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The Implementation of Conservation Policy and the Application of Solar Energy Technology in Small House Areas: Stockholm, Sweden

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ABSTRACT

This paper investigates the dynamic between protection of the historic environment and the application of solar energy technology on 1- or 2-family houses in Sweden. More specifically, the building code relating to the installation of photovoltaic (PV) panels on house roofs and how existing policies are implemented in Stockholm City is investigated in order to better understand the challenges in reconciling renewables and the conservation of built heritage. Especially when applied in urban areas PV panels may have a large impact on socio-cultural values, making them difficult to insta where the historic environment is to be protected from large changes. By using a mix of methods (policy analysis, case studies, and interviews) we come to the conclusion that municipalities should develop routines and guidelines that offer homeowners precise information on the potential of solar energy and requirements motivated by concern for the historic environment. Guidelines that are well-known, clear and also require homeowners to dismount exhausted panels could work both to protect built heritage and to promote more use of solar energy in some small house areas.

KEYWORDS

Solar energy; conservation; urban planning; residential architecture; values; policies; renovation; renewables

Introduction

Societal aims to reduce climate change while safeguarding socio-cultural values of the built environment can be difficult to reconcile, even though they are both necessary parts of a sustainable development. In order for these two goals to become compatible it is necessary to make effective use of public policies. This article is a study of how policies encouraging homeowners to become micro-producers of solar energy interact with building regulations intended to protect the historic environment. Renewables and in particular solar energy have increasingly become the first choice when adapting energy systems around the world, and many homeowners have become microproducers of solar energy.[1] While solar energy technology has the potential of supporting a sustainable energy transition, a widespread application of it may change the urban landscape in a profound way. As a consequence, conservation interests may collide with a strive to reduce climate impact.[2]

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Photovoltaics are used to produce electricity from solar energy by using panels that catch radiation from the sun. The visual impact of photovoltaic (PV) panels depends on the design of the panels, their location on a building, the slope of the roof, what kind of building panels are placed on, and visual impact on the surroundings.[3] The colour and shape of the panels, their potential reflection and reversibility of the installation are also aspects that should be considered.[4] Visual impact should however not be understood as an objective quality. On the contrary, we consider it subjective in the sense that it depends on legal context, architectural tradition, and aesthetic taste, which form the 'environmental capital'[5] of a city, to speak with the renowned conservation architect Dennis Rodwell. Socio-cultural values express this capital as they represent both tangible and intangible attributes of a city's environment and are thus often safeguarded and monitored.[6] When applying Rodwell's argument about the significance of the built environment to solar energy technology, it means that even if the materials and authenticity of the built environment in itself is not damaged by the use of PV panels, socio-cultural values can still be affected negatively. A balance thus needs to be struck between conservation aims and solar energy production.

Aims

This paper is part of a research project studying the implementation of policies for energy efficiency and conservation on a local level in Sweden, and aims to increase knowledge of how policies can better address how photovoltaics may be used without reducing socio-cultural values.[7]

The paper studies how policies affect the application of solar energy technology on existing 1- and 2-family homes in Stockholm City, which is the largest metropolitan area in Sweden. An important reason for looking at small houses is that many of them are considered historically valuable, and because homeowners are encouraged to instal photovoltaics by government policies. We focus our attention on what Kanter and Wall has termed 'the renovation phase'[8] of the solar energy planning process. This part of the process has so far received very little scholarly attention compared to the planning of new building construction.

The city has a large number of small houses, many of which are protected for their heritage values.[9] First we will analyse how the existing Swedish policies on solar energy relate to policies concerning the protection of the historic environment. Secondly, we analyse how these policies are implemented in Stockholm districts completely dominated by small houses. We do this by studying a selection of building permit applications submitted by homeowners who wish to instal PV panels on their house. Thirdly, we present an interview study involving administrators working in the public sector with energy efficiency or the built environment. Finally, the functionality of the policies and how it may be improved is discussed.

Previous Research

While there are many studies of different design solutions of PV panels and their visual impact, little attention has been paid to policy design and implementation regarding solar energy production in protected historic environments.[10] There is a striking lack of

internationally published studies of how building codes and other policies restrict the use of solar energy technology with regards to socio-cultural values.[11] Some tools that have been developed for PV panel design and management do not even consider visual impact or how different values are affected. This suggests little interest in public policies in this particular area compared to the interest shown in design and technical development.[12]

The focus on panel design and its visual impact, though, continues to be very strong. The few existing international studies combining panel design and conservation policy have the limitation that they only examine the impact on buildings with outstanding historical values, such as ones located in UNESCO world heritage sites.[13] Studies analysing visual impact or tolerance mostly seem to consider new construction or buildings with more or less outstanding heritage values, whereas the implications for the existing everyday urban fabric are hardly studied at all.[14]

While it is less likely that PV panels will be applied in districts with very restrictive conservation policies, most of the urban environment is associated with socio-cultural values, albeit not on a level equivalent to world heritage. Nevertheless, there is a need to achieve greater understanding of how policies can be used to promote sustainable development in existing urban districts in which there are some identified, however not necessarily outstanding, heritage values. We are here speaking of fairly large areas that may be characteristic for a certain period in the building history of a city, for instance small house areas built in the first decades of the 20th century.

Material and Methods

Methodologically speaking, the paper builds on a qualitative investigation divided in three parts: (1) policy analysis, (2) an analysis of public records relating to four selected cases, and (3) semi-structured interviews carried out individually or in small groups. Interviewees were with public administrators. The methodological implications of the three parts are described below.

Policy Analysis

National and local policies are analysed here since they have a major impact on how PV technology can be applied when renovating residential buildings. Swedish building code consists of a set of administrative policies primarily interpreted first and foremost by building permit administrators at the local level. If a decision is appealed by a homeowner or a neighbour the case will proceed to the county administrative board. In rare instances, when a decision of the county is appealed, it is taken to the Land and Environment Court (*Mark- och miljödomstolen*, MDD). The decisions of this court do not have the authority to guide or indicate how the law should be interpreted in future cases. Decisions taken by the Land and Environment Supreme Court (*Mark- och miljööverdomstolen*), however, become indicative for future decisions.[15]

Another kind of policies used here are informative ones, aiming at supporting home-owners with information about the character of their property or the potential to improve its energy performance. They may also work as tools for public officials. The Stockholm solar map (*Stockholms solkarta*, Figure 1) is one example of such informative policies. It is a digital tool free of charge, offering information to the homeowner about the potential

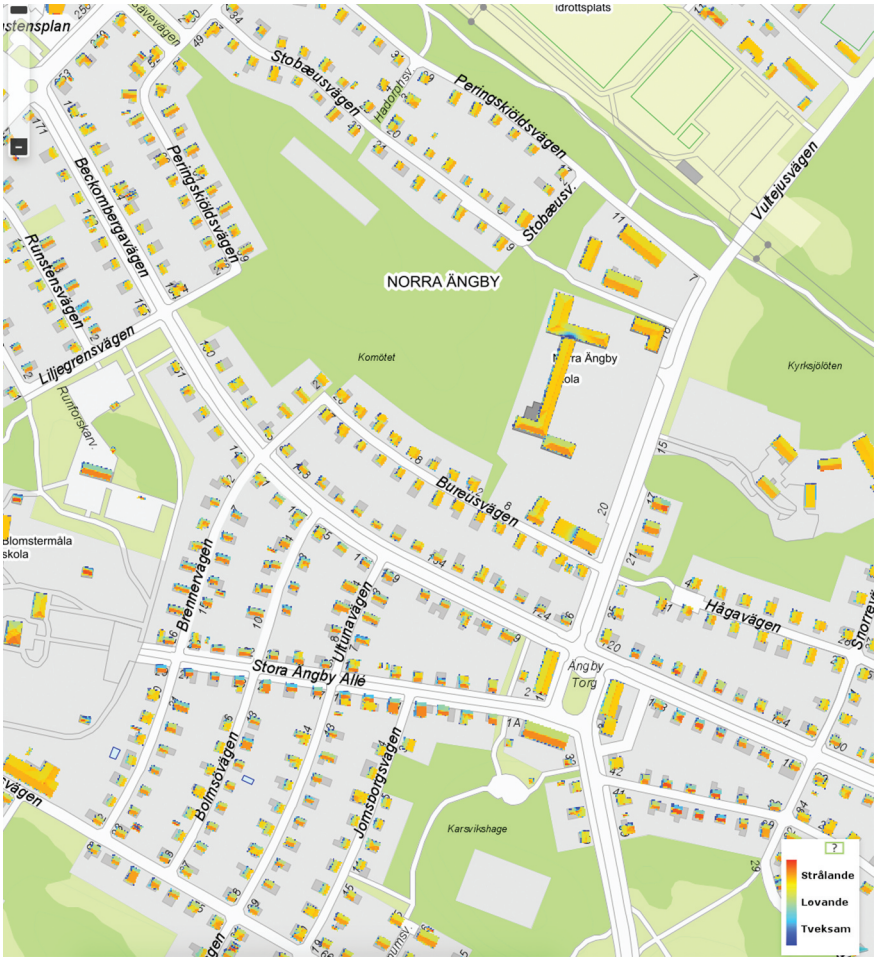

Figure 1. Detail of the solar map showing Norra Ängby, a small house area in Stockholm. Source: The Stockholm solar map.

for producing solar energy on the roof of a particular property, depending on solar radiation.[16] The chart shows what part of a roof should have the greatest potential for producing solar energy, and thus it may strongly encourage a homeowner to instal PV panels. The city is actively encouraging homeowners to make use of this chart.

Stockholm is the largest metropolitan city in Sweden and has a stronger historical tradition of monitoring and evaluating its historic environment than any other city in Sweden. A result of this work is the 'Heritage classification of the City Museum' (*Stadsmuseets kulturhistoriska klassificering*), which is illustrated in an online map giving information on the historic environment at a property level. Both the solar map and the heritage classification map (explained more in detail below) are readily available to the homeowner but demand some level of knowledge about the limitations of the tools and how the information gleaned can be used. Another group of informative policies are guidelines issued by authorities, such as the guideline concerning the installation of PV

panels on buildings just recently adopted by Stockholm City. This guideline aims at clarifying for the homeowner what information it is necessary to gather before installing PVs and to explain the considerations to be made.

Public Records Analysis: Case Studies

Except for surveying the frequency of building permits for solar panels over time, we investigated four cases of building permit applications for mounting PV panels on small houses in protected areas. This has given us a better understanding of how Stockholm City weighs the public interest of the historic environment against the private interest of the homeowner. So far, very few building permit applications have been submitted for this purpose in designated areas almost completely dominated by small houses (typically located in the western part of Stockholm), and even fewer have been granted. The cases are not unique in themselves but illustrate issues arising when homeowners wish to instal PV panels of the most common design (surface-mounted, crystalline silicon – sometimes called 'first generation' panels[17]) on houses with designated values.

In Stockholm City, with a population of 975,500 in 2020, there are 450,000 dwellings representing 9.2% of the national housing stock.[18] Some 35% of the total housing stock in Stockholm was built before 1940, meaning that a large part of it is considered historic.[19] In 2019 there were 45,334 1- and 2-family homes within the city limits.[20] Small houses, then, constitute a significant part of the building stock in the city, in particular semi-detached villas. The great presence of small house areas is a characteristic of all Swedish towns and cities.[21]

The majority of the effect of PV panels in Sweden today is generated by small units, under 20 kW, such as those mounted on 1- and 2-family homes. Their geographic concentration is located in the metropolitan areas of Stockholm, Göteborg and Malmö.[22] Especially in Göteborg and Stockholm they are quickly becoming more common. In Stockholm County there was a total of 7,110 distributive photovoltaic power systems installed in 2020, compared to just 872 in 2016.[23]

Except for the national climate goals there are in Stockholm local climate goals stressing the need to lessen the climate impact of the city. As a consequence, the city is aiming to have become fossil free and CO^2 positive by 2040.[24] Even if there is no specified target for how much solar energy each should contribute, this goal lends moral support to homeowners wishing to engage the fight against climate change.

In the last few years there has been an increase in the number of building permits handled concerning installation of PV panels on existing buildings in Stockholm City.[25] The frequency has nearly doubled over the course of four years (from 70 to 131 per year), pointing to a growing interest among property owners in installing the technology. The growth is almost certainly caused by government incentives and marketing. This data is based on started cases of building permits, which is not the same as to state the number of PV panels that actually have been installed on buildings, or to state their total output. It includes all kinds of buildings and not just 1- and 2-family homes. It should be noted that this category of houses is a minority in these statistics.

Sources used here include plans, photos, application forms, documentation of heritage values and decisions made by authorities. Stockholm City records all building permit applications in an online database that has been utilised here. Records, such as decisions,

are not found in the database but can be retrieved by anyone at no cost from the city building office (*stadsbyggnadsexpeditionen)*. Finally, a MDD court case involving the installation of PV panels on a small home in a protected residential area of Stockholm has been used in order to contribute to the concluding discussion on the possible implications of court cases for existing policies.

Interviews with Public Administrators

The effects of policies are seldom clear-cut since they are always interpreted within a social context.[26] In order to better understand how the different policies are implemented in relation to each other, interviews were conducted with public administrators representing a number of departments or units. The interviews serve to give an understanding of how policies are understood by those who issue building permits or who give advice on energy use or building conservation to citizens.

In addition, a number of roles in the public administration are represented in the interviews. Building inspectors do on-site inspections of building sites while the permit administrators prepare decisions and issue permits. Conservation officers are specialists in cultural heritage employed by the city museum (*Stockholms stadsmuseum)*, the county museum (*Stockholms länsmuseum)* and the county administrative board (*Länsstyrelsen Stockholms län*, abbreviated Lst, which represents the state government). Energy and climate counsellors have an organisation of their own in the Stockholm region, working with giving advice on energy use to homeowners, small companies and housing cooperatives. They are employed by the municipalities in the region, which receives co-funding from the Swedish Energy Agency in order to carry out their mission.

Results

Policy Analysis

Swedish Policies on Increased Energy Efficiency in the Building Stock

In line with EU directive 2012/27/EU, Sweden has set a goal to use energy 50% more efficiently in 2030 compared to 2005.[27] Moreover, in 2017 the Swedish government committed to a long-term goal to have net-zero greenhouse gas emissions by 2045 in which renewable energy production play a significant role.[28] The national goal is to reach 100% of renewable electricity production by 2040. As a consequence of this Climate Act, the government looks quite favourably at microproduction of renewable energy.[29] A much wider application of PV panels on small houses, housing association buildings, businesses as well as public buildings, is thus encouraged at state level.[30] The Swedish demand for electricity is expected to grow considerably in coming years, and therefore there is a need not just for more domestic and fossil-free production of electricity but also for a more robust and flexible infrastructure for distributing it.[31]

The National Board of Housing, Building and Planning (*Boverket)* argues that the situation in Sweden shows a discrepancy between ambitiously set goals for increased energy efficiency in the housing stock and a strikingly slow rate of renovation and the adoption of energy savings measures.[32] In 2020 roughly 40% of the households in

Sweden were found in 1- or 2-family houses.[33] In all 93% of all residential buildings in Sweden are such small houses, but only 15% of these houses belong to those that show the highest level of energy performance.[34]

The Swedish government is keen on seeing substantial improvements in energy performance of this building stock. One part of the policies for increasing renewable electricity production is called 'green technology' (*grön teknik*). It offers homeowners financial support equivalent to 20% of the installation costs when investing in solar energy. There is also a substantial subsidy (equivalent to Euro 0.06 per kWh sold) aiming at making it more profitable to sell home-produced solar energy on the market.[35] *Grön teknik* policies, and their precedents, have thus aimed at 'nudging' homeowners towards investing in solar energy by using incentives.[36]

Even though panels with other colours have become available, roughly 95% of global production still consists of cells made of crystalline silicon (so called 'black' panels), which most commonly are mounted on rooftops.[37] The motives of homeowners for adopting PV panels are varied, ranging from a wish to lower ones' heating costs to considerations of global climate change.[38] Decreasing costs for installing panels, shifting electricity rates, the existence of government subsidies and public debate on how to limit climate impact all serve to make production of renewable energy more interesting to homeowners. There are however building regulations in place that restrict the application of PV technology on rooftops in many urban areas that have detailed plans.[39] Until the time of writing (February 2022) very few cases of building permits involving PV panels have been tried in courts. Instead almost all cases are tried on a municipal level. Research on how these legal restrictions are handled in practice by local authorities is, however, still lacking.

Swedish Building Legislation

According to the Swedish Building and Planning Act of 2010 (*Plan- och bygglagen*, PBL), the historic environment should be dealt with regardless of the consequences for climate impact or other considerations of the environment. An exemption from building permits that was introduced for PV panels in 2018 applies to 1- or 2-family homes in areas with detailed plans if the panels installed are in alignment with the shape of the roof. The character of the roof can be changed but its shape needs to stay intact, then. However, if the building or area in question has designated heritage values, a permit is still needed.[40]

In Swedish building administration three different sets of socio-cultural values (*kulturvärden*) are identified: cultural-historical, social and aesthetic values.[41] The building legislation associates not only the materiality of buildings with values; there are also intangible values.[42] In so called 'post-modern conservation' buildings can be valued because they represent an epoch or a social class, meaning that they are valued also for what they can say about the historical development of the surrounding community.[43]

These values should preferably be described in detailed plans or area restrictions in order to be legally valid and possible to implement. In order to reject a building permit, the city needs to prove that there are considerable values at stake that are associated with the building or its surroundings. Even if such documentation is missing municipal authorities still have the right to deny a building permit on the grounds that there is a risk of disfigurement (*förvanskning*). The disfigurement can be of the specific building in question or the impact that it might have on the surrounding environment.[44]

PBL states that all buildings should be renovated with care in order to protect their character.[45] The act furthermore says that buildings with extraordinary heritage values cannot be disfigured.[46] The concept of disfigurement is of importance here since it is regulated in PBL and describes an act, rather than a condition, in which a building's character is changed in a way that is intolerable. The general ban on disfigurement expressed in PBL applies to both exterior and interior changes made to a building that do not respect its character and values. However, as long as the values that the building is identified with are respected, different kinds of measures can be carried out.

In Stockholm PBL is first and foremost implemented by the city, and supports the use of local policies regulating building. Since 2020 Stockholm City has a new building ordnance describing the character of the cityscape and the different districts, offering some guidelines to how additions and other changes to existing areas should be designed.[47] This ordnance has been criticised by architects for being too vague in its guidelines and not lending enough support to the protection of the historic environment.[48]

A specific unit for building permits issues building permits for, among many other measures, PV panels. The work of the unit is sanctioned by the Board of City Building (*Stadsbyggnadsnämnden*), which consists of elected councillors. If a homeowner or someone else is dissatisfied with a decision of the board, s/he can appeal first to the Board of City Building, and if its decision is not satisfactory to the owner the case can be taken further to the County Administrative Board. The board has the power to disqualify a decision made by the city if it is evident that the law has not been applied correctly. The decision of the County Administrative Board can in turn be appealed to MDD.

PBL requires municipalities to consider the different dimensions of sustainable development in decision-making concerning the built environment.[49] Consequently, a decision on the suitability of PV panels should consider both private interests and the common interests of society, integrating aspects of sustainable energy production and use with the need to protect the historic environment. As will be discussed below, however, it may not be the case that each decision is grounded in such an assessment of the sustainability of a measure.

The Heritage Classification of the Stockholm City Museum

In order to protect the historic environment from disfigurement it is necessary to carry out surveys identifying the values at stake. The Stockholm City Museum has worked for a long time collecting data on the heritage values of the built environment. In the inner city the most recent systematic survey was carried out in the 1990s, but surveys have been conducted since the 1970s. In the outer city a systematic survey was begun in 2004.[50] After collection the data is processed and finally published in an open access online map. This map has so far been used extremely little in academic research, despite that it is extremely rich in information.[51]

The heritage classification of Stockholm City Museum marks buildings and areas with different colours identifying the level of heritage values. (Figure 2) The highest level is marked blue in the map, the second highest green, the third highest yellow, and the lowest grey. The classification is based on building surveys conducted in previous years, and serves as a knowledge base used in the daily work of the municipality's administration, such as detailed planning and building permits. Properties need to have reached

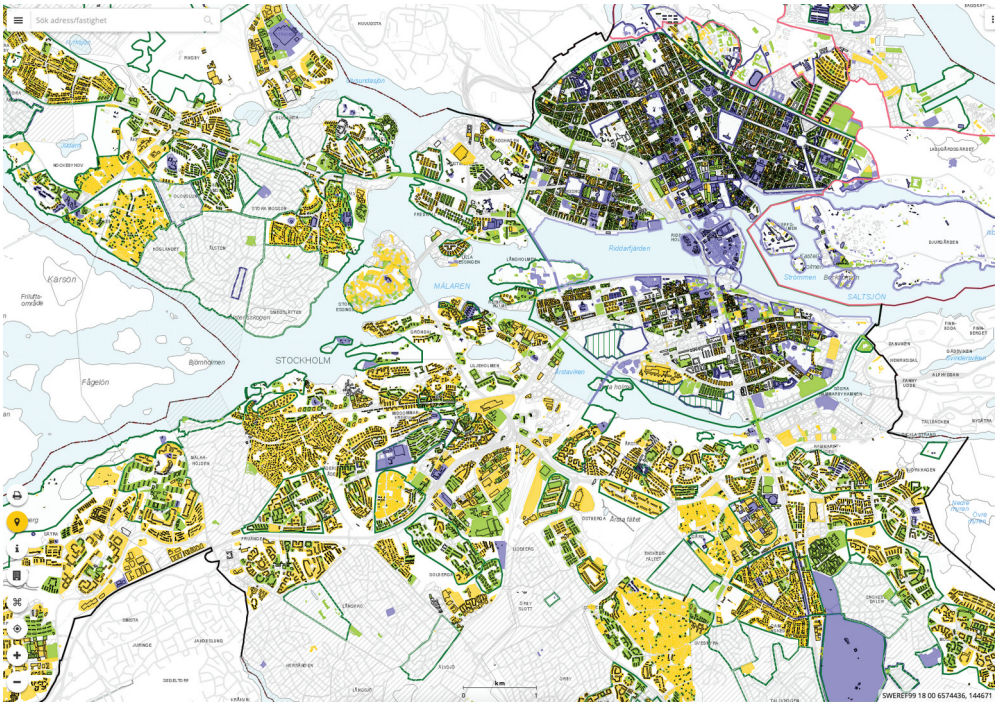

Figure 2. Detail of the heritage classification of Stockholm City Museum. Source: Stockholm City Museum.

a certain age in order to be classified: in the outer city properties built after 1990 have generally not been classified, whereas in the inner-city properties need to have been built before 1960 in order to be assessed.[52]

The city explains on its website that all buildings marked green or blue need a building permit before PV panels are installed.[53] This does not seem to be a fully functional practice, though, because there needs to be an assessment of the socio-cultural values of not just the individual building but also of the surrounding environment. Even 'yellow' house roofs can thus be deemed unsuitable for PV panels since they can represent significant values.

The Stockholm Guideline on PV Panels

In an attempt to clarify when a homeowner needs a permit, Stockholm City adopted a guideline issued in March 2021. This is the most extensive yet adopted in Sweden. Local guidelines have been published by some municipalities, but they are most often extremely brief and lack illustrative examples.[54] In other cases, such as in Göteborg, there are guidelines for internal use only.[55] What makes the Stockholm guideline particular, is not only that it is more detailed than previous policies, but also that it devotes attention to heritage values and the impact that PV panels may have on them. It also includes illustrations intended to show examples of locations in which panels may be accepted. One reason why this guideline was developed is that the legal practice is not yet fully

developed in Sweden. Municipalities wait for court decisions and try to understand their possible implications. They are looking to reduce the level of conflict between private and common interests.

The city plan defines the considerations that need to be made. Weighed together, scale, positioning, proportions, materials, and the colour are decisive in whether a proposed change is tolerable or not. If a homeowner is denied a permit to instal PV panels, this means that a particular type of panels are not accepted in that particular location. It is not a general ban on panels on a house or in an area.[56] Changes are to be conducted in a way that protects and even develops the character of the built environment. Integral PV panels are treated somewhat differently in Stockholm than surface-mounted ones since they replace roofing or cladding. Integral panels require a permit if they change the character of the building or its surroundings significantly, whereas surface-mounted ones require a permit if they don't follow the slope of the roof.[57] This is also the case even if the shape of the roof is not altered but the building is located in a designated area. Some examples are given in the guideline order to serve as illustrations. In an area with a heterogeneous mix of houses, PV panels are said not to make as much visual impact as in an area where houses have been built in a more stringent fashion.

Analysis of Four Cases of Building Permits

In this section two cases of successful permit applications and two cases of denied building permits, all regarding small houses in Stockholm areas protected for their historic environment, will be analysed in short. The cases have been selected because the proposals are of a very recent origin, and because the houses are located in designated areas.

Nockeby: Permits Approved

In 2019 the case of a homeowner in Nockeby wishing to mount black PV panels on a tile roof of a house from 1931 was appealed to MDD. (Figure 3) According to the owner, the suggested plant would produce c. 6 700 kWh per year, whereas the solar map predicts that 16,840 kWh could be produced if the most promising portion (40%) of the roof area is used.[58] The house is quite characteristic for this part of suburban Stockholm, and is marked yellow on the heritage classification map. Both the comprehensive plan and the building ordnance state that Nockeby has great values, meaning that care must be taken for the conservation of the complete environment as well as for the individual buildings.[59] It is one of several examples of how the idea of garden cities was implemented in Stockholm from 1908 onwards.[60] Nockeby is characterised by single-family homes built in the 1930s, showing a restrained and uniform style in a shifting and irregular terrain. Houses are built with two floors with red tile saddle roofs and wooden panel facades. The homeowner's building permit application was granted by the city on the grounds that the house is located at the end of a cul-de-sac where the slope of the roof is hardly visible from the ground. The visual impact was estimated to be very small.

Shortly afterwards a neighbour living on a parallel street appealed to Lst, arguing that the reflections of the panels would be disturbing and that this was an act of disfigurement.[61] The risk of glare from the panels was considered to be too small to

Figure 3. The Nockeby home. Source: Stockholm City Museum, (Nockeby stadsdelsinventering).

qualify for an appeal. Unlike the city which thought that the measure was tolerable since its visibility was extremely low, Lst found that disfigurement would be a fact regardless of the visibility.[62] In order to protect the red tiled roofs of the area, Lst withdrew the permit.

The owners applying for a permit were not content with the permit having been revoked, but instead appealed to MDD. This was indeed the first instance in the Stockholm region that a case of PV panels on a house located in an area with designated heritage values was tried by the court. In their appeal the owners quoted the official climate vision developed by the city. 'Tile roofs may be beautiful, but for us renewable energy weighs heavier', the owners said.[63] MDD concluded that the city had issued a permit on good grounds, thus reversing the Lst decision. Even though the area has great values (according to Lst) the court could not find that the detailed plan would restrict this measure. The installation would not affect the shape of the building, as the panels would be surface-mounted and consequently easy to dismount in the future.

In this case the court evidently viewed surface-mounted panels as a less sensitive intervention than integrated ones because of the alleged reversibility. The roofing material is kept beneath the panel and is thus preserved. The slope of the roof is small and the house has two floors, meaning that visual impact is limited. Shortly after the court decision a next-door neighbour, owning an identical house, decided to instal PV panels as well.[64] An observation from this case is that if one homeowner instals PV panels on a house in an area protected for its heritage values, neighbours may be encouraged to proceed with their own installations. This turn of events shows that the MDD decision did not just have importance for an individual house, but that it may indeed have

repercussions for the area and for small houses in the city at large. Even if the MDD decision is not a precedent and its validity is limited, local authorities may hesitate before denying a permit in this area again.

Norra Ängby: Permits Denied

According to the city plan five areas in Stockholm with 1- and 2-family houses are protected for their heritage values.[65] They are 'the garden city' Gamla Enskede, Olovslund, Pungpinan, Norra Ängby, Södra Ängby, and Ålstensgatan, located in the western part of Stockholm (Figure 4). In the building ordnance, many other areas dominated by small houses are also characterised as valuable.[66]

Norra Ängby is characterised by some 1,300 small (less than 120 square metres), single-family homes built between 1931 and 1938 under the management of the city.[67] It is the largest area of cottages (*småstugor*) found in Stockholm, many of them built in person by middle-class officials, policemen, firemen, foremen, and the like. Today the area has c. 5,500 inhabitants.[68] In recent years there has been increasing pressure from homeowners wishing to renovate and extend the small cottages. These changes have mainly been tolerated when they have not been visible from the street.[69]

In Norra Ängby and the other garden city areas homeowners are not exempt from applying for a building permit for PV panels, and it should be more difficult for them to obtain a permit than in less protected areas. There have so far been few applications in these five areas and all of them have been turned down. As is developed below, however, the reason is not just a restrained policy but also that homeowners do not adapt their proposed measures to the character of their houses.

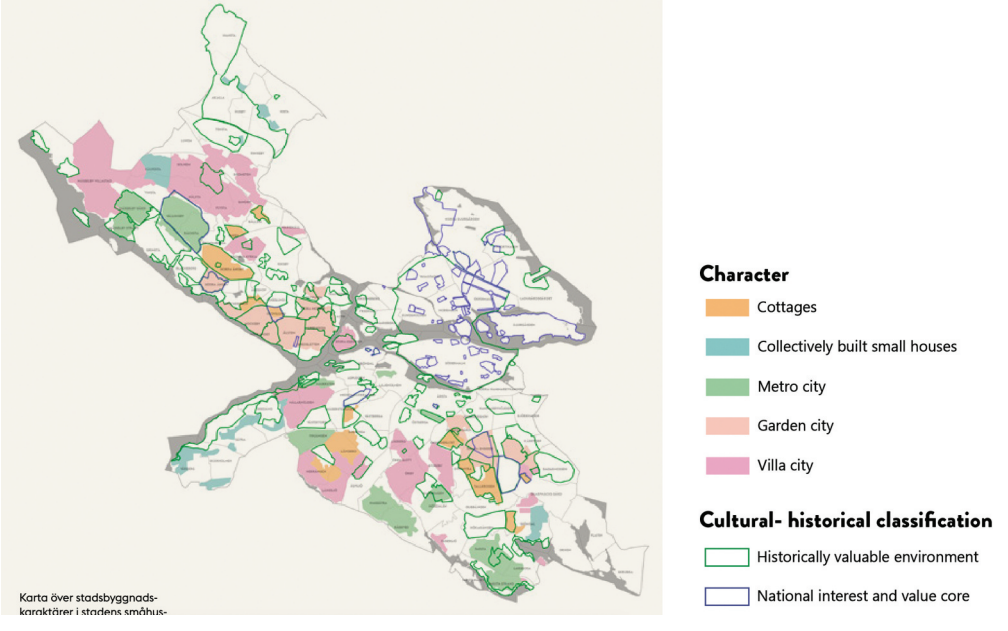

Figure 4. A-b. Map of Stockholm showing the presence of historically designated areas dominated by small houses. Source: Stockholm City, 'Varsam', 12.

Since 2018 there have been five applications for permits relating to the installation of PV panels here. All of them have been denied, pointing to the fact that homeowners so far have not been able to show how to make an acceptable installation despite that these houses are not among the most valuable small houses in the city. In the city's guideline for installations of PV panels, Norra Ängby is stated as an example of an area with a well-preserved roof landscape that should be sustained (Figure 7).[70]

The first instance (2019, Figure 5) studied in Norra Ängby shows the intention of the owner and the response of the city. The owners of the house (located on the street Danavägen) wished to place black, surface-mounted panels on a red concrete tile roof facing the street, covering 36 square metres of the roof.[71] They pointed out that the roof is hardly visible from the street. The house is marked yellow in the heritage classification map. In this area most houses are yellow while a small minority are green. The building stock of Norra Ängby is quite homogenous and built in a short period of time.

The act of putting black PV panels on a red roof was in itself viewed as an insensitive proposal by the city. Letting the panels face the street would make the degree of disfigurement even more severe. It was also pointed out by the city that Norra Ängby is a nationally designated area (*riksintresse)*. The city denied the owners a permit and recommended instead red, building-integrated panels (BIPV) or another solution that is available on the market and that would be adapted to the character of the roof. Unlike the MDD case above, the city argued that integrated panels would constitute a lesser intervention on the building. The owners have not proceeded with this suggestion.

Figure 5. The Norra Ängby houses. Bebyggelseregistret.

In the second instance in this particular area (also from 2019, Figure 6), which also concerns a yellow-marked house, the owners first installed black surface-mounted panels covering about 25 square metres or a quarter of their red tile roof, and then applied for a permit.[72] The potential accounted for by the solar map

Figure 6. The Norra Ängby houses. Bebyggelseregistret.

Figure 7. The roof landscape of Norra Ängby. Source: Stockholm City, 'Vägledning'.

is excellent: 49,500 kWh, given that all of the roof is used.[73] The city, however, denied a permit on the grounds that it was deemed a highly insensitive measure, emphasising that this is a particularly well-preserved house in a protected area. The panels are also clearly visible from the street. In a case such as this, where the owner has already installed panels, the city is supposed to consider the investment made by the homeowner when making a decision. Public interest should be weighed against private interest, which could be a monetary investment. In this case the owners were given the options of either dismounting the panels or paying a fine of c. Euro 650, a sum decided according to the area of the panels (21 square metres).[74] The fine is quite small compared to the cost of having the panels mounted, which should have cost roughly Euro 8–9,000 before subtracting the government subsidy.[75]

The Norra Ängby cases show that the city is ready to consider not only blue or green houses as unsuitable for roof-mounted PV panels. The large majority of houses in the areas mentioned here are yellow but are still protected for the values they represent according to surveys that have been conducted. Installing PV panels on these houses, then, requires an approach that is sensitive to designated values. In the cases mentioned above the homeowners suggested standard solutions involving little, if any, consideration of the visual impact of their measures. Black, surface-mounted panels were to be placed on red tile roofs, and in locations clearly visible from the street (since this was the best location from a solar energy point of view). When the city recommended another solution the owner in question responded by withdrawing the application. In the other case the owner had already installed the panels, which is illegal in this and many other small house areas in Stockholm.

Interviews with Public Administrators

The cases presented above give an understanding of the challenges that homeowners as well as the city face when considering the possibilities and limitations of installing PV panels. Nockeby is an area where black, surface-mounted PV panels have been accepted, whereas in Norra Ängby they have not been allowed so far. In this final section of the investigation we have sought to deepen our knowledge about the building permit process as it is understood by the public administrators.

There is evidently some confusion about how to correctly interpret the classification of the city museum. It is interesting to study a bit closer what is causing this confusion and if it can be alleviated. According to one interviewee working at the building permit unit of the city, there is a misunderstanding among the public that only blue and green buildings on the map count as historically valuable:

> [. . .] those who live in category yellow houses, they may think they are free to do whatever they like and are very surprised when it turns out they are not.[76]

Consequently, some owners of yellow-marked properties may think that their home is not protected for its heritage value. Developing this line of thought, the same interviewee says that some homeowners seem to think of the map as a form of restriction. The city museum, however, stresses that the classification works as a support in decision-making. The classification cannot be viewed as a restriction on homeowners despite that some citizens may believe so.[77] In 2012 a homeowner decided to try the validity of the classification by reporting the city to the Parliamentary Ombudsmen (*Riksdagens ombudsmän, JO*) – a supervising office handling citizens' complaints on authorities – for having given the impression that the map presents restrictions.[78] JO concluded that the homeowner actually had been given this impression and criticised the city.

Values are often abstract and even if the colour scheme of the city museum can be a support in pointing them out, colours alone cannot describe which concrete measures can be accepted on a building. The building permit office describes it as a difficult task to explain to homeowners why they can't instal PV panels in a certain location.[79] Even for the individual administrator it is difficult to know when a building permit is required or not – 'it is complex', as one of them said.[80] The office compares PV panels with the replacement of original windows when it comes to the degree of complexity.

It is for this reason that a guideline on the installation of PV panels was developed. The guideline is expected to answer a variety of questions that homeowners may ask and inform them about what they need to do in order to increase their chances of receiving a permit. Furthermore, the city does not wish to cause conflicts with individual homeowners, and issuing guidelines may be a way to prevent misunderstandings and grievances. As the conservation officer at the County Museum says, the arguments of the building permit unit are often questioned by homeowners.[81]

Information published online by municipalities in the form of interactive maps and guidelines does not necessarily mean that it is readily accessible to homeowners. This information can still be difficult to digest. Maps, for instance, are simplified renderings of a much more complex reality. One of the counsellors on energy and climate comments the fact that information does not help you if you don't know how to interpret it. There are

> online maps [the classification] you can have a look at, but I had a very hard time navigating in them, I couldn't make out if my house is in an area that is covered by the exemption [from permit] or not. I think you need some training in interpreting these maps in order to navigate correctly.[82]

A homeowner needs to collect and process different kinds of information before making an application for a building permit or deciding that a permit is not necessary. The exact mounting on the roof, what kind of panel to use, issues of fire safety, socio-cultural values and visual impact need to be considered together.

A conservation officer working at the Stockholm County Administrative Board is thinking along the same line as the counsellor mentioned above when saying that homeowners should be able to easily gain access to accurate information not just on the technical and financial aspects of solar energy, but also on other aspects, such as how to think about visual impact.[83] According to the interviewee at Lst, a permit application considering all of the relevant aspects is more likely to be successful than one solely aiming at producing as much energy as possible to the lowest cost.[84]

The guideline on PV panels stresses the balance that ideally should be achieved between private and common interests. Street views and public spaces are to be protected, whereas closed courtyards or backyards are seen as less public and more acceptable for PV panels. The administrator involved in writing the guideline explains:

> It is important to understand that this guideline does not say 'do this or do that'. It is very difficult for us to say exactly what do. Instead, we have tried to emphasise what may be valuable in areas and what should be regarded etcetera, because except for the paragraphs it is very much about making an assessment of care and disfigurement.[85]

Another administrator involved in producing the guideline, stresses the importance of looking at a number of variables:

> We need to look at it [the proposal] and cannot answer in general regarding all permits on solar energy. We have to study what it looks like from the street [. . .] and what the roof landscape looks like, and how the roofs appear, what the character of the area is and which the valuable parts are. It is an overall assessment.[86]

The quote sums up the complexity of the assessment, emphasising the difficulties in explaining how a homeowner should act. The guideline, then, becomes limited to giving a very brief explanation of the legal requirements and a few illustrative examples of acceptable solutions. Since it is quite new and not so well known yet it is difficult to say what the value of the guideline will be to the public.

Discussion

Even though a few previous studies have observed that socio-cultural values may restrict the location of PV panels, there is a striking lack of studies of how conservation policies interact with building and planning policy and the actions of homeowners. If the visual impact of urban roofscapes is considered without paying attention to conservation policies this may give the impression that the potential of solar energy in cities is much of much greater importance than heritage values. Our study shows that this is not just an issue of national and local governments encouraging homeowners to become producers

of renewables, but a much more complex issue, especially in existing residential areas. It involves the historical and architectural characteristics of a neighbourhood, the design of the proposed installation, its visibility from different vantage points *and* the issue of reversibility.

Even if national as well as local government encourages homeowners to become producers of renewables the mix of relevant policies may appear confusing for homeowners navigating through them. Currently tools aiming at nudging homeowners, such as the solar map, are not coordinated with existing national and local guidelines on building. The adoption of a guideline on PV panels is a step in the right direction, but does not exactly address the problems identified in our case studies. Homeowners consistently chose the most affordable and most visible solution, instead of suggesting a less visible location or another kind of panel design (BIPV) or colour. In one of the areas studied (Nockeby), black panels were accepted on the grounds of reversibility and low visibility, whereas in a neighbouring area (Norra Ängby) the same solution was not accepted and seen a disfigurement of the roof landscape. In Norra Ängby panels in a colour similar to the roof would be acceptable since they would be less visible.

We identify three ambiguities here, which may be resolved by refining informative and administrative policies. First, some homeowners who receive a rejection may go ahead with installing PV panels anyway, accepting the risk that they will need to pay a fine if they don't receive a permit. If given the choice, a homeowner may choose to pay a fine instead of dismounting an unpermitted PV system. There may be a reason to consider an adjustment of PBL, or to sharpen the local building ordnance, in order to better protect the historic environment from disfigurement. Presently PBL does not consider the socio-cultural values of a building when a fine for disfigurement is exacted. Making it more expensive to instal PV panels illegally on buildings could make the incentives to follow the guideline stronger.

A second ambiguity regards the design of PV panels when it comes to renovation of existing homes. There is currently no policy on how surface-mounted panels, contra BIPVs, should be assessed when it comes to the issue of reversibility. The court decision, MDD P4921-19, noted that in that particular case the surface-mounted panels could easily be dismantled in the future. If this argument becomes generally accepted surface-mounted panels may become viewed as non-intrusive and non-disfiguring due to their supposed reversibility. If this is the case, one could question if it would even require a building permit before installing panels in the future. When interviewed about the reversibility of the two different approaches, a conservation officer said that each case has to be assessed individually, meaning that it is not possible to say in general that surface-mounted PVs are less intrusive than BIPVs.[87] An assessment has to be made in each case, considering the values of the building and the visual impact of the installation.

Some previous research has tended to view BIPVs as less intrusive,[88] but no internationally published study has yet looked at how PV panels actually affect historic environments. BIPVs mean that original roofing materials need to be replaced, making it more difficult to reverse the measure once the life cycle of the panels comes to an end. If reversibility really is important and not just a theoretical possibility, the dismounting of the panels once the production of solar energy has ceased should be required. Currently, building permits do not include any such requirement. It is worth considering if all panels should be considered as permanent and non-reversible until there are policies in place demanding that owners

replace or dismount exhausted panels. The issue of reversibility is likely to spark debate and call for further interpretation of existing policies in the future as panels become exhausted and roofs need to be restored in order for heritage values not to be lost permanently.

A third ambiguity is the shortage of precise, non-partial and readily accessible information on available technology and its expected production of energy. This includes the lack of any official plans on how much solar energy production Stockholm City is aiming for, and how much of this energy should be produced by panels mounted on small homes. In the cases studied here, the discrepancy between potential calculated in the solar map and the expected production accounted for in the building permit application is striking. The solar map seems to give much bigger numbers, and if this is not just a coincidence it might mean that the solar map in some cases may exaggerate the potential. Furthermore, surface-mounted crystalline silicon panels seem to be preferred by homeowners since they are still the most common and affordable technical solution. There is an obvious risk that a homeowner makes a premature decision on what product to use and how to instal it without first having considered other aspects that are assessed when applying for a permit, such as visual impact. If energy and climate counsellors at an early stage in a renovation phase could offer detailed information to homeowners this problem could be lessened. Cooperation between energy and climate counsellors and building permit administrators could also serve to give homeowners more precise information. At the present the staff in Stockholm has very little, if any, exchange, and one group does not consider the expertise of the other group. The interviews conducted suggest there is a lack of cooperation between these functions.

Conclusion

A general conclusion from this study is that municipalities need to follow the example of Stockholm and develop guidelines for the application of solar energy technology. A city can encourage its citizens to become microproducers by formulating and communicating visions, but building and planning laws still apply, and it is the responsibility of the city's administration to safeguard the historic environment. Policies should be written in a clear and precise way in order to prevent misunderstandings or loopholes from occurring. An example of vagueness can be found in the Stockholm building ordnance, which does not clearly say that the materials or colours of roofs in small house areas should be preserved. It just says that these features should be 'taken advantage of' (*tas tillvara*) and that the shape of a roof should be something to start from (*utgå från*) when renovating.[89] If some characteristics of the historic environment really are to be protected, there should be sharp formulations about this in policies.

Cooperation between energy and climate counsellors and building permit administrators can also be improved. A problem today is that they work in completely different organisations in Stockholm: building permits are handled by the city administration, but counselling is organised by a regional organisation disconnected from the city. The counsellors could, if they become better informed about building regulations, give more accurate advice to homeowners at an early stage. There may be more efficient

ways of reducing the climate impact of a home than by installing PV panels, for example by making it more energy efficient. In Sweden solar energy will never be the one and only solution to the problem of climate change induced by residential buildings.

Finally, the results of this study suggest that the conflict between solar energy production and heritage values may be alleviated to some degree by using informative policies that serve to guide homeowners. Cooperation between energy and climate counselling and the building permit officials could improve the effect of precise informative policies. It is worth mentioning here that there are also other informative policies used in this area, such as counselling and public webinars directed at homeowners, housing associations of owner-occupiers, and small companies about the potential of solar energy. Clear guidelines that are well known and considered legitimate will support homeowners' decision-making. Finally, incentives to follow policies would become stronger if there were stronger sanctions against the illegal installation of PV panels.

Notes

1. IEA, *Trends*.
2. Pendlebury et al, 'Conservation'; Franco, 'Impacts'.
3. Probst and Roecker, 'Criteria'.
4. Rosa, 'Building-Integrated'.
5. Rodwell, *Conservation*, 205.
6. Rodwell, *Conservation*, ch. 10.
7. 'Energy efficiency and cultural values in housing. How well do the policies function on the local level?', funded by the Swedish Energy Agency, project 50,041–1.
8. Kanters and Wall, 'A planning', 175.
9. Stockholm City 2014.
10. Lingfors et al, 'Target-based'; Probst and Roecker, 'Criteria'; Florio et al, 'Designing'; Bao et al, 'Understanding'.
11. See however Malafry, 'Skyddet'.
12. Pabasara et al, "Design".
13. Franco, 'Impacts'; Franco, 'Solar powered'
14. See note 10 above.
15. SFS 1999:175, § 6.
16. Energirådgivningen, "Solkartan".
17. Temby et al, "Building-integrated", 7.
18. Statistiska centralbyrån.
19. Ibid.
20. Stockholm City, "Statistisk".
21. See note 18 above.
22. Swedish Energy Agency, "Solcellsstatistik".
23. Swedish Energy Agency, "Nätanslutna".
24. Stockholm City, "Klimathandlingsplan".
25. Stockholm City, "Data".
26. Yarrow, 'Negotiating', 343.
27. Swedish Government, 'Mål'.
28. SFS, 'Klimatlag'.
29. SFS, 'Klimatlag'; Swedish Government, 'Skattereduktion'.
30. Swedish Energy Agency, 'Förslag'.
31. Swedish Government, 'Milstolpe'.
32. Boverket, "Underlag", 10–11.
33. Statistiska centralbyrån, "Boende".

34. Boverket, "Underlag", 23.
35. Energimarknadsbyrån, 'Skattereduktion'.
36. Abrardi, 'Behavorial', 38; Palm and Lantz, "Information".
37. Solcellskollen, 'Dags'.
38. Palm, "Household".
39. Malafry, "Skyddet".
40. PBL, "Plan- och bygglag", ch. 8 § 13.
41. Boverket, "Förvanskningsförbudet".
42. BBR, "Boverkets".
43. Pendlebury, *Conservation*, 170. There is also *Kulturmiljölagen*, but this law is not relevant in the present study.
44. PBL, "Plan- och bygglag", ch. 2 § 6.
45. PBL, "Plan- och bygglag", ch. 8 § 17.
46. PBL, "Plan- och bygglag", ch. 8, § 13.
47. Stockholm City, *Stockholms byggnadsordning*.
48. See f.e. Lewan, 'Oroväckande'.
49. PBL, "Plan- och bygglag", ch. 2 § 3.
50. Stockholm City Museum, 'Stadsmuseet'.
51. Tunefalk et al, 'Long-term'; Stockholm City Museum, 'Stadsmuseets'.
52. See note 50 above.
53. Stockholm City, 'Bygglov'.
54. See for instance Linköping Municipality, 'Solenergi'.
55. Göteborg City, N300A01690.
56. Interviewee A1.
57. Stockholm City, 'Vägledning'.
58. Dnr 2018–13,771; Stockholm City, 'Solkartan'.
59. Stockholm City Plan; Stockholm City, *Stockholms byggnadsordning*, 133.
60. Stockholm City Museum, 'Nockeby'.
61. Dnr 2018–13,771.
62. Lst 40,321–12,609-2019.
63. MDD P4921-19.
64. Dnr 2020–00832.
65. Stockholm City Plan.
66. See note 47 above.
67. Olofgörs et al, 'Södra Ängby', 159.
68. See note 65 above.
69. Stockholm City, *Stockholms byggnadsordning*, 135–7.
70. See note 57 above.
71. Dnr 2019–03356-575. The owner did not state the expected production of solar energy.
72. Dnr 2020–06305.
73. Stockholm City, 'Solkartan'.
74. See note 72 above..
75. Greenmatch, 'Solceller'.
76. Interview A.
77. Ibid.
78. JO 5716–2010.
79. See note 76 above.
80. Interview D.
81. Interview E.
82. Interview B.
83. Interview C.
84. Ibid.
85. See note 76 above.
86. See note 82 above.

87. See note above.
88. F.e. Franco, 'Impacts'; Probst and Roecker, 'Criteria'.
89. Stockholm City, Stockholms byggnadsordning, 133, 137.

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