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Inequalities in the energy transition in The Hague

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1

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Summary

Over the last decade, solar energy has proven to be a key technology in transitioning to a sustainable energy system. However, current solar energy policies favour affluent households, limiting the participation of disadvantaged households in the energy transition. This leaves disadvantaged households even more vulnerable to increasing energy costs, as the recent unprecedented rise in energy prices has painfully demonstrated. To ensure that transition mechanisms are accessible to all households, solar energy policy needs to consider spatial justice. With this perspective, we go beyond technical analyses of solar energy potential and use a socio-spatial approach to evaluate the adoption of solar energy in The Hague. This policy brief is based on a research study that evaluated the transition to solar energy in the city of The Hague, The Netherlands, from a spatial justice perspective. Through a socio-spatial analysis at the postcode level, the research identified four distinct groups with varying levels of access to solar energy. The results show that these groups are not only strongly segregated across the city but also overlap with existing socio-spatial inequalities. The four levels of access to solar energy are then compared to current solar adoption rates and technical rooftop energy potential in the city. Results show that decreasing levels of access to solar energy align with decreasing adoption rates, revealing that current policies fail to provide equitable access to solar energy, leading to inequalities in adoption rates. Furthermore, the study quantifies how much of the technical potential available in The Hague is in areas where access to solar energy is limited, revealing a significant amount of untapped technical potential with the potential to address existing socio-spatial inequalities. Finally, two groups of interest and related leverage points for future policy interventions to address equity in the transition to solar energy in The Hague were identified.

Introduction

With decreasing prices and technological improvements, solar photovoltaic (PV) systems have proven to be a cost-effective way for households to cover their electricity consumption (Kannan & Vakeseen, 2016). According to the latest available data, the year 2021 has been a record year for solar energy generation in The Netherlands, with an increase of 28% compared to 2020, largely due to growth in the number of solar panels (CBS, 2022). However, not everybody has been able to benefit from solar energy. Illustrative is the situation in The Hague, as described by an article published last year in Volkskrant (Volkskrant, 2022). In The Hague, the energy transition has seen a swift acceleration in affluent areas of the city but has remained stagnant in many of the low-income neighbourhoods. Because of this, the more affluent areas have been less affected by the rise in energy prices, while low-income households have seen their energy bills increase drastically whilst paying for the subsidies that flow into affluent households as they acquire solar panels.

Differences in solar energy adoption between high and low-income households are often a consequence of the financial support mechanisms currently in place to stimulate the residential adoption of solar PV panels, which tend to favour advantaged households (Sovacool et al., 2019). Advantaged households are able to tap into these finance streams to exploit the benefits of solar energy (Lacey-Barnacle, 2020). The unequal access to adoption mechanics for solar energy leads to an inequitable distribution of solar PV systems across the city. This process has the potential to lock in or even exacerbate existing social inequalities (Sovacool et al., 2022). As a result, solar energy is perceived as accessible only to affluent people, hindering widespread societal support for the renewable energy transition (Gambhir et al., 2018), which is vital in our efforts to curb greenhouse gas emissions and mitigate climate change.

To ensure that solar energy benefits are available to all, it is necessary to design solar energy policies with an explicit focus on spatial justice. This is, however, not evident, since policies are often designed and measured based on their cost-effectiveness or technology penetration rate (Brugger & Henry, 2015). Only a policy framework that recognises justice aspects when assessing the transition to solar energy will be able to deliver an equitable distribution of solar energy benefits. In our research, we developed a framework that evaluates access to solar energy not only based on technical or financial aspects but also on spatial justice. We applied the framework to the city of The Hague to evaluate the transition to solar energy and identify policy opportunities from a justice perspective.

Methodology

Most studies evaluating solar PV potential follow a purely technical approach and evaluate solar energy through technical units such as the number of megawatt hours that can be generated on a given rooftop area. In contrast, a justice perspective on access to solar energy considers whether the people living under these rooftops are actually capable of realising these potential megawatt hours. People's capacity to realise the technical solar PV potential depends on various factors. Scientific literature showed that the most important factors are the following:

(1) Type of building/house: not all housing types are suitable for solar PV systems. Access to solar energy for multi-family homes, such as large apartment buildings, has proven to be more difficult than for single-family homes due to complex coordination among residents. This research distinguishes between low-rise single-family homes and high-rise multi-family housing, such as large apartment buildings.

(2) Homeownership: non-homeowners are very limited in their capability to adopt solar PV. Due to the difficulty of aligning the interests of both property owners and renters, non-homeowners face significant barriers to adopting solar energy. This research measures homeownership as the percentage of owner-occupied homes per spatial unit.

(3) Upfront costs: the adoption of solar PV is capital intensive, and only limited groups in society have access to financing. Due to limited available data at the high spatial resolution, this research uses average house value as a proxy to measure the financial capacities of households within each spatial unit.

(4) Lack of information: information on solar PV adoption is not available to all for various reasons. Access to credible, clear information can be difficult to obtain for certain groups of people. This could be due to the complex nature of the respective information, a lack of digital skills or a language barrier. To measure this effect, this research uses the percentage of population per spatial unit with a migration background as a proxy.

Taking these social factors into account, our research was structured in three parts.

First, we use these factors to identify which groups lack access to solar energy and where they are located across the city. In other words, we identify who has real access to solar energy in The Hague. Next, we look at the households that have adopted solar systems so far. We check whether there is a mismatch between access to solar energy and actual adoption. This analysis helps us to evaluate whether households with real access to solar energy have adopted solar energy or not.

Second, we also look at the technical solar potential to quantify the amount of electricity that can technically be generated via rooftop solar panels within the city. This analysis helps us to identify the most technically suitable rooftops for solar energy.

Finally, we look at areas with high technical solar potential and evaluate their level of access to solar energy, providing a better understanding of the capacity of people to realise the potential that is located in an area. Our research shows that social factors should also be considered in order to assess real solar potential in the city. From these insights, we identify policy opportunities to ensure equitable access to solar energy and, thus, a just energy transition.

Who has *real* access to solar energy in The Hague?

Access to solar energy is not distributed equally across the city of The Hague. Figure 1 highlights four distinct groups, characterised by:

(1) Non-native background (non-Dutch), renters, low home value, and high-rise buildings

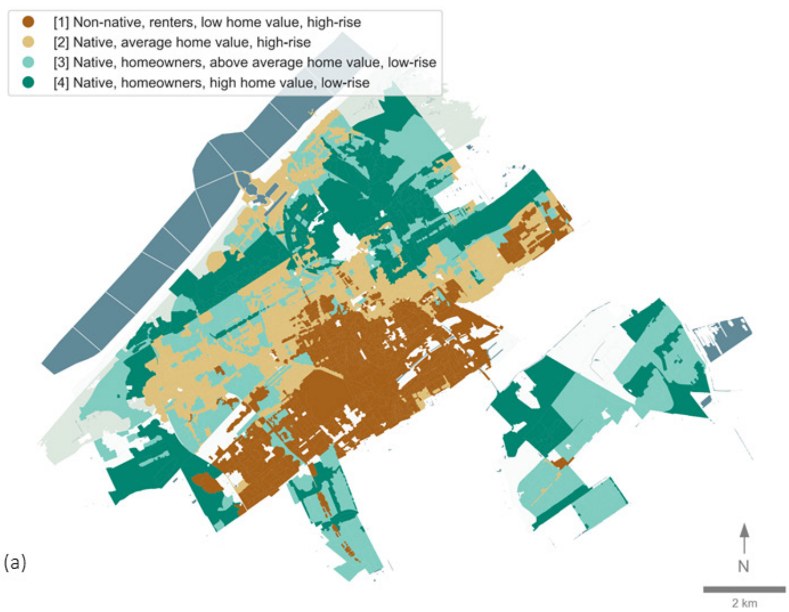
(2) Native background (Dutch), similar share of renters and homeowners, average home value, and high-rise buildings

(3) Native background (Dutch), homeowners, above-average home value, and low-rise buildings

(4) Native background (Dutch), homeowners, high home value, and low-rise buildings

Based on these characteristics, each group receives a relative access score, with 1 being the lowest and 4 being the highest. This means that households within group 1 have the lowest access to solar energy, and households in group 4 have the highest. Figure 1 shows that these groups are spatially segregated: Certain areas within The Hague have much lower access to solar energy compared to others.

Figure 2 presents the spatial distribution of the four groups in relation to currently installed solar PV systems, revealing that areas with low access to solar energy (groups 1 and 2) also have the lowest percentages of buildings with solar panels, indicated by red areas in the centre and southwest of the city. In addition, high levels of access (groups 3 and



(a)

Indicator	Cluster 1	Cluster 2	Cluster 3	Cluster 4	*The Hague Average*
Home value (€)	169 000	237 000	339 000	640 000	*269 000*
% with native background	21.8	58.5	60.9	62.7	*44.3*
% of owner-occupied homes	28.9	46.1	63.9	73.5	*44.1*
% of apartment buildings	63.8	77.5	24.7	25.9	*58.0*
Adoption rate (%)	3.78	3.94	10.71	9.99	*7.99*

(b)

Figure 1 - Spatial distribution of the four access groups across the Hague. A short description of the characteristics of each group/ group is provided in the legend presented in the top left of the figure (Kraaijvanger et al., 2023).

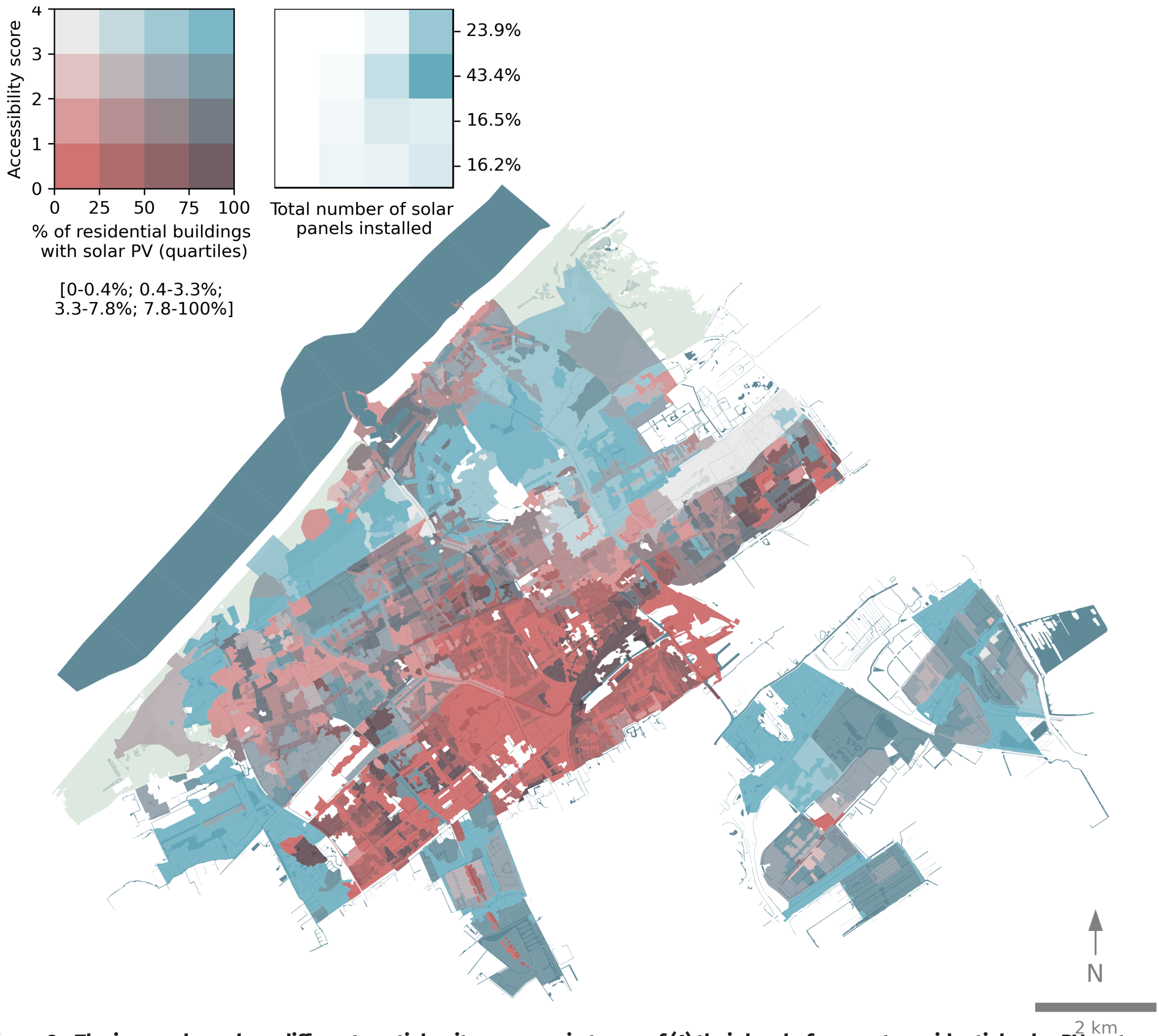


Figure 2 - The image shows how different spatial units compare in terms of (1) their level of access to residential solar PV systems and (2) their adoption rate of residential solar PV systems. Each area on the map is coloured based on its scores for both access and adoption. For instance, red areas in the bottom left part of the map mean low access (1 lowest, 4 highest) and a low adoption rate of solar panels (in the bottom 25% of all areas). The map also shows the different ranges of adoption rates, which are divided into four groups called quartiles. For example, if an area is in the first quartile, it is in the lowest 25%, which matches an adoption rate between 0 and 0.4% (Kraaijvanger et al., 2023).

4) correspond to relatively high adoption rates, as indicated by the blue areas in the figure. The blue-white legend, which represents the absolute number of solar panels installed, supports this pattern, as it shows that the two groups with the highest access together account for 67.3% (23.9% + 43.4%) of all solar panels installed, despite comprising only 34.4% of The Hague's population.

Where can we install solar PV systems in The Hague?

To find out where to install solar PV systems in The Hague, we identified the areas with the highest level of technical potential for solar PV systems. As shown in Figure 3, many of the areas with high solar potential are in groups 1 and 2, where access to solar energy is relatively low. The blue-white legend in the figure presents the total PV potential per group in the city, aggregated over their respective areas. This shows that 58.5% (30.4% + 28.1%) of the technical solar potential in The Hague is situated in areas where real access to solar energy is low, indicating a significant amount of untapped potential in groups where solar PV adoption rates are currently still low.

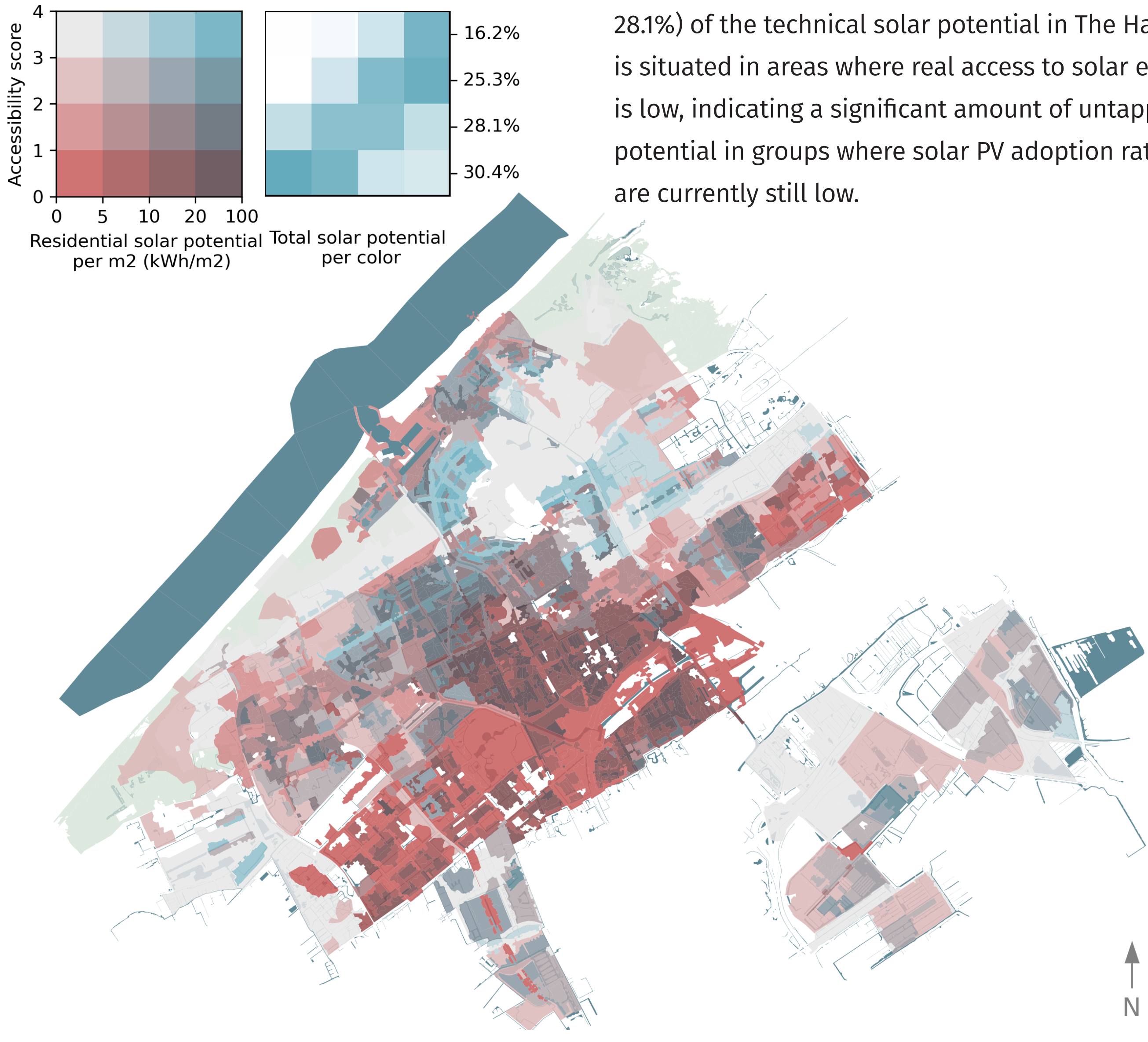


Figure 3 - This graph shows how much solar energy could be generated per different spatial unit, compared to the level of access to residential solar PV systems in these spatial units. Each area on the graph is coloured based on its solar potential and its access score. The legend on the right side of the graph shows how much solar energy each colour represents. The numbers on the right side of the second legend show what percentage of the total solar energy potential is represented by each row of colours (Kraaijvanger et al., 2023).

Who should be targeted by solar energy policies?

Upon closer examination of the four groups, we find two groups with particularly unfavourable profiles for the adoption of solar PV (i.e., low real access to solar energy) and where levels of solar PV adoption per household are lagging. These groups comprise households that are either part of social housing corporations or owner associations (abbreviated as VVE in Dutch). As presented in Figure 4, we find that the solar PV adoption levels of these two groups are below average, even though they provide ample roof space throughout the city. Only 4.2% of buildings owned by social housing have adopted solar PV panels. For buildings part of owner associations, this number is only 3.0%. These percentages are significantly lower than the average adoption percentage of 11.8% for other buildings (non-social housing and non-owner association buildings).

Social housing in The Hague is coordinated by eight corporations, and it is primarily occupied by low-income households. Due to their housing situation and lower income, these households have low access to solar energy. Therefore, supporting social housing corporations through policy could be an opportunity to achieve a just energy transition, ensuring that the

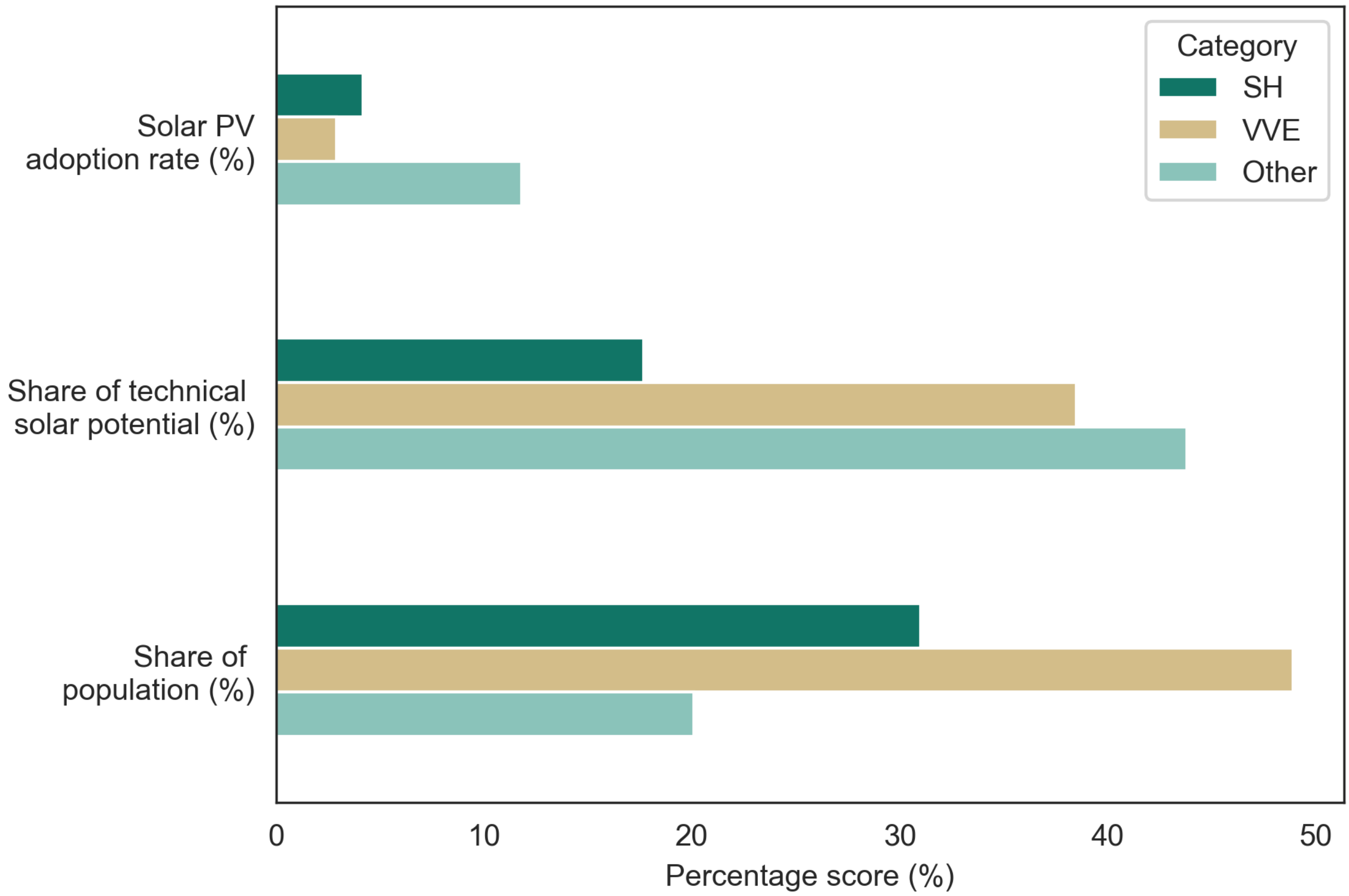


Figure 4 - Percentage plot of the solar PV adoption rate, the share of technical solar PV potential, and population share per housing category (Kraaijvanger et al., 2023).

most vulnerable are not left behind. Additionally, having all social housing in The Hague consolidated under eight corporations reduces implementation hurdles, from both administrational and practical perspectives, as opposed to policy support targeting individual households.

Buildings owned by owner associations are a second type with low solar adoption rates. Arguably, one of the reasons for low levels of adoption is the complexity behind installing solar PV systems on a shared roof. A shared roof requires households to deal with multiple issues, such as engaging all owners and getting everybody to participate, dividing the roof among participants and non-participants, deciding on insurance, and registering the owners association as a separate energy cooperation. Moreover, households living under a housing tenure are not part of the owner association, which means that tenants do not participate in such decisions. Policies that reduce the complexity of such processes and enable tenant participation may help unlock the solar PV potential available in buildings under the management of owner associations.

Conclusion

Although the sun provides us all with free energy in the form of sunlight, our study shows that only a privileged minority group in The Hague has been able to profit from the benefits of solar energy in terms of more affordable and secure electricity generation. It indicates that policy efforts taken to stimulate the adoption of solar PV have led to a skewed distribution of solar PV resources, where affluent households seize the benefits, and disadvantaged households see their energy burdens rise whilst contributing to the subsidies that flow into privileged households for the adoption of solar energy. To change this situation, solar energy policies that target currently underserved groups are crucial. This will not only allow for large amounts of untapped technical PV potential to be realised but also will foster a just energy transition, ensuring that no one is left behind.

Key take-aways

1. The transition to solar energy in The Hague has been highly unequal, with higher adoption in affluent areas

2. Almost 60% of the solar technical potential in The Hague is situated in areas where households have difficulty exploiting this potential through current policy mechanisms

3. Designing new policies that target social housing and homeowner associations can foster a more equitable distribution of solar PV resources

4. To achieve a just energy system, it is crucial that all people have the opportunity to participate in the energy transition through equitable access to renewable energy technologies

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Colophon

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In the conduct and dissemination of this policy paper, we have adhered to the highest standards of ethical research practice. The study upon which this policy brief is based was approved by an Ethics Committee at the TU Delft.
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