetsbyggnad	Parkeringshus	2681,91	1
59	Industribyggnad	Industribyggnad	1577,37	1
60	Industribyggnad	Industribyggnad	1756,63	1
76	Bostadsbyggnad	Flerbostadshus	2709,13	1
81	Verksamhetsbyggnad	Handel	3260,78	1
88	Industribyggnad	Industribyggnad	1011,99	1
100	Verksamhetsbyggnad	Kontor	1524,35	1
109	Bostadsbyggnad	Flerbostadshus	1427,79	1
110	Industribyggnad	Industribyggnad	1786,84	1
116	Industribyggnad	Industribyggnad	11251,5	1
118	Verksamhetsbyggnad	Kontor	1275,95	1
122	Industribyggnad	Industribyggnad	1325,88	1
129	Industribyggnad	Industribyggnad	1287,35	1
130	Samhällsfunktionsbyggnad	Allmän byggnad	1588,1	1
131	Industribyggnad	Industribyggnad	1678,7	1
132	Samhällsfunktionsbyggnad	Allmän byggnad	1759,01	1
133	Industribyggnad	Industribyggnad	7772,3	1
148	Industribyggnad	Industribyggnad	4129,94	1
159	Industribyggnad	Industribyggnad	13136,8	1
170	Samhällsfunktionsbyggnad	Idrott	41015,2	1
175	Industribyggnad	Industribyggnad	1252,52	1
186	Industribyggnad	Industribyggnad	1819,62	1
187	Bostadsbyggnad	Flerbostadshus	1367,9	1
202	Verksamhetsbyggnad	Kontor	2240,27	1
206	Industribyggnad	Industribyggnad	1984,41	1
208	Industribyggnad	Industribyggnad	1794,2	1
212	Samhällsfunktionsbyggnad	Idrott	2767,8	1
214	Industribyggnad	Industribyggnad	5521,62	1
216	Samhällsfunktionsbyggnad	Allmän byggnad	3071,07	1
217	Industribyggnad	Industribyggnad	3276,76	1
231	Industribyggnad	Industribyggnad	8460,68	1
234	Industribyggnad	Industribyggnad	1757,66	1
251	Industribyggnad	Industribyggnad	1944,24	1
254	Industribyggnad	Industribyggnad	5194,45	1
260	Industribyggnad	Industribyggnad	4126,06	1
274	Bostadsbyggnad	Flerbostadshus	1866,27	1
280	Bostadsbyggnad	Flerbostadshus	1364,62	1
283	Bostadsbyggnad	Flerbostadshus	2058,95	1
294	Verksamhetsbyggnad	Kontor	1635,31	1
305	Industribyggnad	Industribyggnad	2138,93	1
309	Industribyggnad	Industribyggnad	1685,89	1
312	Industribyggnad	Industribyggnad	1847,32	1
323	Samhällsfunktionsbyggnad	Allmän byggnad	3563,31	1
337	Verksamhetsbyggnad	Handel	1491,31	1
341	Industribyggnad	Industribyggnad	25151,1	1
350	Industribyggnad	Industribyggnad	1430,14	1
352	Samhällsfunktionsbyggnad	Allmän byggnad	1070,18	1
364	Bostadsbyggnad	Flerbostadshus	1815,94	1
370	Industribyggnad	Industribyggnad	2408,85	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Kungsholmen

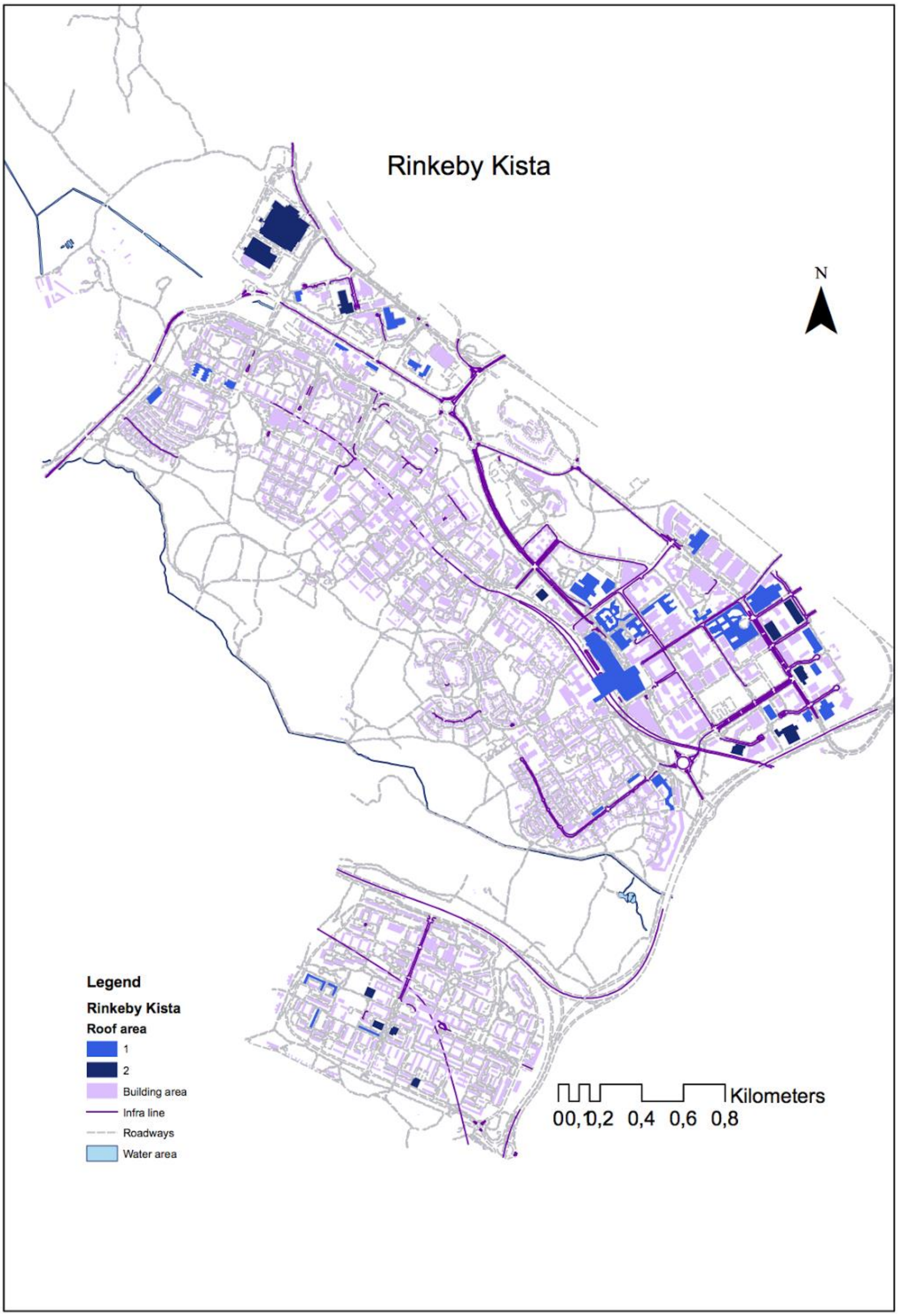
FID	GRUPP	KATEGORI	Takarea	Takytor
33	Verksamhetsbyggnad	Kontor	4133,55	2
65	Samhällsfunktionsbyggnad	Vårdbyggnad	3731,62	2
115	Verksamhetsbyggnad	Kontor	2432,44	2
116	Verksamhetsbyggnad	Kontor	2133,59	2
129	Industribyggnad	Industribyggnad	2139,89	2
196	Verksamhetsbyggnad	Kontor	9223,96	2
206	Verksamhetsbyggnad	Kontor	2013,36	2
220	Verksamhetsbyggnad	Handel	1290,64	2
230	Industribyggnad	Industribyggnad	5766,63	2
2	Verksamhetsbyggnad	Kontor	1696,95	1
11	Industribyggnad	Industribyggnad	3644,22	1
25	Bostadsbyggnad	Flerbostadshus	1608,16	1
30	Bostadsbyggnad	Flerbostadshus	1048,89	1
45	Samhällsfunktionsbyggnad	Allmän byggnad	2942,89	1
52	Samhällsfunktionsbyggnad	Allmän byggnad	4677,87	1
53	Bostadsbyggnad	Flerbostadshus	2867,36	1
56	Bostadsbyggnad	Flerbostadshus	1012,98	1
59	Samhällsfunktionsbyggnad	Allmän byggnad	2797,65	1
74	Verksamhetsbyggnad	Kontor	9674,64	1
83	Verksamhetsbyggnad	Hotell	2383,49	1
88	Bostadsbyggnad	Flerbostadshus	1051,09	1
91	Samhällsfunktionsbyggnad	Allmän byggnad	2597,81	1
97	Bostadsbyggnad	Flerbostadshus	1809,09	1
98	Verksamhetsbyggnad	Kontor	4420,98	1
106	Samhällsfunktionsbyggnad	Allmän byggnad	1038,17	1
114	Verksamhetsbyggnad	Kontor	1956,09	1
122	Samfundsbyggnad	Ospec. samfundsbyggnad	1256,5	1
127	Samhällsfunktionsbyggnad	Allmän byggnad	2299,95	1
140	Samhällsfunktionsbyggnad	Allmän byggnad	2312,16	1
144	Samhällsfunktionsbyggnad	Allmän byggnad	2270,82	1
145	Samhällsfunktionsbyggnad	Allmän byggnad	2907,82	1
166	Samhällsfunktionsbyggnad	Allmän byggnad	3112,98	1
173	Samhällsfunktionsbyggnad	Allmän byggnad	5736,32	1
195	Industribyggnad	Industribyggnad	2405,21	1
207	Samhällsfunktionsbyggnad	Allmän byggnad	2791,38	1
208	Verksamhetsbyggnad	Kontor	2014,82	1
213	Bostadsbyggnad	Flerbostadshus	1116,79	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Norrmalm

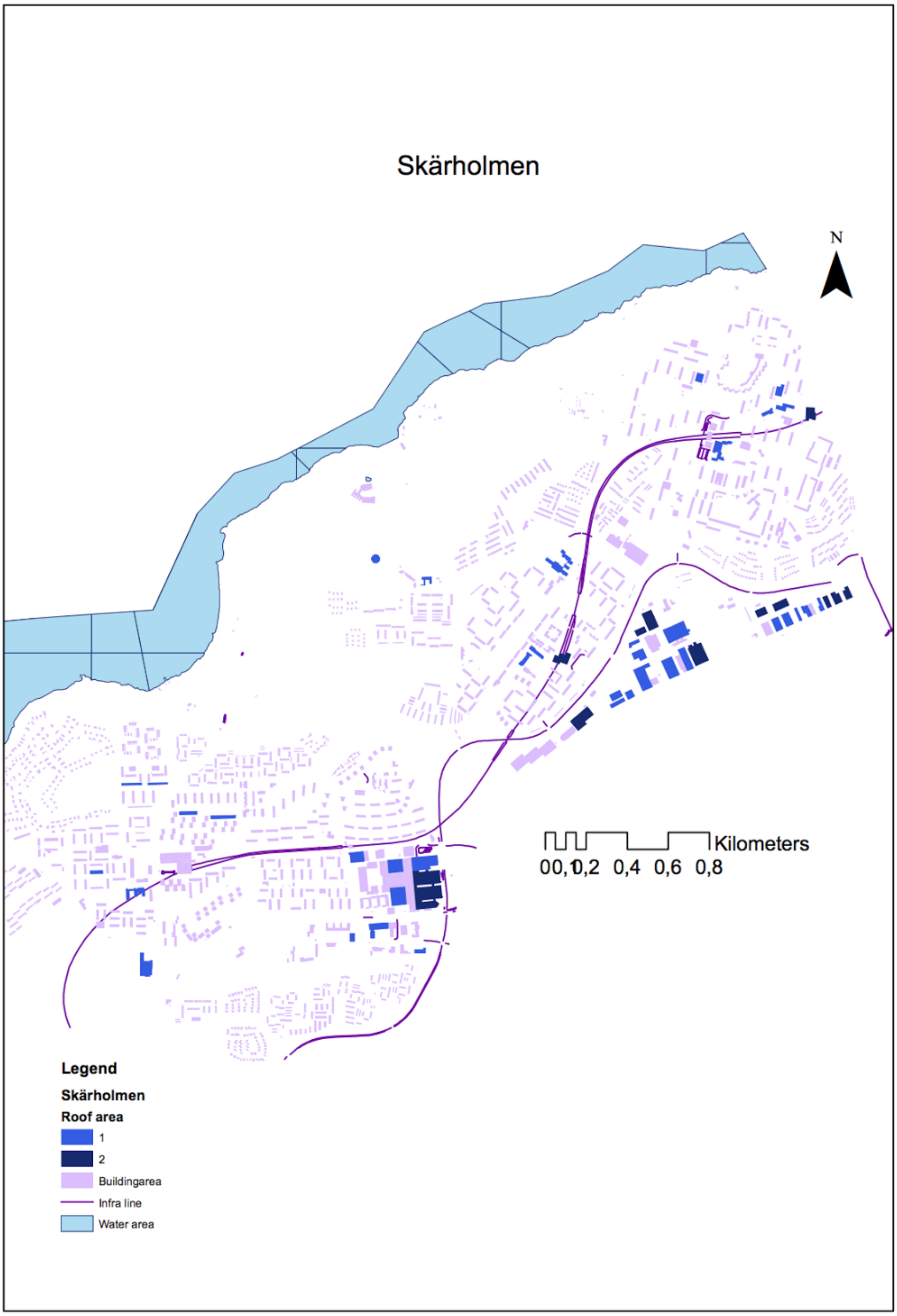
FID	GRUPP	KATEGORI	Takarea	Takyta
8	Verksamhetsbyggnad	Kontor	2617,08	2
9	Verksamhetsbyggnad	Ospec. verksamhetsbyggnad	2342,84	2
23	Servicebyggnad	Vattentorn	1530,62	2
125	Verksamhetsbyggnad	Hotell	3878,5	2
168	Verksamhetsbyggnad	Hotell	4210,94	2
253	Bostadsbyggnad	Flerbostadshus	2865,34	2
297	Verksamhetsbyggnad	Handel	6403,12	2
6	Verksamhetsbyggnad	Kontor	7119,99	1
13	Bostadsbyggnad	Flerbostadshus	2854,48	1
24	Verksamhetsbyggnad	Kontor	11006,7	1
31	Bostadsbyggnad	Flerbostadshus	1155,39	1
64	Verksamhetsbyggnad	Hotell	2980,16	1
75	Verksamhetsbyggnad	Handel	4906,81	1
78	Verksamhetsbyggnad	Handel	5330,2	1
79	Samhällsfunktionsbyggnad	Allmän byggnad	2484,56	1
88	Verksamhetsbyggnad	Kontor	5095,95	1
108	Verksamhetsbyggnad	Kontor	2882,71	1
128	Bostadsbyggnad	Flerbostadshus	1007,88	1
151	Verksamhetsbyggnad	Ospec. verksamhetsbyggnad	3420,08	1
174	Verksamhetsbyggnad	Kontor	1609,45	1
194	Verksamhetsbyggnad	Kontor	5074,89	1
195	Samfundsbyggnad	Ospec. samfundsbyggnad	1150,99	1
197	Samfundsbyggnad	Ospec. samfundsbyggnad	2075,81	1
209	Bostadsbyggnad	Flerbostadshus	1308,09	1
212	Bostadsbyggnad	Flerbostadshus	4283,93	1
228	Bostadsbyggnad	Flerbostadshus	2429,17	1
278	Bostadsbyggnad	Flerbostadshus	4046,6	1
307	Bostadsbyggnad	Flerbostadshus	2606,63	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Rinkeby Kista

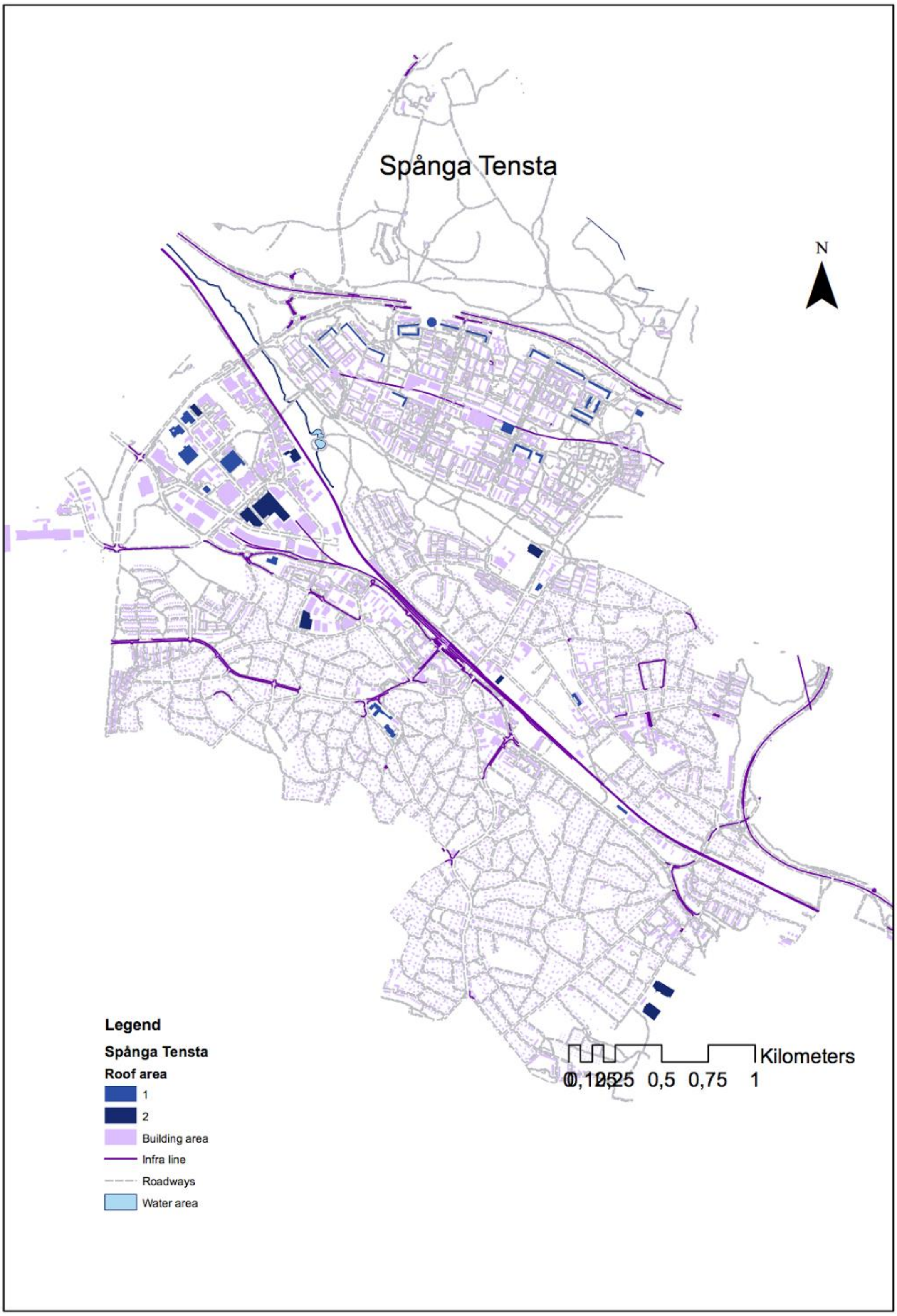
FID	GRUPP	KATEGORI	Takarea	Takytor
0	Verksamhetsbyggnad	Parkeringshus	1701,35	2
52	Industribyggnad	Industribyggnad	13159,7	2
75	Industribyggnad	Industribyggnad	2055	2
99	Industribyggnad	Industribyggnad	3456,86	2
116	Industribyggnad	Industribyggnad	4206,69	2
121	Bostadsbyggnad	Flerbostadshus	1318,36	2
150	Industribyggnad	Industribyggnad	34402	2
161	Industribyggnad	Industribyggnad	5046,35	2
186	Industribyggnad	Industribyggnad	5451,97	2
192	Industribyggnad	Industribyggnad	6322,64	2
212	Samhällsfunktionsbyggnad	Allmän byggnad	1936,6	2
231	Industribyggnad	Industribyggnad	2725,66	2
244	Bostadsbyggnad	Flerbostadshus	1483,51	2
2	Bostadsbyggnad	Flerbostadshus	1060,03	1
12	Industribyggnad	Industribyggnad	1497,62	1
16	Industribyggnad	Industribyggnad	21767,1	1
23	Industribyggnad	Industribyggnad	1370,44	1
27	Industribyggnad	Industribyggnad	4977,49	1
30	Industribyggnad	Industribyggnad	2481,1	1
37	Industribyggnad	Industribyggnad	1235,72	1
38	Industribyggnad	Industribyggnad	5693,97	1
44	Industribyggnad	Industribyggnad	4467	1
74	Verksamhetsbyggnad	Kontor	43522,4	1
82	Industribyggnad	Industribyggnad	5433,02	1
88	Verksamhetsbyggnad	Kontor	3123,41	1
111	Verksamhetsbyggnad	Handel	1612,62	1
119	Industribyggnad	Industribyggnad	9206,47	1
124	Industribyggnad	Industribyggnad	5893,88	1
147	Verksamhetsbyggnad	Parkeringshus	1119,83	1
149	Industribyggnad	Industribyggnad	1866,15	1
160	Bostadsbyggnad	Flerbostadshus	1154,38	1
166	Industribyggnad	Industribyggnad	10645,2	1
172	Industribyggnad	Industribyggnad	4981,31	1
182	Verksamhetsbyggnad	Parkeringshus	2967,43	1
189	Industribyggnad	Industribyggnad	2610,95	1
197	Samhällsfunktionsbyggnad	Allmän byggnad	13442,7	1
199	Industribyggnad	Industribyggnad	1756,64	1
201	Industribyggnad	Industribyggnad	1873,43	1
219	Industribyggnad	Industribyggnad	5404,24	1
230	Samhällsfunktionsbyggnad	Allmän byggnad	3731,41	1
232	Bostadsbyggnad	Flerbostadshus	1166,45	1
237	Industribyggnad	Industribyggnad	6211,77	1
238	Bostadsbyggnad	Flerbostadshus	2142,4	1
246	Bostadsbyggnad	Flerbostadshus	1199,54	1
248	Industribyggnad	Industribyggnad	1443,25	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Skärholmen

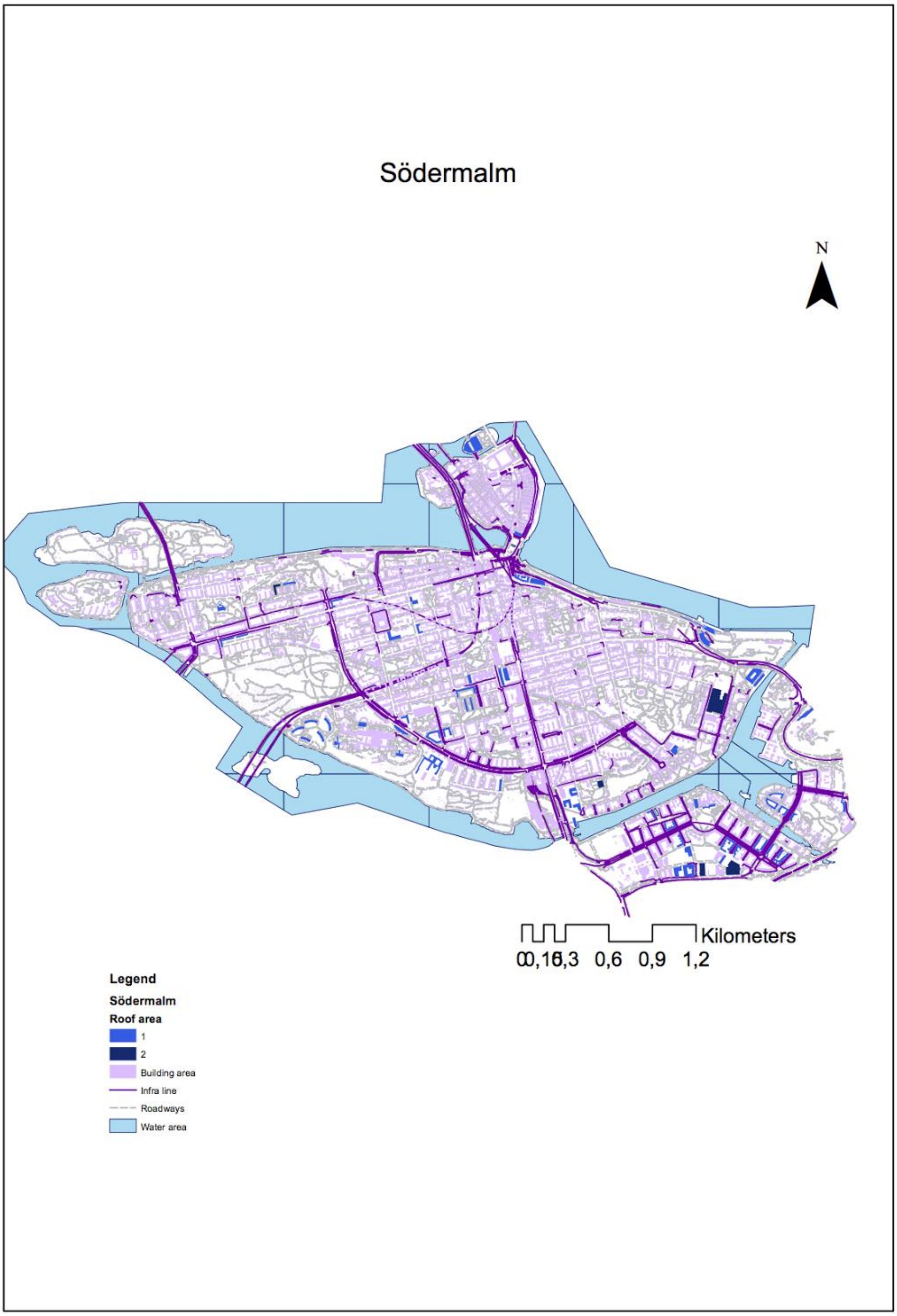
FID	GRUPP	KATEGORI	Takarea	Takyta
13	Industribyggnad	Industribyggnad	1647,98	2
28	Industribyggnad	Industribyggnad	4656,28	2
32	Industribyggnad	Industribyggnad	2871,54	2
49	Industribyggnad	Industribyggnad	2992,91	2
50	Industribyggnad	Industribyggnad	7371,54	2
58	Industribyggnad	Industribyggnad	1489,05	2
72	Verksamhetsbyggnad	Handel	21880,6	2
86	Industribyggnad	Industribyggnad	2036,54	2
90	Industribyggnad	Industribyggnad	6302,36	2
112	Ospecificerad byggnad	Ospecificerad byggnad	3608,88	2
116	Industribyggnad	Industribyggnad	2187,23	2
121	Industribyggnad	Industribyggnad	1904,51	2
2	Industribyggnad	Industribyggnad	2060,8	1
8	Verksamhetsbyggnad	Ospec. verksamhetsbyggnad	1264,19	1
9	Industribyggnad	Industribyggnad	1538,22	1
11	Samhällsfunktionsbyggnad	Allmän byggnad	1565,56	1
12	Samhällsfunktionsbyggnad	Allmän byggnad	1458,95	1
14	Bostadsbyggnad	Flerbostadshus	1549,19	1
20	Industribyggnad	Industribyggnad	1006,7	1
26	Industribyggnad	Industribyggnad	1723,46	1
27	Bostadsbyggnad	Flerbostadshus	2977,1	1
30	Industribyggnad	Industribyggnad	2567,44	1
34	Industribyggnad	Industribyggnad	4144,43	1
39	Industribyggnad	Industribyggnad	1458,81	1
40	Övrig byggnad	Komplementbyggnad	1126,88	1
46	Industribyggnad	Industribyggnad	2481,53	1
47	Bostadsbyggnad	Flerbostadshus	1106,74	1
52	Samhällsfunktionsbyggnad	Idrott	3575,79	1
53	Industribyggnad	Industribyggnad	1955,72	1
54	Verksamhetsbyggnad	Handel	6535	1
56	Industribyggnad	Industribyggnad	1177,28	1
60	Industribyggnad	Industribyggnad	1285,17	1
74	Samhällsfunktionsbyggnad	Vårdbyggnad	5347,54	1
75	Bostadsbyggnad	Flerbostadshus	1082,82	1
79	Verksamhetsbyggnad	Parkeringshus	2155,66	1
81	Samhällsfunktionsbyggnad	Allmän byggnad	1070,11	1
82	Industribyggnad	Industribyggnad	3770,15	1
84	Industribyggnad	Industribyggnad	6915,13	1
88	Verksamhetsbyggnad	Handel	7832,97	1
91	Samhällsfunktionsbyggnad	Allmän byggnad	4161,81	1
93	Samhällsfunktionsbyggnad	Vårdbyggnad	3658,61	1
95	Samhällsfunktionsbyggnad	Vårdbyggnad	1621,64	1
98	Industribyggnad	Industribyggnad	1012,21	1
101	Servicebyggnad	Vattentorn	1472,84	1
103	Övrig byggnad	Komplementbyggnad	1706,51	1
104	Industribyggnad	Industribyggnad	8177,66	1
105	Industribyggnad	Industribyggnad	5492,12	1
108	Industribyggnad	Industribyggnad	2737,34	1
115	Verksamhetsbyggnad	Handel	4678,46	1
117	Verksamhetsbyggnad	Parkeringshus	1549,19	1
119	Verksamhetsbyggnad	Handel	1252,46	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Spånga Tensta

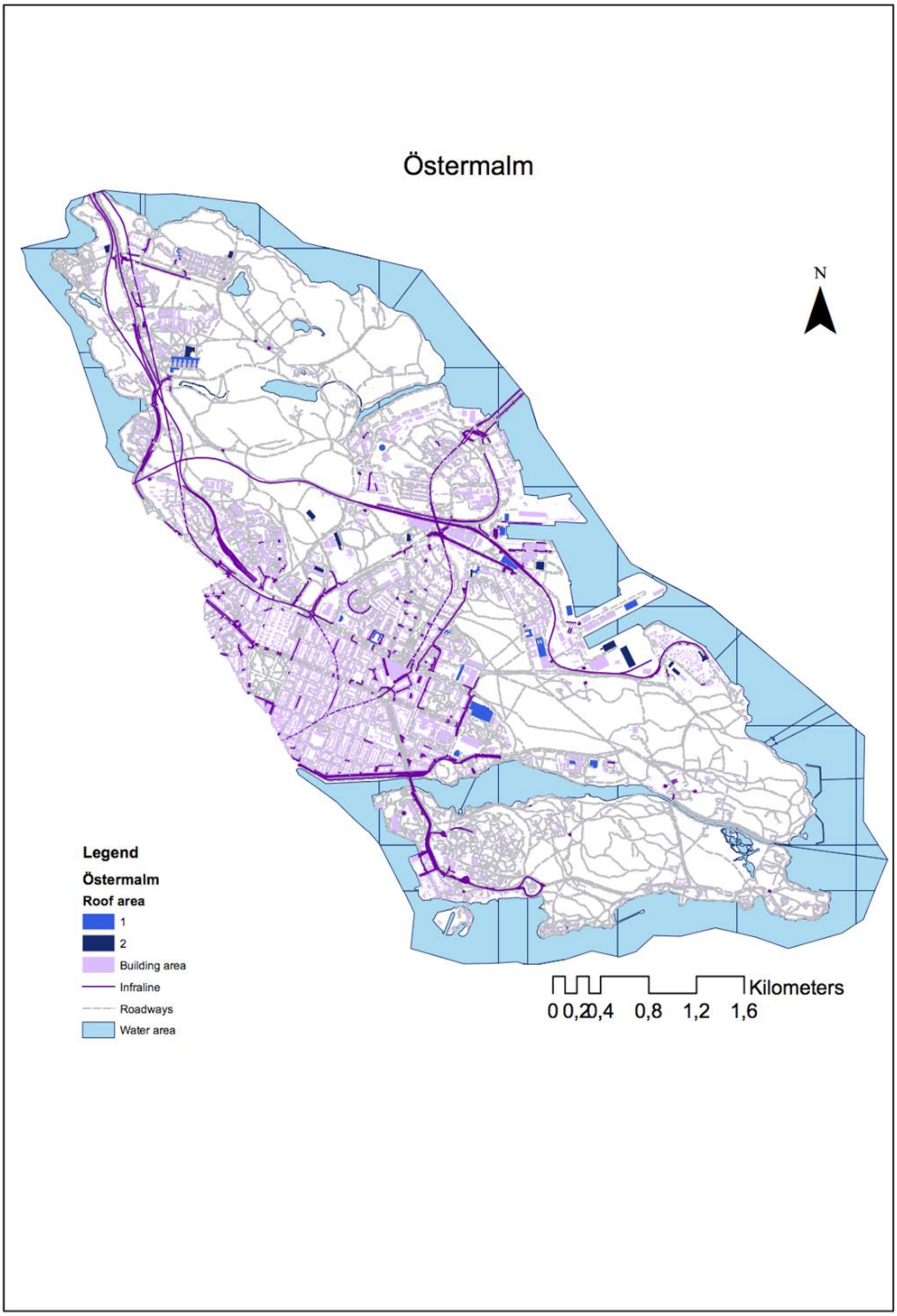
FID	GRUPP	KATEGORI	Takarea	Takytor
1	Ospecificerad byggnad	Ospecificerad byggnad	1224,2	2
14	Industribyggnad	Industribyggnad	5388,31	2
15	Samhällsfunktionsbyggnad	Idrott	3621,56	2
26	Industribyggnad	Industribyggnad	15662,4	2
37	Industribyggnad	Industribyggnad	3402,18	2
56	Industribyggnad	Industribyggnad	4976,44	2
89	Industribyggnad	Industribyggnad	6262,79	2
91	Industribyggnad	Industribyggnad	5006,83	2
93	Industribyggnad	Industribyggnad	2133,38	2
3	Bostadsbyggnad	Flerbostadshus	1540,3	1
16	Industribyggnad	Industribyggnad	8422,39	1
18	Bostadsbyggnad	Flerbostadshus	2176,14	1
21	Bostadsbyggnad	Flerbostadshus	1299,03	1
27	Industribyggnad	Industribyggnad	1871,93	1
28	Bostadsbyggnad	Flerbostadshus	1142,03	1
33	Bostadsbyggnad	Flerbostadshus	1233,84	1
44	Bostadsbyggnad	Flerbostadshus	1072,32	1
48	Industribyggnad	Industribyggnad	3177,15	1
52	Bostadsbyggnad	Flerbostadshus	2356,47	1
53	Industribyggnad	Industribyggnad	1361,75	1
59	Industribyggnad	Industribyggnad	3206,58	1
62	Bostadsbyggnad	Flerbostadshus	1506,47	1
63	Bostadsbyggnad	Flerbostadshus	1971,42	1
66	Industribyggnad	Industribyggnad	1010,29	1
70	Samhällsfunktionsbyggnad	Idrott	2142,61	1
82	Ospecificerad byggnad	Ospecificerad byggnad	1234,84	1
84	Bostadsbyggnad	Flerbostadshus	1492,23	1
94	Industribyggnad	Industribyggnad	6383,14	1
102	Bostadsbyggnad	Flerbostadshus	1413,58	1
108	Ospecificerad byggnad	Ospecificerad byggnad	3159,31	1
109	Bostadsbyggnad	Flerbostadshus	1758,51	1
119	Bostadsbyggnad	Flerbostadshus	2040,95	1
124	Bostadsbyggnad	Flerbostadshus	1074,38	1
136	Bostadsbyggnad	Flerbostadshus	1941,15	1
137	Samhällsfunktionsbyggnad	Allmän byggnad	3167,43	1
139	Bostadsbyggnad	Flerbostadshus	1598,99	1
154	Bostadsbyggnad	Flerbostadshus	1394,61	1
158	Industribyggnad	Industribyggnad	1112,95	1
159	Industribyggnad	Industribyggnad	1028,94	1
166	Bostadsbyggnad	Flerbostadshus	1360,81	1
167	Servicebyggnad	Vattentorn	2158,11	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Södermalm

FID	GRUPP	KATEGORI	takarea	Taktyp
19	Samhällsfunktionsbyggnad	Idrott	1832,397301	2
76	Industribyggnad	Industribyggnad	3260,46461	2
125	Industribyggnad	Industribyggnad	7632,515539	2
259	Bostadsbyggnad	Flerbostadshus	1676,08197	2
332	Industribyggnad	Industribyggnad	16969,787131	2
2	Bostadsbyggnad	Flerbostadshus	1883,404346	1
4	Bostadsbyggnad	Flerbostadshus	1633,976367	1
9	Industribyggnad	Industribyggnad	1452,771474	1
11	Industribyggnad	Industribyggnad	2298,384372	1
25	Bostadsbyggnad	Flerbostadshus	1115,476049	1
32	Bostadsbyggnad	Flerbostadshus	1151,473364	1
46	Samhällsfunktionsbyggnad	Allmän byggnad	7229,033888	1
55	Ospecificerad byggnad	Ospecificerad byggnad	1266,702129	1
59	Verksamhetsbyggnad	Kontor	3554,120159	1
63	Bostadsbyggnad	Flerbostadshus	1045,737329	1
64	Bostadsbyggnad	Flerbostadshus	1650,148885	1
66	Bostadsbyggnad	Flerbostadshus	3258,08741	1
69	Bostadsbyggnad	Flerbostadshus	1743,819162	1
74	Bostadsbyggnad	Flerbostadshus	2243,831527	1
77	Bostadsbyggnad	Flerbostadshus	1590,238974	1
78	Industribyggnad	Industribyggnad	5779,59136	1
83	Bostadsbyggnad	Flerbostadshus	1676,222439	1
94	Samhällsfunktionsbyggnad	Vårdbyggnad	1454,827139	1
117	Bostadsbyggnad	Flerbostadshus	2353,263448	1
122	Bostadsbyggnad	Flerbostadshus	1332,955562	1
131	Verksamhetsbyggnad	Kontor	1974,541101	1
135	Samhällsfunktionsbyggnad	Allmän byggnad	2884,428108	1
151	Samfundsbyggnad	Ospec. samfundsbyggnad	1984,89309	1
152	Bostadsbyggnad	Flerbostadshus	2219,220274	1
154	Verksamhetsbyggnad	Parkeringshus	3620,800639	1
163	Industribyggnad	Industribyggnad	1219,867685	1
168	Bostadsbyggnad	Flerbostadshus	2741,718848	1
170	Bostadsbyggnad	Flerbostadshus	1301,546399	1
172	Samhällsfunktionsbyggnad	Vårdbyggnad	1546,890325	1
183	Verksamhetsbyggnad	Kontor	2564,675933	1
187	Bostadsbyggnad	Flerbostadshus	1449,751264	1
190	Bostadsbyggnad	Flerbostadshus	1157,971554	1
191	Verksamhetsbyggnad	Kontor	3231,505152	1
197	Bostadsbyggnad	Flerbostadshus	2238,711642	1
209	Bostadsbyggnad	Flerbostadshus	1501,063272	1
214	Bostadsbyggnad	Flerbostadshus	1213,775	1
223	Samhällsfunktionsbyggnad	Allmän byggnad	1126,293186	1
226	Verksamhetsbyggnad	Kontor	1984,543625	1
231	Bostadsbyggnad	Flerbostadshus	2195,250931	1
242	Bostadsbyggnad	Flerbostadshus	1046,646373	1
246	Industribyggnad	Industribyggnad	2500,915037	1
250	Samhällsfunktionsbyggnad	Allmän byggnad	9104,466778	1
251	Bostadsbyggnad	Flerbostadshus	1561,707346	1
252	Bostadsbyggnad	Flerbostadshus	1244,793525	1
262	Bostadsbyggnad	Flerbostadshus	1736,766076	1
264	Samhällsfunktionsbyggnad	Allmän byggnad	1466,737365	1
271	Samhällsfunktionsbyggnad	Vårdbyggnad	1325,541664	1
273	Industribyggnad	Industribyggnad	2666,059731	1
284	Bostadsbyggnad	Flerbostadshus	1017,778035	1
287	Verksamhetsbyggnad	Kontor	1234,385888	1
296	Bostadsbyggnad	Flerbostadshus	1659,323127	1
300	Bostadsbyggnad	Flerbostadshus	1325,812449	1
305	Bostadsbyggnad	Flerbostadshus	1099,456535	1
308	Bostadsbyggnad	Flerbostadshus	3798,217424	1
311	Bostadsbyggnad	Flerbostadshus	1242,029521	1
315	Industribyggnad	Industribyggnad	4762,411849	1
318	Bostadsbyggnad	Flerbostadshus	1755,023519	1
337	Bostadsbyggnad	Flerbostadshus	1297,087358	1
346	Bostadsbyggnad	Flerbostadshus	1212,253517	1
369	Bostadsbyggnad	Flerbostadshus	2141,805949	1
376	Bostadsbyggnad	Flerbostadshus	1451,009925	1
377	Bostadsbyggnad	Flerbostadshus	2761,647237	1
387	Ospecificerad byggnad	Ospecificerad byggnad	2209,182611	1



Data sets provided by: Stockholms Stadsbyggnadskontor (2017)

Östermalm

FID	GRUPP	KATEGORI	Takarea	Takytor
116	Samhällsfunktionsbyggnad	Allmän byggnad	4093,18	2
137	Industribyggnad	Industribyggnad	1311,81	2
174	Bostadsbyggnad	Flerbostadshus	1931,41	2
177	Servicebyggnad	Vattentorn	3248,34	2
181	Industribyggnad	Industribyggnad	1977,94	2
224	Industribyggnad	Industribyggnad	10856,7	2
227	Verksamhetsbyggnad	Kontor	1939,16	2
243	Industribyggnad	Industribyggnad	2499,37	2
257	Samhällsfunktionsbyggnad	Allmän byggnad	1127,85	2
259	Industribyggnad	Industribyggnad	6163,33	2
267	Samhällsfunktionsbyggnad	Allmän byggnad	5790,55	2
269	Samhällsfunktionsbyggnad	Allmän byggnad	2501,2	2
270	Industribyggnad	Industribyggnad	4323,23	2
358	Ospecificerad byggnad	Ospecificerad byggnad	2405,01	2
33	Bostadsbyggnad	Flerbostadshus	1425,49	1
47	Samhällsfunktionsbyggnad	Vårdbyggnad	1798,11	1
48	Industribyggnad	Industribyggnad	3588,77	1
54	Industribyggnad	Industribyggnad	2116,82	1
89	Bostadsbyggnad	Flerbostadshus	1048,91	1
90	Bostadsbyggnad	Flerbostadshus	2387,08	1
98	Samhällsfunktionsbyggnad	Allmän byggnad	2125,79	1
129	Industribyggnad	Industribyggnad	2198,56	1
133	Samhällsfunktionsbyggnad	Allmän byggnad	1225,66	1
136	Industribyggnad	Industribyggnad	5894,84	1
147	Samhällsfunktionsbyggnad	Allmän byggnad	10680,5	1
178	Industribyggnad	Industribyggnad	6696,45	1
205	Samhällsfunktionsbyggnad	Allmän byggnad	3341,34	1
233	Samhällsfunktionsbyggnad	Allmän byggnad	20938,3	1
239	Samhällsfunktionsbyggnad	Allmän byggnad	3658,89	1
258	Samhällsfunktionsbyggnad	Allmän byggnad	1455,45	1
268	Industribyggnad	Industribyggnad	5588,68	1
291	Samhällsfunktionsbyggnad	Allmän byggnad	1511,92	1
303	Verksamhetsbyggnad	Ospec. verksamhetsbyggnad	2237,81	1
309	Industribyggnad	Industribyggnad	3379,2	1
324	Bostadsbyggnad	Flerbostadshus	2588,63	1
347	Industribyggnad	Industribyggnad	3270,27	1