CONSULTANCY PROJECT GSS
UTRECHT UNIVERSITY
APRIL 15TH 2021

WIJK C STROOM

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Executive Summary

This research focuses on a consultancy project for the citizen initiative *Wijk C Stroom*. The consultancy project is commissioned by eight students of Utrecht University for the third year course 'Consultancy Project' of the bachelor 'Global Sustainability Science'. The students have different academic backgrounds, ranging from a focus on 'energy and resources' to 'governance and societal transformation'.

Wijk C Stroom is a grass roots civil initiative with the objective to provide solar energy for all citizens in the Utrecht neighbourhood 'Wijk C'. There are different types of residents in Wijk C, such as home-owners, renters, and residents from social housing. For a just and inclusive energy transition on a local scale, all groups of residents need affordable solutions to participate in solar energy or other forms of sustainable energy generation. One solution is participating in an energy collective. Wijk C Stroom aims to include all the residents of the neighbourhood, also including house owners, apartment building owner collectives and social housing residents.

Wijk C Stroom was founded in 2019 by five citizens, with the aim to come with proposals to organisations such as the housing corporations 'Portaal' and 'Mitros'. After the initial enthusiasm by the stakeholders involved, later Wijk C Stroom faced delays in the process. It was suspected that this was due to the reflex to fall back into old habits and uncertainties about responsibilities and authority in decision making. However, if we want the energy transition to take off, new approaches are necessary to overcome these boundaries.

Firstly, this consultancy project aims to answer what the attitudes and roles of the residents, housing corporation and relevant stakeholders are towards integration of renewable energy in Wijk C. Therefore, the relevant stakeholders are mapped out, as well as the attitudes of the residents. A survey was sent out to the residents to map this. Furthermore, legal and financial opportunities and barriers, as well as the technological solutions are taken into account in this research. A cost-benefit analysis is done in order to understand the various possibilities for the residents and wijk C, as well as for Wijk C Stroom as an energy collective.

The final advice provided in this project consists of two parts. Firstly, it is advised to make a clear overview of the different options for the residents of Wijk C when it comes to integrating solar energy. This will lead to an increased engagement of the residents of Wijk C to participate in a local energy collective. The overview will be visualized in the form of a 'menu', which will make up the impact deliverable of the project. Secondly, we have mapped out future steps of Wijk C Stroom as an energy collective and intensify communication with the stakeholders. This can be done by presenting clear and coherent proposals to relevant stakeholders, which are worked out in detail. This is key when it comes to convincing both social housing corporations, as well as other roof owners in the neighbourhood.

Integrative Advice

Introduction

Situation

The Wijk C Stroom initiative has to do with a diverse demographic composition of residents. The initiative would like to offer all these residents an option to become part of the energy transition. Initially, they want to do this by guiding people in the transition to solar panels for energy use. To achieve this, collaboration with and providing information to relevant groups is of great importance.

Complication

The diverse demographic leads to a great variety in the interests and needs of the residents and the stakeholders involved. This makes it difficult to provide a universal solution. Together with the difficulty of collaborating with all stakeholders, a barrier has occurred of which the initiative has difficulty moving on.

Question

The coming advice provides potential options the initiative could follow in order to move on. The advices are guided by the following questions

- *What are the opportunities for residents of Wijk C?*
- *What are the future steps to be taken by Wijk C Stoom?*

Opportunities for residents of Wijk C

Advice 1

In the next section we will expand upon the advice in the form of the impact deliverable. The arguments following will be explaining the different routes one can take in the menu, for homeowners, renters and social housing residents respectively.

Argument 1

Homeowners in Wijk C should opt for buying solar panels, if they are willing to make an initial investment. Ideally, this is combined with a green roof. This initial investment depends on the amount of solar panels that fit the homeowner's roof. For example, considering an investment in ten solar panels, this would result in an initial investment of roughly €6000. If the homeowner does not prefer this investment, leasing solar panels is a possibility. However, this will only result in short term financial benefits, as leasing is more expensive in the long term. For those who live in a monumental building or protected townscape, extra rules apply and in many cases it is not allowed to make major adjustments to the outside of the house such as solar panels. For them it is more beneficial to join a collective and perform other sustainability measures.

Evidence 1.1

The cost-benefit analyses (see subchapter 2) of buying and leasing solar panels in Wijk C showed that buying solar panels results in long-term financial benefits relative to leasing solar panels. Furthermore, the CBA of solar panels combined with a green roof is also shown to be a viable option for homeowners. This requires a higher initial investment, however, the personal and social benefits on the long term are evident.

Evidence 1.2

The survey held among the residents of Wijk C indicated that 61% of the residents want to have a smaller impact on the environment. Furthermore, 20% of the residents want a lower energy bill (see subchapter 1). By investing in solar panels, savings are made on the electricity bills and the carbon footprint of the residents is reduced. If a solar panel roof is combined with a green roof, the environmental benefits are even higher, such as a reduction of the urban heat island effect, increasing local biodiversity and increasing water retention capacities.

Evidence 1.3

In the 'Daken Kansenkaart' in appendix 3 there is an overview of all the monuments and protected townscape in Wijk C. Many of these buildings are not suitable for solar energy. This can be due to the cultural and historic worth which does not allow owners to make changes or due to the fragility of the roof (Restauratiefonds, n.a). Additionally, solar panels lower the housing price, in contrast to the usual (Restauratiefonds, n.a). Because of this, it is more beneficial for those who live in monuments to invest in other sustainability measures and/or join a collective such as Wijk C Stroom.

Argument 2

People who are renting their home and have ownership over their roof should opt to lease solar panels. If the renter does not have ownership over its roof, the renter should consider joining the Wijk C stroom energy collective.

Considering that the average renter does not stay for a very long period , leasing solar panels is preferred. There are multiple options for leasing agreements, providing the renters with the possibility to not commit long-term. The lessee will pay a monthly fee for the solar panels without an initial investment. However, the option for leasing is not economically viable for the long term: the NPV for leasing solar panels is €-105.26.

Evidence 2.1

The cost-benefit analysis in subchapter 2, shows that leasing solar panels does not result in financial benefits in the long-term. Assuming that a typical tenant lives for three to four years, and no longer than six years, the total costs of leasing solar panels per m^2 will be between €92.4 and €184.8. Leasing solar panels will lower the energy bill with around €19.71 per year, according to the cost-benefit analysis in subchapter 2.

Evidence 2.2

In the survey, question 10, we see that many people indicate that they are tenants, and that this is their biggest obstacle for them in acquiring solar panels. However, in the short term, leasing solar panels gives tenants a lower energy bill, while also maintaining several options on the solar panels when moving out. As discussed in subchapter 2, there are three possibilities for residents when moving out: transfer, take over and return.

Argument 3

Residents of Wijk C living in social housing buildings from Mitros & Portaal currently have limited options concerning solar energy. Even though negotiations with mitros are looking promising, currently those residents do not have much say over the roofs of the buildings, and often they indicate that they do not have enough resources to make big investments. However these residents are still highly motivated to combat climate change and indicated they want to help set up an energy collective, here Wijk C Stroom.

Evidence 3.1

The survey held among the residents of Wijk C indicated that 61% or the residents want to have a smaller impact on the environment. These results based on their willingness to combat climate change indicates that residents have a high motivation towards introducing sustainable energy in Wijk. C.

Future plans for Wijk C Stroom

Communication and Utilisation of Resources

Advice 1

Wijk C Stroom should encourage housing corporations to make use of the communication agreement between the housing corporations and the municipality in which the municipality offers to help activate tenants (subchapter 1, evidence 3.1). By providing the corporations with a clear and concise list of facts and information that residents find important for taking up the offer for solar.

Argument 1

Housing corporations have a long list of tasks and could have the tendency not to prioritize these types of projects. and providing them with the needed information for a particular task will lower the bar of taking action

Evidence 1.1

From the interview with Mitros as well as with the woman residing below the green roof in Wijk C, it has become clear that by providing clear, concise and detailed plans, the obstacles for housing corporations are taken away and actions will be taken (subchapter 1, evidence 2.1).

Argument 2

Intensified communication between housing corporations and the municipality enables knowledge to flow both ways. This will benefit future collaboration.

Evidence 2.1

According to The Business Communication (n.d.) two-way communication first, helps subordinates within organisations to make suggestions that enrich future policies and plans and enable tailormade solutions. When applied in this sense, it can increase the satisfaction of both housing corporations as well as the municipality. Second, it helps overcome ambiguity and confusion as an immediate response for clarification is possible, in turn, increasing the efficiency and effectiveness of communication (The Business Communication, n.d.).

Evidence 2.2

Corporations are dependent on the percentage of people that take up the offer in order to reach the goal of solar panels on 20% of roofs (subchapter 1, evidence 3.1) and an activation letter from the municipality could help with this (Utrecht Municipality, 2019). But now that corporations are on track with reaching this 20%, it will only take some time for the municipality to set a new goal in which the corporations would need to put the effort in (Utrecht Municipality, 2019; appendix 2.3). By now diminishing the barrier of communication, future collaborations are made easier as trust can be built for the future (Hoppe, 2012). We believe this reduces the risk of resistance from corporations that could be created by new municipal demands but could also make way for future initiatives.

Advice 2

Wijk C Stroom should encourage citizen participation in the neighbourhood in order to achieve energy transitions, not only in the present for solar energy but also in the future for further investment in local energy transition projects. They can increase citizen participation by organising public events, such as group yogas, documentary nights, soup day etc. Along with that, social media and the local newspaper should also be used regularly to campaign and keep the residents updated. These engagements will help Wijk C Stroom to inform a broader

range of residents and help achieve their goal of decentralising the understanding of energy needs at the grassroot level.

Argument

People tend to have a sense of commitment to their neighbourhood and are willing to be actively involved in activities to enhance the standard of living there. For everyone to participate, engagement practices are key, because they give a sense of belonging and a communal sense of ownership. (Chibambo, 2019)

Evidence 1.1

When it comes to citizen participation in energy transition, it comes down to the difference between a community choosing themselves or a community being forced or imposed. Engaging residents is not only practical but it also increases legitimacy and helps the residents become active participants in the transition. According to Kalkbrenner and Roosena (2016), the acceptance and support of citizens are essential. Additionally, this can also be seen in Germany where community energy and citizen participation are the most fundamental components of the German energy transition

Evidence 1.2

Trust and community identity have a positive effect on the willingness to participate. Because community helps in raising public awareness, that can help the community make a more informed and knowledge-based consensus (EnergyCities, n.d.).

Wijk C Stroom as a pilot project for all neighbourhoods within the city centre

Advice 3

Wijk C Stroom should be a pilot project for other neighbourhoods in Utrecht by close communication with the housing corporations and the municipality and making use of the rooftops in other neighbourhoods with technologies used in Wijk C.

Argument

There is little knowledge about the results of regulations concerning solar panels because many changes have been made recently (see advice 1). By using Wijk C Stroom as a pilot project, new challenges and opportunities can be identified. This is relevant for scaling up to other neighbourhoods in Utrecht.

Furthermore, by using Wijk C Stroom as a pilot project, this contribution can help with reaching the climate goals that the Dutch government agreed upon according to the Climate Act. from 2019 (Ministry of Economic Affairs, Agriculture and Innovation, 2020).

Evidence 1.1

Nowadays many changes are taking place around subsidies and other regulations regarding solar panels. By applying solar panels to Wijk C, it is possible to properly monitor what the barriers and opportunities are. As a result, when solar panels are applied to other neighbourhoods in Utrecht, the process can take place more efficiently through the appropriate help that the municipality can provide, for example, through the acquired knowledge that Wijk C Stroom is able to provide.

Evidence 1.2

These future steps for Wijk C Stroom make the neighbourhood a more sustainable place, for example by means of energy savings, etc (advice 4). The Dutch government wants to reduce greenhouse gases emissions and in order to achieve this, Utrecht, as one of the largest cities in the country, will also have to contribute to this. By using

Tableau and literature review, roofs can be classified as suitable for solar panels (appendix 3, figure 4). If this is not the case, other sustainable options can be looked at to make use of these 'unsuitable' roofs. By looking at how these options are realized in Wijk C, it can be identified how the other neighbourhoods could also play a role in bringing this greenhouse gas reduction to reality.

Future Pathway

Advice 4

After the completion of the project in Wijk C, Wijk C Stroom can continue to make sustainable changes by looking into other ways to make a roof/house more sustainable.

Argument

Creating a blue roof can help to reach the full potential of a roof. Moreover, Wijk C Stroom could help households with saving energy, for example by starting a project to insulate houses and to provide households with useful information to save energy (e.g. installing a water-efficient showerhead, etc.).

Evidence 1.1

Blue roofs can be an option if a roof is not fit for solar panels or when a green roof is too expensive. A blue roof can store rainwater and slowly release it, which reduces runoff (Shafique et al. 2016). Furthermore, by looking beyond the possibilities of the roof -for example by insulation- it is ensured that the potential of a house is fully used regarding sustainability. Saving energy can be simple and does not have to be costly. Besides that, households can immediately see the difference on their energy bill (Milieucentraal, n.d.).

Evidence 1.2

During the interview with Freek Vossen from ‘Zon op dak’ (appendix 2.3), it became clear that the municipality of Utrecht does not necessarily aim to reach a certain number of roofs that have solar panels installed on them (no quota). Instead, the new aim is to focus on maximizing the utilization and yield of a roof (using a roof to its full potential instead of installing as many solar panels as possible).

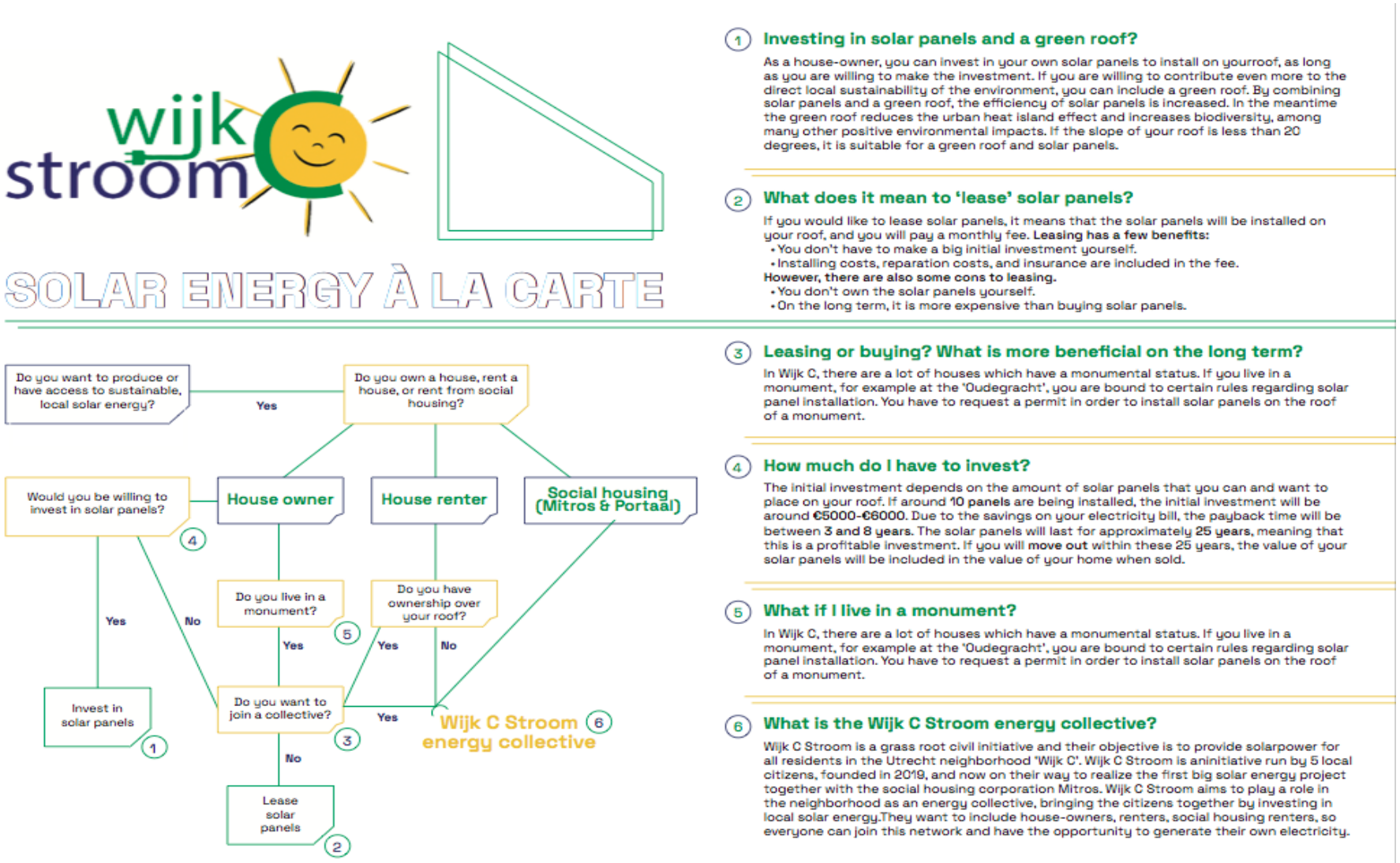

Figure 1: *Impact deliverable for Wijk C stroom: 'menu-a-la-carte' regarding the possibilities for local solar energy for the residents of Wijk*

Motivation and Explanation of the Impact Deliverable

The content and form of our impact deliverable were extensively discussed with the client. Wijk C Stroom were struggling with the fact that the residents of Wijk C have different desires and needs, as obviously the composition of residents is not homogeneous. They wanted an overview of what possibilities are viable for residents in a 'menu-a-la-carte' style setup, where with lay-knowledge, preferably all of Wijk C residents would find their best fit on introducing sustainable local solar energy into Wijk C. This was clear to us from the beginning of the project, thus our subgroups also adapted and equipped our sub-questions so that most of the possibilities for local sustainable solar energy were explored. As this impact deliverable is aimed at all residents of Wijk C, it must be clear, simple and understandable for most. We tried and achieved this by creating a route-map with which residents could navigate through the different options of local solar energy, in a user-friendly manner. In the menu, further information, trade-off points and exceptions to the rule are further explained in an added section, so that the menu itself remains simple and clear. Throughout the menu there are numbered footnotes which refer to this added section, helping the residents navigating and providing the correct information.

The need for this menu was acknowledged by the survey results. Many residents indicated that they were afraid of being tangled up in paperwork, and besides their day to day occupation they would or could not find the time to either sort out their own options for solar energy. Additionally, our desk research and communication with the housing corporations situated in Wijk C, confirmed the need for clear and concise communication, the more complex the menu, the bigger the hurdle to cooperate. How each menu or option on the 'menu-a-la-carte' came to be is expanded upon in Advice 1, where we unified the advice/outcomes for the different sub-group chapters.

Subchapter 1

Introduction

Citizens play an essential role in the energy transition. Their participation and support is needed in order to create energy systems on a local level. These decentralized, bottom-up energy systems can have a large impact on a larger scale, such as a reduction in the amount of CO2 that is emitted, as well as reducing the dependence on the energy grid on a national level (Koirala et al. 2018).
This chapter will focus on the social and legal aspects of the integration of solar energy in Wijk C, and aims to answer the following research question: *"What are the social roles and legal opportunities of the residents, the housing corporations and other relevant stakeholders towards solar energy integration in Wijk C?"*

Situation

The energy transition is happening and is a necessary process (RIVM, n.d.). The willingness of Wijk C citizens to engage in the Wijk C Stroom project is crucial. Their participation is vital in order to transform the local energy system. Besides that, the participation of citizens of Wijk C could create a low-cost and secure energy system with low-carbon emissions (Koirala et al. 2018).

Complication

However, currently, the ones that have a say in this transition are mainly the parties at a governmental level. These stakeholders are the ones that need to create policies and schemes in order to reach the agreed upon goals. But the ones that are affected by these policies are often left out of scope during the designing process. Wijk C Stroom wants to prevent a situation in which the transition results into something that is not compatible with the wants and needs of the residents of Wijk C. Therefore, they seek to involve all relevant stakeholders into their idea of solar energy integration. As there are many stakeholders that can play different roles in the integration, we need to find out their background and possible influence. Hence, the sub-question to be answered is *"What are the social roles and legal opportunities of the residents, the housing corporations and other relevant stakeholders towards solar energy integration in Wijk C?"*
To gain insight in the social and legal aspects of these stakeholders, we have divided the research into the following guiding questions

- *How can we engage Wijk C residents to participate in a local energy collective?*
- *How can we convince roof owners to cooperate with us and our partners in order to install sustainable energy technologies?*
- *What is the role of the local/national government?*
- *What are the legal opportunities and barriers to solar energy integration?*

Main advice

Stakeholder analysis

Step 1: Specify Stakeholder Types

The first step in the method is to make a broad inventory of all potential stakeholder types. They have identified four criteria for this, namely: functional, geographical, knowledge/abilities and hierarchical. Some criteria might overlap, however during the identification process it is useful to analytically distinguish between them (André et al. 2012). For our case the geographical criterion becomes redundant as this is normally used to involve stakeholders who due to their proximity might be affected but is not relevant for the adaptation strategy of Wijk C Stroom. The functional criterion refers to the stakeholders who are responsible for adaptation (e.g. decision-makers). The knowledge & abilities criterion refers to the stakeholders who are assumed to have certain knowledge and skills on adaptation processes, or stakeholders with relevant regional knowledge. The hierarchical level criterion focuses on stakeholders which could facilitate or hinder the energy collective.

Table 1: *Specifying stakeholder types*

Selection criteria	**1. Functional criterion**	**2. Knowledge and abilities criterion**	**3. Hierarchical level criterion**
Local	● Gemeente utrecht ● Residents ● Mitros ● Portaal ● Energie-U ● Buurtstroom	● Residents ● Gemeente utrecht ● Buurtstroom ● Volksbuurtmuseum ● Wijk C komitee ● Saskia Enderle	● Mitros ● Portaal ● Gemeente Utrecht
Regional	● Dutch government	● Dakdokters ● Solar sedum ● Energie-U ● Wocozon	● Dutch government
National	● Dutch government ● Mitros and Portaal ● Energie-U ● Buurtstroom	● Dutch government	● Dutch government

Step 2: Specify Stakeholder Roles

This step focuses on the different roles in relation to integrating sustainable energy in Wijk C that should be involved in the participatory process. These roles are rather generic and are derived from literature (André et al. 2012). This step is used to discuss which groups should be internalized in the participatory process and which should be left out.

Stakeholder role	Example/definition
Supporters	Stakeholders who prepare and support adaptation through advice and guidance, evaluation of adaptation, etc.
Providers	Stakeholders who provide research, knowledge and information on climate change causes, impacts, vulnerabilities and adaptation, etc.
Disseminators	Those who disseminate climate knowledge and information
Funders/sponsors	Funders of adaptation measures and/or climate-related research
Experts	Local experts on specific local conditions, climate experts on the climate system and impacts of climate change and/or practical and technical solutions
Implementers	Stakeholders responsible for implementing adaptation measures
Coordinators	Stakeholders that coordinate other actors, research or adaptation strategies in general
Responsible and/or decision-makers	Stakeholders that have an explicit responsibility for climate policies, climate adaptation or activities that are affected by climate change, such as long-term planning or sensitive sectors
Regulators	Initiators or implementers of new legislation, as well as changes in norms and standards
Affected	Stakeholders exposed and/or vulnerable to climate impacts or the responses

Figure 2: *Stakeholder roles explained (André et al, 2012)*

Table 2: *Specifying stakeholder roles*

Name stakeholder	**Stakeholder Role**
Wijk C komitee	Disseminators, Coordinator
Volksbuurtmuseum	Disseminators
Gemeente Utrecht	Responsible and/or decision-makers, Regulators, Coordinators
Energie-U	Implementer
Buurtstroom	Implementer
Portaal	Responsible and/or decision-makers, Implementer
Mitros	Responsible and/or decision-makers, Implementer
Wocozon	Provider
Dakdokters	Provider
Solar sedum	Provider
Residents	Funders
Dutch government	Regulators
Saskia Enderle	Expert

Step 3: Selecting and Classifying Stakeholders

The third step selects and categorizes the stakeholders in the Wijk C Stroom initiative. It builds upon the two previous steps and focuses on the roles, dimensions and criteria specified in the table below. The stakeholders are categorized based on the role they play in or around the initiative. Stakeholders might have multiple roles and the same roles can be held by more than just one stakeholder (André et al. 2012).

Steps 4 and 5: Associate Stakeholders with Roles and Analyse Their Influence and Interests

The last two steps analyse each stakeholder's influence and interest, as it determines to what extent and how the project can be realized (André et al. 2012). This step will be finalized by our interviews and survey output.

Table 3: *Specifying stakeholder influence & interest*

Name stakeholder	**Influence**	**Interest**
Gemeente Utrecht	Responsible and/or decision-makers, Regulators, Coordinators	• Reaching the goals of the Climate Agreement • Reaching municipal goals
Portaal	Responsible and/or decision-makers, Implementer	• Obtaining their goal of only owning CO2-neutral houses by 2050 • Satisfying their tenants • Obtaining a sustainable image
Mitros	Responsible and/or decision-makers, Implementer	• Reaching their goal of installing 1000 solar panels per year • Satisfying their tenants • Obtaining a sustainable image
Residents	Funders	• Climate justice • Greater involvement • Eager to set up energy collective • No fixed ‘wurgcontract’
Dutch government	Regulators	• Working towards the goals agreed upon with European parliament • Working towards goals of the Paris Agreement • Reaching goals of Climate Agreement
Saskia Enderle	Expert	• Climate justice in Utrecht • More solar energy in Wijk C

Advice 1: Engagement of Wijk C residents to participate in a local energy collective

Advice 1.1

Frequent and transparent communication in order to engage Wijk C residents to participate in the local energy collective and also sustain their participation, providing information to those interested is crucial, as well as being open about new innovations and occurrences in other stakeholder interactions. 82,9% of the residents in Wijk C are motivated to make more sustainable choices. This shows that citizens must not be merely reduced to rational beings making choices based on their financial means, and environmental justice not just as a factor, but as a vector in their decision making. Not only is frequent and transparent communication on the project important, but various physical events can help motivate participants. Additionally, their preferred medium to be kept in contact with is email and physical meetups.

Results & Evidence

Evidence 1.1: Survey results (appendix 1)

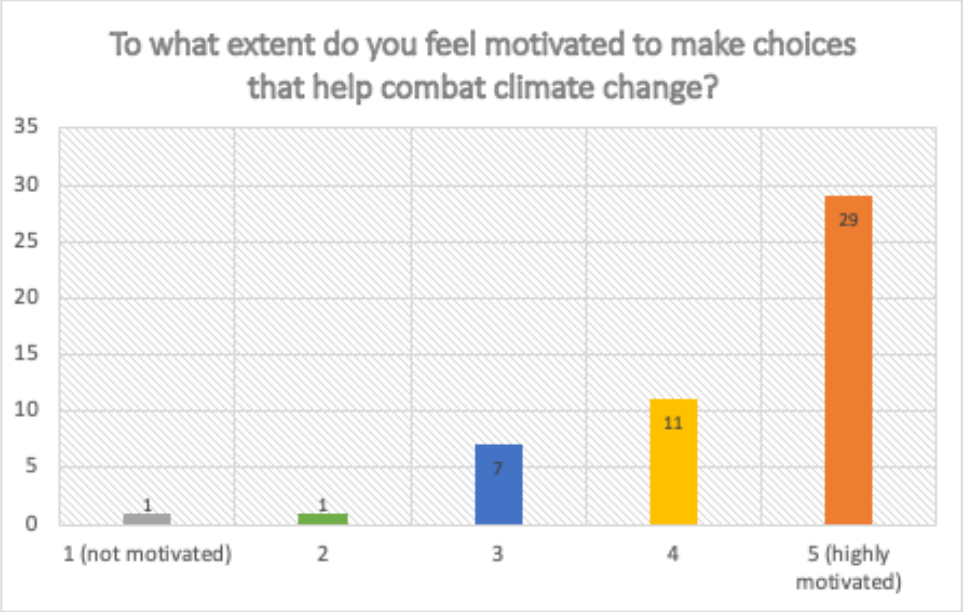

Figure 3: *'To what extent residents are willing to combat climate change on a Likert scale' (with 5 being highly motivated)*

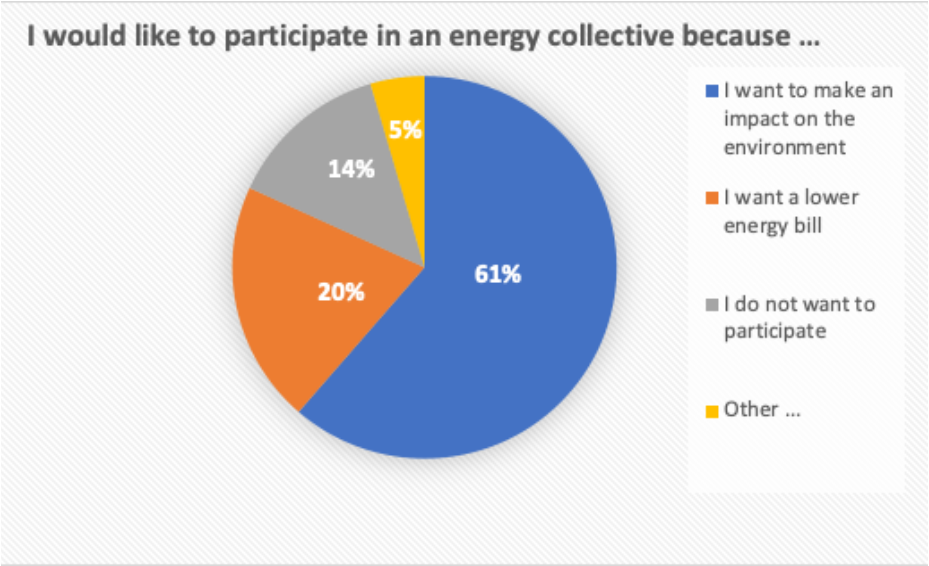

Figure 4: *'I would participate in an energy collective because…' I want to help the environment (blue), I want a lower energy bill (red), I like being involved in projects in Wijk C (orange), I do not participate (green), Other (purple)*

Evidence 1.2

Results in line with general analysis by Koirala et al (2018). Which state that environmental justice/concerns, are guiding in the willingness of residents to cooperate in an energy collective in the Netherlands.

Evidence 1.3

Hofmann & Pippert (2009), state that continuous communication is key to recruiting and sustaining participation in an energy collective. Further prompting spontaneous and creative events, like e.g. cooperating a cookout with the 'volksbuurt museum' or local workshops through 'Wijk C komitee' could turn out to be highly effective in reaching their goal.

Evidence 1.4

'Werkgroep zon op daken' states that Being open about new innovations and occurrences in other stakeholder interactions and sharing this knowledge with the residents is key to involvement (Zon op daken, 2021).

Advice 1.2

Create opportunities for residents to be involved to a greater extent. More than half of the surveyed residents (52,9%) are willing to participate in setting up the energy collective, thus transcending the role of merely funding to active involvement (appendix 1).

Results & Evidence

Evidence 1.2.1

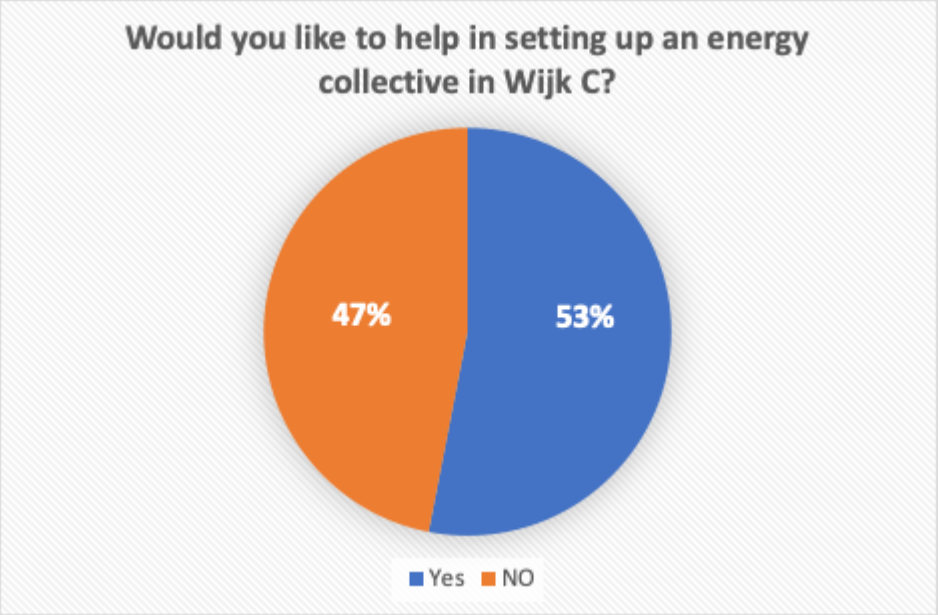

Figure 5: *'Would you be willing to help in setting up an energy collective'*

Evidence 1.2.2

Koirala et al (2018) further states that empowering the residents to cooperate in the collective, will contribute to its success.

Advice 1.3

Provide various investment options for residents.

Results & Evidence

Evidence 1.3.1

The survey results show that the main concern of renters is that they are worried about getting tied up in their investment (appendix 1). In the open questions of the survey, residents expressed a form of neophobia, a fear that their investment would suffer from seething troubles from a starting energy collective. However, this can be resolved in communicating and presenting the tenants with various investment options, clearly displaying the costs and benefits, and how these are eventually shared in the collective arrangement, increasing the participants' trust (Hoppe, 2012).

Evidence 1.3.2

Survey respondents expressed some lack of trust in the project. For example, a respondent communicated that as he was already 60 years of age he would never be able to get back his investment on solar panels. Many other respondents indicated that uncertainty in financial consequences of being involved in the energy collective is their main turnoff for not participating.

Advice 2: Ways to ensure that roof owners cooperate

Advice

It is advised to work out completely and in clear detail what exactly Wijk C Stroom wants to propose and plans on doing in order to make sure that there is no uncertainty, confusion or vagueness.

Results & Evidence

Evidence 2.1

Presenting a proposal that is completely clear and worked out in detail is key when it comes to convincing roof owners. In the interview with housing corporation Mitros, it became clear how important a proposal is that is completely worked out and extremely clear and straight to the point (appendix 2.1). When the proposal is vague and not comprehensive enough, this forms an obstacle for Mitros to cooperate with Wijk C Stroom. The importance of a clear proposal also became clear after the interview with green roof resident Saskia Enderle (appendix 2.2). She acknowledged that one main reason why her initiative to create a green roof succeeded was the fact that she had a proposal that was extremely detailed and in which all the work was already done for Mitros. The only thing Mitros had to do was give their approval.

Evidence 2.2

Existing scientific literature also acknowledges the importance of providing enough information to gain legitimacy as a novel business/firm/initiative. Since Wijk C Stroom can gain legitimacy by being extremely clear and open about their goals, aims, and what they are exactly about. This will take away a part of the hesitancy that stakeholders could have towards new initiatives.

Stakeholders are often hesitant to cooperate with novel businesses, because it is hard to assess whether a new business will be successful in the future and what it's potential exactly is. In order to convince stakeholders to cooperate, it is important for a new business to give as much information as possible about what the business is exactly about and what its aims for, since there generally is a lack of sufficient information on new businesses. In short, the business first needs to convince the stakeholder of its legitimacy (Van Werven et al. 2015). Besides legitimacy, the distinctiveness of a new business is important as well. This can make a new business stand out and distinctiveness can be beneficial when competing against other new businesses. New businesses have to create the perception that they are different and better than other new businesses (Van Werven et al. 2015).

When trying to build a good business relationship with stakeholders, effective communication is key. This relationship between stakeholders is built on different important factors, such as time, understanding, mutual trust, and information. A stakeholder should give the same priority to speaking as to listening to another stakeholder, in order to have the best interactive relationship. This can make the 'distance' between different stakeholders less grand (Quinn et al. 2014).

Advice 3: The role of local/national government

Advice

It is advised to introduce Wijk C Stroom as a pilot project for all neighbourhoods within the city centre.

Results & Evidence

Evidence 3.1

There have been many changes of the previous regulations and subsidy schemes that are concerned with solar panels. Therefore, there is little information and experience with the implementation of new regulations. To gain these insights, Wijk C could be used as a pilot project for the new regulations. This could help identify the opportunities and barriers for other neighbourhoods, as well as identify where the municipality could be of more assistance.

The following part describes the results from the literature review about governmental roles and it discusses the interview with Freek Vossen, project leader Zon op dak at Utrecht Municipality.

The European Union (EU) has the role to set up climate as well as renewable energy rules and targets for the EU countries as well as to provide guidance on this. As part of the EU, the Dutch National Government has the role to translate and integrate EU policy into national policy. Therefore, it has outlined its main priorities of the climate and energy policy in its national energy climate plans (NECPs) for 2021-2030 which is largely based on the National Climate Agreement established in June 2019. This is an agreement between social parties, public as well as private, that outlines the goal of the Dutch government to reduce emission with 49% relative to 1990 by 2030. It outlines emission goals per sector and is in line with the Paris Agreement. The energy transition is important to reach these goals. The energy sector goal is to have 70% of energy come from wind turbines and solar panels by 2030 (Ministry of Economic Affairs and Climate Policy, n.d.-b). Therefore, by means of subsidies, the government encourages citizens, companies and organisations to install solar panels. These subsidies are further discussed in guiding question 4.

Nonetheless, next to progression in the solar energy transition these subsidies and regulations have created barriers too. The Utrecht Municipality sees the plan to phase out the ‘salderingsregeling’ for solar panels as a barrier. This regulation gives small businesses and homeowners the possibility to return a surplus of self-produced energy back into the electricity grid and cancel this out to their later consumption. The municipality is lobbying against the phasing out and wants to make the crediting regulation more favourable (appendix 2.3). The reasons for phasing out the regulation are, first, the grid congestion; therefore, the government wants to reduce the pressure and give other sustainable energy options a chance (appendix 2.3). Second, additionally, the cost-price reduction of solar panels has reduced payback time and increased affordability, diminishing the need for the regulation and subsidies while staying financially attractive without them (appendix 2.3).

The regulations that have created the most progression in the solar energy transition are the SDE regulation which established large roofs to be responsible for about 50% of the generation (appendix 2.3); The ‘salderingsregeling’ established small roofs to be responsible for the other 50% of the generation (appendix 2.3); Contrarily, the ‘postcoderoos regeling’, which is an energy tax rebate for people who team up to generate sustainable energy, has played an almost insignificant role being responsible for only 0.01% (appendix 2.3). The main reason for this is that the neighbourhood initiatives are often organized by volunteers. Currently, the energy tax rebate regulation is changed,

according to the interview with Vossen this has both advantages and disadvantages. Advantages are that the subsidy request becomes easier, and it can move along when changing houses. Disadvantages include that it has become a subsidy pot with a fixed amount of money that can be depleted (appendix 2.3). Nevertheless, the change seems to have little effect because initiatives struggle to find roof owners to provide a roof, since owners often need the space for their own sustainability goals (appendix 2.3).

In accordance with the Climate Agreement, for renewable energy on land, 30 regions have to make a Regional Energy Strategy (RES) in which they outline how they will reach the goals to generate more renewable energy (Climate Agreement, Chapter C5 Electricity, 2019). Utrecht is included in the RES U16. The province and municipality need to implement the RES in their provincial environmental vision and the municipal environmental vision respectively.

This brings us to the role of the local government, Utrecht municipality. The municipality has to act according to the laws and regulations of the national government, as well as the Climate Agreement and needs to implement the RES in its vision and plans. An advantage mentioned in the interview resulting from signing the agreement and creating the RES, is how it activated the municipality to think about how to reach the goals and collaborate with other parties. The officiation causes the generation of new information and exchange of knowledge (appendix 2.3). Utrecht Municipality has the aim to be climate neutral as soon as possible. Its goal to have solar panels on 20% of the roofs by 2025 is part of this (Utrecht Municipality, 2019). The goals and plan are outlined in the report 'Zon op Dak-aanpak' (Sun on Roof project). To reach the goals and make solar energy attractive, the municipality encourages citizens, organisations and corporations to get solar panels. This is done by:

- Informing on opportunities
- Supporting collective initiatives
- Help businesses with organizing and buying with 'zonnepact' (sun pact), a collaboration between the municipality, province, business parks, and banks.
- Asking housing corporations, real-estate owners, entrepreneurs and businesses in Utrecht to commit to the target of 20% solar panels by 2025

Currently, as mentioned in the interview (appendix 2.3), the main barriers for the municipality concerning solar panels include firstly, the discontinuation of the SDE for large roofs. This regulation consisted of a subsidy to stimulate businesses and establishments to produce sustainable energy. Secondly, reaching grid capacity; meaning that no new solar panels can be added. Thirdly, roof structures that are too weak for solar panels. Finally, real-estate owners lack time to start with 'Zon op dak' and/or not know where to start.

Conversely, the initiatives that induced the most change according to the interview (appendix 2.3) were to start, the free roof scan provided by the municipality. Which is accessible and provides a lot of information about the possibilities for solar panels. Next, Collaboration has made a positive impact. The zonnepact has formed a coalition that makes the initiative zon op dak possible. Moreover, the municipality and housing corporations have formed a working group Zon op dak to share experiences and have made performance agreements in the context of Zon op dak. However, Zon op dak is not always a priority since the municipality has composed a list of objectives for the housing corporations. Furthermore, the municipality and housing corporations have made communication agreements. The municipality would like to help activate tenants by, for example, sending letters of encouragement. However, the housing corporations have not yet made use of this option.

Finally, collaborating with other municipalities creates advantages too. Experiences and findings can be shared, as well as opinions on changing the approach towards the transition.

Nevertheless, since every municipality has a slightly different political playing field, possibilities vary (appendix 2.3).

Lastly, following from the interview, there is not yet an official municipal goal after 2025 and after reaching the goal of 20%. However, the new main goal will not be the number of roofs, instead the utilization and yield will be most important. Additionally, the focus will be on utilizing corporate roofs (appendix 2.3).

Evidence 3.2

While new concept plans are being made to implement energy transition, knowledge needs to be gained on what works and what does not. The municipality stimulates knowledge sharing by collaborating with pilot projects, therefore Wijk C could be an option (Utrecht Municipality, 2019).

Advice 4: The legal opportunities and barriers to solar energy integration

Advice

The results from the 'Results & Evidence' below on the legal aspects of solar energy integration form important legal opportunities that should be considered when considering solar panels. These opportunities consist of subsidies that are available, loans and special rules. However, there are also legal barriers regarding the legislation that should be considered as well.

Results & Evidence

Evidence 4.1

House Owners

As a house owner in Utrecht, you can request a subsidy for guidance and support as a collective initiative. For such collective initiatives from house owners, the following subsidies are available:

Table 5: *Guidance and support available for house owners*

Type of guidance/support	Subsidy
Guidance from an energy advisor	Maximum of €140 per participating house owner. Total maximum of €1400
Support from 'Jouw Huis Slimmer'	Maximum of €1850
The rental of a conference room that is owned by the municipality of Utrecht	Maximum of €726
The costs for promoting the initiative (e.g. a campaign, adverts, etc.)	Maximum of €250 with 5 to 30 participants. Maximum of €3500 with more than 30 participants

There are multiple conditions for receiving a subsidy for guidance and/or support as a house owners' initiative; a minimum of five house owners have to participate; the initiative has to be focused on either insulating measures or sustainable energy and/or heat provision.
Moreover, as a house owner in Utrecht, you can also request a subsidy for a solar water heater. For this, the maximum amount of subsidy is €200 per solar water heater per address.

Owners association

Owners associations can request a subsidy for solar water heaters and heat pumps. Besides that, when it is for business use, owners associations can also request a subsidy for solar panels. For the installation of solar water heaters and solar panels for owners associations, the following subsidies are available:

Table 6: *Subsidies available for Owners associations*

Installation	Size/power	Subsidy
Solar water heater with panels	<10 m^2	€0.68 per KWh
Solar water heater with panels	>10 m^2	€0.30 per KWh
Solar panels	>15 KWp	€125 per KWp

Two conditions for the installation of solar panels are that the minimum net own consumption should be 50,000 KWh and the power should be larger than 15 KWp.

Social housing tenants

The foundation Wocozon cooperates with housing corporations and offers the installation of solar panels to social housing tenants. As a social housing tenant, you do not have to purchase the solar panels yourself, but you pay for the energy that is generated by the solar panels through the housing corporation. Sometimes, a fixed price per solar panel is also an option. On average, the costs for the generated solar energy are 20% below the average costs for energy from an energy supplier.

Tenants

If you are a tenant (no social housing tenant) and you do not share a roof (e.g. no apartment building), you can decide to install solar panels. This, of course, has to be done with permission of the house owner. The owner can also decide to install the solar panels themself. The tenant and the house owner have to discuss who is going to be the owner of the solar panels and make clear rules about this. If the tenant is not the owner but merely the user of the solar panels, he or she can make use of the so-called 'salderingsregeling'; the amount of the generated kWh will be settled with the amount of used kWh.

Housing corporations

As a housing corporation, you can request an SDE+ subsidy for solar panels. In order to become eligible for this subsidy, housing corporations have to meet the following conditions;

- The housing corporation should supply the generated energy directly to tenants or general facilities
- The housing corporation should supply the generated energy to an energy meter for communal use

Opportunities & barriers

Opportunities

In Utrecht, you can request a loan for sustainability measures such as solar panels for a relatively small price. House owners and tenants can request such a sustainability loan at the municipality. This can make it easier to consider solar panels on your roof. There are several important conditions to keep in mind when you want to request a loan;

- The house has to be older than two years
- For tenants, the owner of the house has to grant permission to execute the work on the house
- The loan has a minimum of €2,500 and a maximum of €25,000
- For loans below €7,500 the time to pay back is ten years
- For loans over €7,500 the time to pay back is 15 years

Furthermore, leasing solar panels can make it easier to consider solar panels on your roof as well. There are multiple firms where you can rent solar panels. There are multiple benefits to leasing solar panels;

- You immediately benefit from the solar panels (lower energy bill)
- You do not immediately have to invest a lot of money
- You do not have to loan money, you only have to pay monthly rent
- With some providers, it is also possible to rent solar panels as a social housing tenant
- The owner of the solar panels are responsible for the quality and possible defects of the panels

Barriers

The options regarding the legal aspects of solar energy integration are very limited for tenants and social housing tenants. For example, permission from either the house owner or the housing corporation is needed in order to install solar panels. Without this permission, there is not much you can do as a tenant or social housing tenant; the house owners/housing corporations are in a position of power.

Furthermore, in the Netherlands, there are currently plans to lower the subsidies that are available for the installation/purchase of solar panels. For example, the ‘salderingsregeling’ will likely be completely stopped in 2031. The measure will be phased out starting in 2023, because the government agrees that the measure is too major, especially since solar panels are getting less expensive. This means that tenants and social housing tenants -who are generally less willing to wait a long time until their solar panels actually pay off- will become more hesitant to purchase solar panels.

Lastly, leasing solar panels also has a downside;

- It can be extremely expensive if you decide to stop the contract before it is due
- With some providers, the rent you have to pay can increase annually
- Some providers can change the rental agreement from their side if the legislation changes
- The benefit of a lower energy bill can change if the ‘salderingsregeling’ is cancelled

Methodology

The foundation of our research was found through conducting a stakeholder analysis. This framework has guided us through the provided documents, literature, and our own interviews and surveys, in order to map all stakeholders. Additionally, case studies have increased our understanding of energy initiatives. This has resulted in an overview of all the relevant stakeholders, their roles, potential abilities and attitudes ('social roles'). Based on this overview, an additional literature review was conducted to relate our stakeholder overview to real world case studies and literature to come up with sound recommendations.

1) How can we engage Wijk C residents to participate in a local energy collective?

In order for this project to succeed, the participation of the Wijk C residents is crucial. To succeed, building this initiative should focus on maximizing civic engagement, instead of marginalizing it. To maximize the civic engagement, we focussed on recruiting community members first, and sustaining their participation after (Hoffman & Pippert, 2010). Thus, a better overview of the attitudes of the residents was needed. We have done quantitative research based on surveys to gain a greater understanding of this. The research is based on an analytical framework and literature research. Our research method is based on 4 steps:

Step 1: Literature Research, Using analytical framework by Andre et al. (2012)
Step 2: Data collection;
Surveys: conducting surveys to understand the residents' attitudes towards the energy transition
Step 3: Data analysis, Feasibility
Step 4: Write detailed advice

2) How can we convince roof owners to cooperate with us and our partners in order to install sustainable energy technologies?

Our clients project fell into inertia after roof owners, who are a key stakeholder, were not open for cooperation with Wijk C Stroom. In this case, the roof owners are housing corporations and the owners association. In order to gain knowledge on how to convince roof owners in Wijk C, first, a literature review was conducted.

For the second step, a semi-structured interview was arranged with housing corporation Mitros (appendix 2.1). Initially, we also wanted to arrange an interview with housing corporation Portaal, but the contact with Portaal did not go well and they did not respond to any email we sent. When calling them, we were told to send them another email, but they did not respond to this either. The purpose of the semi-structured interview was to try and map the reason for reluctance of cooperating with Wijk C Stroom.

Lastly, we have reached out to the resident of the house with the green roof in Wijk C in order to ask her about how she managed to make Mitros cooperate and create a green roof (appendix 2.2). The contact person for this was Saskia Enderle.

3) What is the role of the local/national government?

In short, the method to answer this question was by means of conducting literature research and a semi-structured interview with Freek Vossen, project leader Zon op Dak of the municipality of Utrecht.

First, literature research was conducted on the present and future obligations regarding solar energy integration on different governmental levels. This has helped to create an overview of the roles of the governmental levels, as well as detect missing information. These governmental levels include the national government, provincial governments, and the municipality. Literature research was done by using sources such as governmental websites, provincial websites, municipality websites, as well as existing academic and grey literature. Furthermore, literature research was conducted on the stance and initiatives the municipality has taken in order to enable the solar energy integration within the municipality of Utrecht.

Secondly, in order to fill the information gaps, along with obtaining information on the results of ongoing projects, a semi-structured interview was conducted with Freek Vossen (appendix 2.3). Before conducting the interview, questions have first been discussed with our contact person Charlie Spork, who is an energy transition advisor at Utrecht municipality.

4) What are the legal opportunities and barriers to solar energy integration?

The main aim of this guiding question is to give residents of Wijk C a clear overview of what subsidies are relevant for them. This is important to know, because the opportunities can help with getting stakeholders to cooperate. The barriers are crucial as well, since these give insight in where certain obstacles arise. Five different types of residents were identified, as different subsidies are available for these groups;

1) House owners
2) Owners association
3) Tenants
4) Social housing tenants
5) Housing corporations

The first step in answering this sub-question was to do a literature review and with that create an overview of the different subsidies that are available for the different stakeholders.

Secondly, with the knowledge obtained in the first step of answering this guiding question, the opportunities and barriers regarding the legal aspect of solar energy integration were identified and discussed. The information provided in the first step has helped identify possible opportunities and barriers.

Subchapter 2

Introduction

Situation

This chapter will focus on the financial and technical aspects of Wijk C Stroom. The main idea of Wijk C Stroom is to install solar PV on the roofs in the neighbourhood (Wijk C Stroom, 2021). This form of sustainable energy is chosen as it is known to the citizens of the neighbourhood, besides it being the most common form of sustainable energy generation in the Netherlands on a residential scale. Solar PV is therefore the most logical and straightforward option to make the neighbourhood a more sustainable place. The neighbourhood of Wijk C comprises residents that belong to different categories. For simplification, the residents can be classified into three categories:

(1) People living in their own houses
(2) Tenants, people who live in rented houses
(3) Social housing residents

Complication

Residents from these three categories all require a different and tailor-made solution in order to make an investment in solar energy affordable for them all. The viable solutions will differ, e.g. solutions for people who are willing to invest will be different from people who are not. In order to make the energy transition financially achievable subsidies are in place for various stakeholders (Rijksoverheid, 2021a). In addition to the different types of residents, the following stakeholders will be considered in the financial analysis of the project:

(4) Owners associations
(5) Housing corporations

An overview of relevant subsidies for stakeholders is therefore necessary. Furthermore, some legal challenges can come forward in considering social housing subsidies in combination with the energy transition. The integration of the legal aspects of subgroup 1 will be integrated with the findings of subgroup 2, in order to define the complete picture. Additionally, a change in regulations like the abolishment of the current net-metering scheme can bring challenges or opportunities for the future of solar energy in Wijk C (Rijksoverheid, 2021b).

However, not only solar PV but other sustainable solutions for Wijk C could also be viable. Looking at the diversity of houses in the neighbourhood, we see for example the Oudegracht, where many houses could improve the sustainability of their homes by insulation. This however differs greatly, as there is a diverse range of buildings in terms of age (very old (late 19th century), medium (the 60s, 70s), and new/renewed (Bijenkorf, Decathlon etc.) and function (shops/homes / cafés / offices) (Topografisch Bureau, 2021). Many buildings which would be suitable for insulation have a monument status, meaning that making changes to the buildings brings legal complications (Rijksoverheid, 2021c).

As the neighbourhood is quite diverse, the solutions to make the area more sustainable are also diverse. We already came across the example of insulating homes along the canals of Utrecht, but other solutions such as Building-integrated Photovoltaics (BiPV), solar heating technologies, energy storage technology and a combination of green roofs and solar PV are also considered. The third

research question, therefore, focuses on the possibilities in Wijk C, besides the existing idea of Solar PV.

Questions

The overarching sub-question of the financial analysis is:

1) ***'What are financial opportunities and/or barriers for solar energy integration?'***

Aspects that will be dealt with in this section are the following:

- *How can we make investing in solar energy affordable for all residents in Wijk C?*
- *What are the existing and future barriers for solar energy integration?*

The overarching research question of the technical analysis is:

2) **'Which other technological solutions besides solar PV are viable in Wijk C?'**

By answering these questions, the financial and technical aspects of Wijk C Stroom and the realization thereof are considered. The next section will elaborate on how these questions will be answered and which analyses will be carried out.

Main advice

'What are financial opportunities and/or barriers for solar energy integration?'

There are various opportunities for solar energy integration. Both buying, as well as leasing, are good options for solar energy integration. The biggest distinction between advising to buy versus to lease is the ability or willingness to make a big investment. Buying is the most viable in the long term but both are good options. Additionally, the biggest financial barriers are related to these initial investments.

'Which other technological solutions besides solar PV are viable in Wijk C?'

The most viable technological solution other than just Solar PV for Wijk C would be a combination of green roofs with solar PV. Green roofs contribute to the efficiency of solar PV and have many positive impacts on the local urban climate in Wijk C. Other technological solutions such as BiPV require tailor-made designs, which are not feasible looking at the budget and aim of Wijk C Stroom. Charging poles are also a valid option however it is only attractive for electric car owners thereby excluding a number of Wijk C residents from this technology.

Cost-benefit Analysis (CBA) results overview

Table 7 shows the overview of the various cost-benefit analyses of solar PV and green roofs in Wijk C. In advice 1 and 2, the analysed data and obtained results will be elaborated with respect to Table 7.

Table 7. *Overview of the parameters and CBA concepts for the various sustainable (energy) technologies*

Unit	Solar PV buying (€/m2)	Solar PV leasing (€/m2)	Green roof (€/m2)	Green roof + solar PV (€/m2)
r (Discount rate)	€ 0.10	€ 0.10	€ 0.03	€ 0.10
I (Initial investment)	€ 235.12	€ 0.00	€ 30.00	€ 265.12
B (Benefit in year 1)	€ 252.79	€ 19.71	€ 11.67	€ 264.53
C (Cost in year 1)	€ 169.95	€ 30.80	€ 1.15	€ 171.10
n (Lifetime of the project)	€ 25.00	€ 25.00	€ 40.00	€ 40.00
a (Capital recovery factor)	€ 0.11	€ 0.11	€ 0.04	€ 0.10
F (Annual fuel costs)	€ 0.00	€ 0.00	-	€ 0.00
OM (Operation & Maintenance costs)	€ 169.95	€ 0.00	€ 1.15	€ 171.10
E (Annual energy production)	126.339.00	126.339.00	-	126.339.00
M (Amount of avoided CO2 emissions)	36236.88	36236.88	-	36236.88
NPV (Net Present Value)	€ 987.02	-€ 100.67	€ 273.17	€ 1.178.73
PBP (Payback Period)	2.84	0.00	2.85	2.84
LCOE (Levelized Cost of Energy)	€ 0.0016	€ 0.0000	-	€ 0.0016
Cspec CO2	-€ 0.0016	€ 0.0003	-	-€ 0.0016

Advice 1: Buying and leasing solar panels to excess solar energy

Advice

Leasing and buying are both good solutions to shift to solar energy. However, which once suits who comes down to two factors: (1) how much you are willing to invest (2) how long you are going to stay. While assessing we found that on a long term scale, buying solar energy is cheaper as opposed to leasing them. That is why we recommend that house owners should opt for buying solar energy instead of leasing them, as long as they are willing to invest. On the other hand, it is recommended that people who are renting a house and living in social housing to lease them, because these are residents that usually do not stay in the same house for a very long period of time (assumption) (Anderson, 2015). As each rooftop is unique, for the residents it is also not ideal to buy solar panels because they might not be able to use them in the future when they move. With leasing, there are multiple options of getting away with the leasing agreement.

Results & Evidence

The NPV is calculated using a discount rate of 10% (Kohle & Joshi, 2002). For buying solar panels the NPV is €987.02 meaning that the option of buying solar panels is very economically viable (table 7). Additionally, the PBP for buying solar panels is 2.8 years, this means that the initial investment will be earned back in just under 3 years. It is important to note that this PBP value is leaning to the more optimistic side. In the long term buying solar panels is the most viable.
The NPV for leasing solar panels is €-105.26. This means that leasing solar panels is not economically viable, however, this is focused on the long term. The PBP for leasing solar panels is 0 as no initial investment is needed and the leaser can immediately see the effects of a lower energy bill. Due to this leasing solar panels is not viable for the long term. It is, however, interesting for people who live in a house for a shorter period of time or do not have the means to make an investment.

Buying Solar Panels

Studies show that solar energy in the form of solars panels (also called solar PV) have a high potential to become the main source of renewable energy in the long term because of a high output per square meter (Vausseur & Kemp, 2015). In addition, there are various direct costs and benefits that can be identified, as well as indirect costs and benefits.

Direct costs and benefits refer to the aspects of installing solar PV that the consumer is directly affected by. The direct costs and benefits that are defined in this chapter for buying solar panels are:

- Initial installation cost
- Tax reductions/subsidies
- Maintenance costs
- Energy bill savings
- Property value

The direct costs and benefits that are defined in this chapter for leasing solar panels are:

- Leasing cost
- Tax reduction/subsidies
- Savings on the energy bill

In addition to direct costs and benefits, some indirect costs and benefits can be defined. These will not be taken into consideration during the cost-benefit analysis but are important to mention nonetheless.

Ramadhan and Naseeb (2011) define the following indirect benefits that can bring opportunities for solar panels:

- Growing demand for ‘green energy.
- Reducing dependence on fossil fuels - environmental gain.
- Saving natural resources.
- Increasing fossil fuel prices make solar PV more financially interesting.
- Job generation.
- Technological development.

The reduction in dependence on fossil fuels and saving of natural resources is not only a long-term economic gain but also has a positive influence on the environment. Another benefit of solar PV is the fact that it is generated on-site or in any way close to the location of usage. This way, it is more efficient in use than energy sources that rely on transport and storing space (Borenstein, 2008). Furthermore, a challenge can be seen in the fluctuation caused by the location of installation of the solar panel, particularly this means the amount of sunlight a certain area is getting (Grant & Hicks, 2019). The number of people installing Solar PVs is not very high and this is because the costs associated with the purchasing, installation and maintenance of solar photovoltaic (PV) systems are quite high and way past the comfortable reach of most consumers (Rodl & Partner, 2019).

Solar PV Leasing

Solar PV leasing is when a consumer signs a contract with a solar company to have a solar energy system installed on their rooftop with no advance costs. With this contract the consumer enters into a long-term agreement with the company, which entails that the consumer pays monthly rents for use of the system in exchange for the benefits, that is the electricity that the system will produce (Sunrun, 2019). There are various advantages and disadvantages to leasing as compared to buying, an overview can be seen in Table 8.

Advantages of Leasing as compared to buying

It is a simplified and faster way of entering the solar market as opposed to buying because it does not require any permits and an upfront large amount of money for the installation (Falde, 2020). It just requires the customer to select a leasing company, sign a contract and the installation process starts immediately. Moreover, there is no upfront investment required and the monthly leasing costs plus the electric bill is less than what you currently pay for power so instead of paying to the energy company, the consumer pays towards the asset (solar panels) (Garskof, 2016). There is a monthly fixed cost so there are no unexpected costs for the customer. Additionally, with a solar lease, the customer does not have to worry about the maintenance, repairs, monitoring of the system, insurances and warranties as these are the responsibilities of the lesser.

Disadvantages of Leasing as compared to buying

While there are advantages to leasing, there are also drawbacks. To start with, the customer loses the right to claim subsidies and tax credits given by the government. Instead, these are claimed by Solar leasing companies (Falde, 2020). The customer cannot benefit by selling excess power to a utility company (net metering scheme) as the panels are not owned but only leased.

Figure 7. *Overview of Advantages and disadvantages of leasing compared to buying*

Table 8: *Overview of Advantages and disadvantages of leasing compared to buying*

Advantages	Disadvantages
No initial investment required	Cannot claim subsidies and tax credits given by the government.
Leasing costs + electric bill is less than current bills	Consumers can not sell excess power
Fixed amount per month.	
No maintenance and repairs costs	

Options when you move out of the house

In the scenario where the person leasing out solar panels has to move out of the house expectedly/unexpectedly, the following options are available for them.

- Transfer
- To take over
- Return

Firstly, in transfer what happens is that the consumer who initially started the leasing contract has the option of transferring the solar panels to the new homeowner/renter. Transferring the lease is the easiest option, and as mentioned earlier, the savings on the electricity bills are higher than the rent for solar panels, so there are high chances that the new residents will want to opt for this option (Sunrun, 2021). This can be done by either transferring the service agreement to them or you can buy the solar panels and sell them with the house. Buying solar panels comes under the option of taking over, the customer can buy the solar panels from the leasing company at market value (Solease, 2021). Every month the customer rents, they build up a purchase discount so in the end when the customer ends up buying the solar panels then the leasing company deducts the customers already accrued purchase discount from the current market price.

Lastly, in case none of these options is viable, there is one last option available, in which the customer can return the leasing agreement. What happens is that the solar leasing companies remove the solar panels without any penalties from the roof of the house, but they ask the customer to pay for the book value of leasing plus the cost of dismantling. But if 15 years have passed since the customer has been leasing the solar panels then these costs are lifted (Solease, 2021).

Cost-Benefit Analysis

In this chapter, a cost-benefit analysis will be conducted for buying solar PV, as well as for leasing solar PV. A comparison is made of the NPV (Net Present Value) and PBP (Payback Period).

Buying solar panels: CBA based on (Manohar et al 2015).

Table 9. *Data input for the CBA of buying solar panels in Wijk C*

Cost/Benefit	Buying solar panels (€/m2)	Type	Time frame	Assumptions	References
Initial installation costs	€297.62	Cost	One time (every 25 years)	Average of 10 solar panels placed (which is €5000), including inverter and installation. Average solar panel is 100cm x 168cm (Trinasolar, n.d; Sunpower, n.d.) Average lifespan of solar panels is 25 years.	Milieucentraal (2021)
Tax reduction / subsidies	€62.50	Benefit	One time	21% subsidy SAV.	Rijksoverheid d (n.a.)
O&M costs (operation & maintenance costs)	€6.62	Cost	Annual	Cleaning cost per solar panel = €10 to €15. Average solar panel is 100cm x 168 cm. Cleaning cost: €7.44/m2. Average savings due to cleaning: €15 per 11 solar panels. So €0.82/m2.	Homedeal, (2021)
	€90	Cost	Annual	Maintenance check: €80 to €100 so average €90 (Homedeal)	
	€1100	Cost	Every 10-15 years	Inverter replacement: €1000 to €1200 (Homedeal)	
Savings on energy bill	€39.76	Benefit	Annual	Three types of solar panels : €694, €704, €606. Average €668 per year per 10 solar panels. (Vattenfall)	Vattenfall (2021)
Property value	€317	Benefit	One time	2.56% of property value: €7456.00 if the installation costs €7000, so €5325.71 if initial investment is €5000.	Moller (2016)

Leasing solar panels

Table 10. *Data input for the CBA of leasing solar panels in Wijk C*

Cost/benefit	Leasing solar panels /m2	Type	Time frame	Assumptions	References
Leasing costs	€30.80	Cost	Annual	Price taken from a specific leasing company based in NL. The tax reduction/subsidies are included in the leasing costs.	(Solease., n.d.)
Savings on energy bill	€ 19.71	Benefit	Annual	Solar PV electricity generation is multiplied with the average price per kWh	(Veen,2014; GlobalPetrolPrices ,n.d.)

Advice 2: Other technological sustainability solutions for Wijk C

Advice 2.1

Green Roof and Solar PV combination for the citizens of Wijk C

Most of the benefits that green roofs have will still be present if solar panels are also implemented. The combination of solar panels with a green roof can be very beneficial in terms of efficiency. When it comes down to electricity bills for the citizens of Wijk C, green roofs will not be as financially beneficial as solar PV. With green roofs, one can reduce the water and heat stress of the local area. However, the direct financial results are only visible after 20 years, as soon as a conventional roof would have to be replaced and the green roof has a longer lifespan (40-55 years).

In comparison, in the case of Solar PV, the financial benefits are visible from day one. The electricity generated with the solar panels can be directly used, which reduces the electricity bills. Furthermore, until 2030, big parts of the electricity which is generated but not directly used, can be delivered back to the energy corporations, for which a compensation included in the energy-bill is provided.

When combining green roofs and solar PV, the local climate impacts such as reducing the UHI, temperature, and increasing biodiversity, besides the beneficial economic effects of solar electricity generation are guaranteed. The option of combining the two seems attractive, however, the feasibility depends on the initial investment costs and decisions the citizens and housing corporations of Wijk C are willing to make. Furthermore, many roofs are not suitable for green roofs, as their angle is too big (>20 degrees) to install a green roof.

Results & Evidence

Solar PV is a measure to generate sustainable energy which is generally known to the citizens of Wijk C. However, this technology can also be combined with green roofs, as long as the distance between the roof and the solar panels leaves enough space to bring in light and air. Existing studies about this combination have indicated that this combination is positive in terms of the local climate. This is because the green roof reduces the temperature of the roof, which is beneficial for the solar panels, as they work more efficiently if the temperature is lower.

Personal and social costs and benefits green roofs

Green roofs offer various benefits, both 'personal' benefits as well as 'social' benefits. Bianchini & Hewage (2012) identified the various personal and social benefits of a CBA of green roofs.

The personal costs & benefits identified in this project are:

- Initial installation cost;
- Property value;
- Tax reduction / subsidies;
- Energy reduction - cooling and heating effect;
- Longevity benefit (average lifespan is 40-55 years), while the life of conventional roofs is about 20 years. Therefore, you only have to replace it for half of the time span. Longevity is the sum of installation and demolition costs;
- Operation and Maintenance (O&M) costs.

For this CBA, just the personal benefits are taken into account, as the monetary results for the residents of Wijk C will be highly important in the decision-making process. The social costs and benefits are interesting from an environmental point of view, however not directly relevant for the residents of Wijk C. The personal costs will be directly visible in monthly energy bills, while the social costs are less visible.

Social costs and benefits as identified by Bianchini & Hewage (2012) are:

- Air pollution reduction;
- Carbon reduction;
- Air quality improvement;
- Reduction of infrastructure improvement costs;
- Reduction of flood risks & increased water retention;
- Habitat creating;
- Aesthetics;
- Mitigation of UHI (Urban Heat Island) effect & high albedo (meaning a lot of light will be reflected, compared to conventional dark grey roofs. Reflection of light will reduce the temperature in the city).

Many social costs and benefits are however difficult to define in monetary terms. When looking at the personal costs and benefits, such as electricity costs, this reduction or increase has monetary value. On the other hand, social impacts such as biodiversity and reduction of the Urban Heat Island effect are harder to measure as economic value. This is mainly because these are long-term impacts, of which the economic impact is still uncertain.

Type of green roof

In this analysis, the most common green roof will be analyzed, namely an extensive sedum green roof. Sedum is a small plant that can survive during heatwaves, but also during very cold winters (source). This form of green roof is the most common. Other forms of green roofs are more suitable for actual roof parks, but cost a lot more and are expensive to maintain. Intensive green roofs will not be considered in this CBA, as the feasibility of this type of green roof is unclear for Wijk C. Extensive green roofs can be thin and lightweight, self-sustaining, and don't need as much attention as intensive green roofs (Solarsedum, 2021). The sedum roofs need to be placed predominantly on flat roofs or slightly sloping, otherwise, the installation costs are higher. This type of green roof is easy to combine with solar PV.

Table 11. *Data input for the CBA of an extensive green roof in Wijk C.*

Costs / Benefits	Extensive green roof (€/m2)	Regular roof	Type	Time frame	Assumptions	Reference
Initial installation costs	55	15	Cost	One time		(Bos, 2014; Klooster et al, 2008)
Property value	112	-	Benefit	One time	Calculated from $ to €	(Bianchini & Hewage, 2012)
Tax reduction / subsidies	25	-	Benefit	One time		(Utrecht Municipality, 2021)
Energy-saving (cooling & heating)	2.07	-	Benefit	Annual	Mean is taken of 0,38 - 3.76	(Hop & Hiemstra, 2013)
O&M costs (OM)	1.15	0.58	Cost	Annual		(Bos, 2014)
Longevity	136	-	Benefit	Every 20 years	Calculated from $ to €	(Bianchini & Hewage, 2012)

First, the NPV is calculated, using a discount rate of 3%. As the green roof is estimated to last for 40 years, this rate is determined as suitable for the distant future, according to Gollier & Weitzman (2010). In order to calculate the yearly costs and benefits, such as property value and longevity, these values are divided by 40 and 20 years, respectively. The property value is divided by 40 years, as this is considered the lifetime of the green roof. The longevity is divided by 20 years, as this is the lifespan of a regular roof. The results can be seen in table 2. The NPV is positive, meaning that the green roof project is economically attractive.

As a green roof is not a technology generating sustainable energy, the LCOE and the Cspec CO2 are both not relevant in this case. However, it is relevant to calculate the PBP. The results in Table 7 show that the PBP is 2.852, which is less than 5 years and can therefore be considered attractive for the residents of Wijk C.

Green roof in combination with Solar PV

The CBA of the green roof combined with Solar PV includes the benefit the green roof has on the efficiency of the solar panels. The solar panels are cooled by the green roof, which is included with an extra annual benefit of €0,07 due to a reduction in electricity used to cool the building and the increased efficiency of the solar panels. Table 7 shows that the NPV of buying solar panels and investing in a green roof both result in positive NPVs. Furthermore, the LCOE and the Cspec results for this combination are comparable to the results of a solar PV system without a green roof. The payback period of solar PV is similar to green roofs, namely 2.84 years. The Tableau map of Wijk C (appendix 3, figure 4) in which the possibilities for the rooftops of Wijk C are shown, this combination of green roofs and solar PV is indicated as a viable solution for many roofs, especially on the west side of the neighbourhood. Therefore, combining a solar PV system with a green roof would be a viable solution for many households in Wijk C. Unfortunately, the houses at the Oudegracht would not be viable for this solution, because the Tableau map indicated the monumental status of

these buildings (appendix 3, figure 5). For these buildings, other sustainable solutions such as insulation should be explored in future research.

Advice 2.2

Building Integrated PVs and charging poles
The Building Integrated PVs are not a suitable option for Wijk C because in Wijk C no new buildings are being built and this technology is mainly attractive for new building constructions. Charging poles are a suitable option for Wijk C when there is leftover energy from the solar panels that can be charged onto the charging poles. However, this technology is not an inclusive measure, as this technology is only attractive for electric car owners in the neighbourhood.

Results & Evidence

The Building-integrated PVs are good options when constructing new buildings. However, Wijk C consists of already existing buildings. This means that only when destructing elements of already existing buildings and then building new elements integrated with solar PVs, BiPVs can be incorporated into the building. This is very expensive and not a suitable option for Wijk C.

The energy from the charging poles can also be recharged from the car to the charging pole and that energy can then be used for daily routines such as cooking, etc. A practical limitation is that the project is currently only suitable for electric bidirectional cars; cars that can both 'absorb' and store energy as well as deposit energy back. (Smart Solar Charging, 2021). Because there are no charging stations in Wijk C yet, few to no residents of this district will also have suitable cars for it. This also makes the barrier to shift to this technology even greater.

Building Integrated PVs are PV systems that also take on the role of a building element. It currently has a low share in the overall PV market being responsible for just 1-3% of the total generation (Roberts & Guariento, 2009). However, the BiPV market is strongly emerging (Osseweijer et al., 2017). Most BiPV, around 85%, are c-Si BiPV systems where crystalline silicon semiconductor materials are used (Peng et al., 2011). These BiPVs can be placed out of sight, for example, integrated in the roof but they can also be integrated in walls or other building elements in a discreet way. This technology is especially attractive when constructing new buildings; the cost of a BiPV system comprises the cost of the PV system and the cost for the building material. This combination results in a lower cost than producing the non-integrated PV system and building materials separately (Roberts & Guariento, 2009). According to the research of James et al. (2012), it is difficult to determine the costs of BiPV systems as not many BiPV systems have been installed. Therefore, it has been determined what the costs would be if BiPV systems were used on a large scale. The potential installed cost for c-Si BiPV would be around 3.33 USD/W compared to 4.31 USD/W for standard c-Si PV modules. The reduction in cost between normal PV systems and BiPV systems is due to '*hardware racking and its associated labour costs'*. (James et al., 2012). The initial capital cost is significantly higher than for normal PV systems. In order to compete with other solar energy technologies, the costs need to be reduced or the benefits increased. Therefore, some BiPVs have thermal energy recovery (BiPV-T). These systems convert the absorbed solar energy into both thermal and electrical energy.

When integrating the PV systems into building elements after the building is already constructed, the costs far exceed the costs of just implementing a non-integrated PV system (Santos & Rüther, 2012). Therefore a cost-benefit analysis will not be conducted as this technology is not attractive to implement by definition in Wijk C.

A currently emerging solar energy technology is solar energy-based charging poles or stations. This is a storage technology that involves the use of batteries, useful when, for example, the sun is not shining or if you want to use solar energy directly at night. Due to climate agreements, rules have been drawn up regarding petrol-powered cars. The goal is to no longer have cars that run on petrol within ten years (Smart Solar Charging, 2021). That is why LomboXnet, together with We Drive Solar and Smart Solar Charging, started a project in 2019 that concerns the first solar energy-based charging stations in the world. The current aim is to install 145 of these charging poles all throughout the city of Utrecht.

The way it works is that solar energy is generated from local energy systems in the neighbourhood and are connected to charging poles. These charging poles can be discharged from energy but also be charged with energy. When the charging pole delivers energy, the energy can be tapped into an electrically powered car that can store this energy. Because the batteries of cars have such a large storage, they are used to easily store this sustainable energy. (We Drive Solar, 2021). Smart Solar Charging calls the concept solar energy-storing batteries on wheels.

Despite the fact that 145 charging stations are built or are being built in Utrecht, none of these charging stations are planned in Wijk C (LomboXnet, 2021). Yet, these solar energy-based charging poles are a viable and sustainable option for Wijk C.

However, there are some limitations. Because the project has only existed for three years and was only scaled up on a city level at the beginning of 2021 (Smart Solar Charging, 2021), little to no data is available about concrete numbers of the costs and benefits of this technology. Therefore, no cost-benefit analysis can be applied to this technology.

Methodology

The methods are summarized in three steps:

Step 1. Data collection: Literature research (academic and grey literature) + analysis of Tableau map *duurzame kansenkaart*;
Step 2. Analytical framework: Cost-benefit analysis;
Step 3. Formulate financial and technological advice on the different technologies and its applicability in Wijk C.

Data collection

The data collection was mainly done by literature review where we examined scientific literature using search engines such as Scopus and Google Scholar. Firstly, we used the Dutch government website, Utrecht municipality website, Utrecht province website, and other existing academic and grey literature to look into the costs associated with installing Solar PVs in households in the Netherlands. Furthermore, additional literature research was carried out on the four different sustainable technologies which might potentially be implemented in Wijk C The specific data on buildings in Wijk Cis was analyzed using the computer programme Tableau. Here, we had access to the *duurzame kansenkaart* (sustainable opportunity map) provided by the municipality of Utrecht, in which the buildings in Wijk C, their functions and opportunities are identified. This provided us with data on the structure of the neighbourhood of Wijk C and the 'green' possibilities in terms of rooftops.

Analytical Framework

The analytical framework that was used for subquestions two and three is a cost-benefit analysis (CBA). The analytical framework includes a literature review. The goal of the CBA was to measure the efficiency of techniques (Hwang, 2015). In this research, the CBA was used to look at the efficiency and effectiveness of different roof-related environmental techniques. This analysis was chosen as the options in terms of sustainable technologies are diverse with regard to the technical, legal, social, and financial aspects. Since the main question of this consultancy project is stating the importance of integrating affordable sustainable energy in the neighbourhood for its residents, efforts are made to include potential social and financial opportunities and barriers. The framework used is based on the book by Blok and Nieuwlaar (2017, pp. 216–224).

The logic of a cost-benefit analysis is based on the principle that a project is only undertaken when the benefits exceed costs, the CBA, therefore, focuses on an economic aspect. Various formulas are used in performing a cost-benefit analysis. These are presented below and their variables are explained.

The first concept is the NPV (net present value) which looks at whether investments are economically viable.

$$NPV = B_0 - C_0 + \frac{B_1 - C_1}{1+r} + \frac{B_2 - C_2}{(1+r)^2} + \ldots = \Sigma \frac{B_i - C_i}{(1+r)^i}$$

Equation 1. Net Present Value (NPV)

- B = benefits of the project in the year I
- C = costs in the year I
- r = discount rate: this has to do with time preference, to someone 100 euros now or 108 euros in two years might be of the same worth (in this case the discount rate is then 8%)

A positive NPV means that the project is economically attractive.

Many projects have an initial investment (I) followed by a constant annual net benefit. In this case the formula can be simplified and the capital recovery factor (α) is used.

$$\alpha = \frac{r}{1-(1+r)^{-n}}$$

Equation 2. Capital recovery factor

$$NPV = -I + \frac{B-C}{\alpha}$$

Equation 3. Simplified way to calculate the net present value (NPV)

- I = initial investment
- α = capital recovery factor
- n = lifetime of the project

Another concept that can be used for cost-benefit analysis is the LCOE (Levelized costs-of-energy) which can be used for comparing the costs of different electric power generation technologies. The LCOE can be found when NPV = 0 and is expressed in euros per kWh or MWh produced.

$$LCOE = \frac{\alpha * I + OM + F}{E}$$

Equation 4. Levelized costs-of-energy (LCOE)

- OM = annual costs for operation and maintenance
- F = annual fuel costs
- E = annual energy production

The lower the LCOE is, the lower the costs for energy per kWh or mWh is and therefore the lower the LCOE, the more economically attractive a project is.

Another indicator for a CBA is the PBP (pay-back period), this provides a better indication of the profitability of a project in relation to the initial investment.

$$PBP = \frac{I}{B-C}$$

Equation 5. Pay-back Period (PBP)

This is especially relevant for the Wijk C Stroom project as tenants are more likely to move quickly and therefore a low PBP is more attractive and necessary for them. Generally, a PBP of less than 5 years is found attractive. This time preference differs greatly per type of project: social projects generally use a lower discount rate than private projects.

In projects related to the energy transition, it is interesting to look at the specific mitigation costs (Cspec and Cspec, CO2).

$$C_{spec} = \frac{\alpha * I + C - B}{\Delta E}$$

Equation 6. Mitigation costs: Cspec

- B & C = constant annual benefits and costs
- delta E = annual saved energy

$$C_{spec,CO2} = \frac{\alpha * I + C - B}{\Delta M_{CO2}}$$

Equation 7. Mitigation costs: Cspec, CO2

- M = amount of avoided CO2 emissions

These formulas give a better overview of the positive CO2 and energy effects projects can have and how much they cost. This is important to see how effective the project is in reaching its goals of saving energy or reducing CO2 emissions.

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Appendices

Appendix 1

Survey Theory & Methodology

We created a survey to get a deeper understanding of the residents' attitudes. The questions are in Dutch considering the target group -the residents- consist mainly of Dutch citizens.

The survey is created based on a study by Koirala et al (2018) and Dietz et al (1998). The research Koirala et al (2018) performed is similar to the research that we are performing through our survey, which makes it a valuable source. The survey consists of 10 questions. Several questions were constructed to measure their environmental concern, their attitude towards the energy collective as a community initiative and finally their motivation on why or why not they would invest in solar panels. In addition, some questions on demographic indicators are asked on: income, energy bill and type of house. Some demographics are available through websites such as the Utrecht municipality and CBS. However, we were not able to find all demographics that are relevant to our research, hence, these questions are implemented in the survey. Three types of questions were used in this survey; open questions, multiple choice (sometimes multiple answers possible), and questions based on a 1-5 Likert scale. The survey ends with an opportunity for the participants to explain if they would have taken a different approach or to discuss their largest barrier for participating in such an initiative.

The survey was tested through a group consisting of 7 students and 5 non-students. Due to the current COVID-19 situation, it was a challenge to reach enough citizens for sufficient responses. The survey was sent through the Wijk C Stroom email list, consisting of 96 people. In addition, we created a flyer (***appendix figure 1)***, including a QR code and a link to the survey. In this way, we were able to reach enough people while still following the governmental covid restrictions. According to Alreck & Settle (1995), a sample size should be about 10% of the parent population. There are 920 households in the district, which means that we should receive about 92 answers (Buurtkompas, n.d.). For the first round we made 200 copies of the flyers and distributed this as equal as possible through the neighbourhood. A map of our route is drawn in ***appendix figure 2***. We divided the district in 4 regions, and distributed equally between houses from Mitros, Portal and homeowners. Our division was the following: 90 houses from Mitros, 75 houses from Portaal, 35 homeowners. This division is based on a map (***appendix figure 3)***, in which we made the estimation that Mitros owns the most homes, followed by Portaal and house owners. After waiting three days, we decided that we were not satisfied with the amount of responses so we printed 200 more flyers, which we distributed to the houses and streets that we did not get to in the first round. In addition, we contacted Saskia Enderle, who is in the neighbourhood committee, and also has an e-mail list of the residents. Overall, we got 51 responses.

Appendix figure 1. *Flyer that was distributed*

Appendix figure 2. *Walking routes for distributing the survey through Wijk C*

Appendix figure 3. *Map of Wijk C, retrieved from Tableau*

Appendix 2.1

Most important results interview Mitros

As a tenant of Mitros, you cannot decide to install solar panels on your house by yourself. You first need an invitation from Mitros after which you can ask for a ZAV (Zelf Aangebrachte Voorziening). This then has to be permitted by Mitros, after which you can choose to purchase solar panels yourself. Wocozon will install it for you. Finally, a rapport is needed to ensure Mitros that the installation happened professionally and that the quality is good etc. Another option is IWV (Individuele Woningverbeteringen). In this case, Mitros installs everything with Wocozon and a rapport is not needed. With this option, Mitros can choose to increase the amount of rent a tenant has to pay. Lastly, Mitros can also decide to start a project in a neighbourhood, which will be selected by the project team.

- Points for improvement by Mitros for Wijk C Stroom that might have hindered the cooperation:
  1) The proposal was very long and unclear. In the proposal, they talked about the combination of solar panels and green roofs, but it was not clear what exactly they wanted. Besides that, there was a long and unnecessary part of the proposal that made it less concrete and not so straight to the point.
  2) Ownership: sometimes, Mitros has to say no to a tenant. Mitros is the owner of the houses, which makes them responsible. The proposal did not take this into account. For example, what if a tenant changes something about their house and then leaves within a year? Possibilities like these form an obstacle for Mitros.
  3) The idea of ‘buurtstroom’ is nice, but in reality and from a point of real estate, it is not convenient that there are multiple owners. Problems with this are for example; can Wocozon cooperate with buurtstroom, and how does this happen? This was overlooked in the proposal.

Appendix 2.2

Most important results interview Saskia Enderle (resident of the green roof house)

Mitros is a difficult housing corporation when it comes to communication. They are not transparent at all, and even when you are in close contact with them, you often get to talk to a different person who does not know anything about the project yet, which makes you have to explain it all over again. This hinders good communication.

- Most important ways in which Saskia has managed to convince Mitros to create a green roof;

  1) She and two other residents did tons of research and had worked everything out in the smallest detail. Nothing was unclear or vague about their proposal to install a green roof. In Saskia's words: "we did all the work for Mitros and they only had to say yes". Everything was worked out. This is in accordance with what Mitros told us: you need to have a perfect business case.

  2) Stay polite and enthusiastic. It is crucial to stay positive, polite and full of enthusiasm. This way, you distinguish yourself from all the other 'annoying' complaints from tenants that want to change something about their house. This is in agreement with Van Werven et al. (2015) (see literature review). Mitros gets tons of complaints and suggestions from tenants, so staying polite and positive is key.

  3) Mitros was already going to do large renovations in Wijk C. Saskia had a leakage in her roof and it was necessary to renovate it. This lowered the bar for Mitros and made it easier to agree with creating a green roof.

Appendix 2.3

Interview with the Municipality

The Dutch version of the questions as posed during the interview, are provided in grey and in square brackets [-]

1. ***What does the municipality see as (the biggest) obstacles in its actions for solar panels caused by:***

- ***The province***
- ***The national government***

[1. Wat ziet de gemeente als (de grootste) belemmeringen in haar acties voor zonnepanelen veroorzaakt door

- *De provincie*
- *De Rijksoverheid]*

The main barrier created by the national government is the plan to phase out the salderingsregeling for solar panels. The municipality is lobbying against this and wants to make the salderingsregeling more favourable. The reasons for phasing out the salderingsregeling are that

the net is congested, and the government wants to reduce the pressure and give other sustainable energy options a change

in addition, the cost-price reduction of solar has made solar more affordable and has reduced payback time

2. ***Which provincial / government schemes have resulted in the most progress in the field of the transition to solar energy?***

[2. Welke regelingen vanuit provincie/overheid hebben voor de meeste vooruitgang gezorgd op het gebied van transitie naar zonne-energie?]

The regulations that have created the most progression in the solar-energy transition are

- The SDE regulation which has caused for 50% yield for large roofs
- The salderingsregeling caused for 50% yield for personal consumption
- The postcoderoos has played an almost insignificant role and yielded only 0.01%. Main reason is that the organisation for neighbourhood initiatives is often done by volunteers.

3. ***Wat worden gezien als eventuele consequenties van het beëindigen van de postcoderoos regeling? Of worden er juist voordelen ingezien?***

   3. What are the possible consequences of ending the 'postcoderoos' scheme? Or are advantages expected?

[3. Wat worden gezien als eventuele consequenties van het beëindigen van de postcoderoos regeling? Of worden er juist voordelen ingezien?]

The change in the postcoderoos regulation has advantages as well as disadvantages

- Advantages are:
    - that the subsidy request becomes easier
    - It can move with you if you change houses
- Disadvantages are:
    - It has become a subsidy pot with a fixed amount of money. Before you would always receive the subsidy, now it can run out.

  However, the change does not seem to have a large effect because it is difficult for initiatives to find roof owners that want to provide a roof for the initiatives as they often need their roofs for their own sustainability goals.

4. ***What are the most striking problems with solar panels that the municipality has encountered so far?***

[4. Wat zijn tot nu toe de opvallendste problemen met betrekking tot zonnepanelen waar de gemeente tegenaan loopt?]

- Discontinuation of the SDE for large roofs
- The net capacity is being reached; this could mean that no new solar panels can be added.
- Roof structures being too weak for solar panels
- Real estate owners often do not have the time to start with 'Zon op dak' and or do not know where to start

5. ***Has there been an approach that has made the most difference, that has triggered people / organisations to adopt solar panels? E.g. free roof scan***

[5. Is er een aanpak geweest die het meeste verschil heeft gemaakt, die mensen/organisaties heeft geactiveerd om zonnepanelen te nemen? Bv. gratis dakscan]

- The free roof scan provided by the municipality is very accessible and gives people a lot of information about the possibilities
- Collaboration has made an impact. The Zonnepact with local parties within the Utrecht municipality that are in close contact with real-estate owners, has formed a coalition that makes zon op dak possible.

6. ***The municipality has almost reached the 20% target for solar panels. Does this mean that the investment in solar panels for the municipality will stagnate after achievement or will the investment then go to other solutions to be energy neutral by 2040?***

[6. De gemeente heeft al bijna het doel van 20% behaald voor zonnepanelen. Betekent dit dat na het behalen de investering in zonnepanelen voor gemeente zal stagneren of zal de investering dan gaan naar andere oplossingen om in 2040 energieneutraal te zijn?]

- There is no official municipal goal after 2025 and after reaching the goal of 20%. However, the main goal will not be the number of roofs, instead the utilization and yield will be most important. Furthermore, the focus will be on utilizing corporate roofs.

7. ***How does cooperation with other municipalities help the municipality of Utrecht?***

[7. Op welke manier helpt de samenwerking met anderen gemeenten de gemeente Utrecht?]

- The advantages of working together with other municipalities is that experiences and findings can be shared, as well as, opinions on what needs to be changed in the approach towards the transition. However, since every municipality has a slightly different political playing field, possibilities vary.

8. ***How is the contact between the municipality and the housing corporations, especially Mitros and Portaal? Is there any encouragement for sustainable initiatives from the corporations or residents themselves?***

[8. Hoe is het contact tussen de gemeente en de woningcorporaties, en dan met name Mitros en Portaal? Is er sprake van aanmoediging voor duurzame initiatieven vanuit de corporaties of bewoners zelf?]

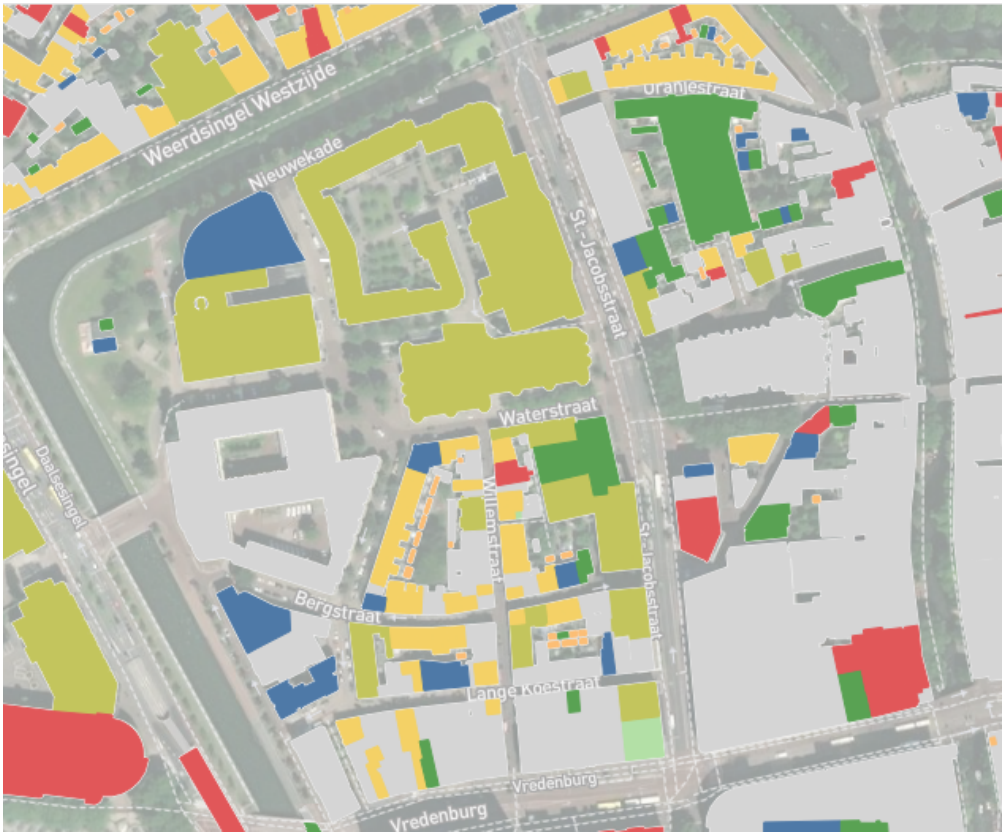
- The municipality and housing corporations have formed a working group Zon op dak to share experiences and have made performance agreements in the context of Zon op dak. However, due to the overall list of objectives that the municipality has composed for the housing corporations, Zon op dak is not always their main focus.
- The municipality and housing corporations have agreed that they can communicate with each other. The municipality would like to help activate tenants by, for example, sending letters of encouragement. However, the housing corporations have not yet made use of this option.

9. ***What benefits does the municipality expect from the RES U16?***

[9. Welke voordelen verwacht de gemeente van de RES U16?]

- The signing of the Climate agreement, which states how much sustainable energy each region needs to generate, has activated the municipality to think about how to reach this and to collaborate with other parties. Even though the municipality worked on this before, the officiation has caused the generation of new information and exchange of knowledge. With that, more attention is put on Zon op dak and possibly create more regulation due to RES and the BZK obligatory means.

Appendix 3



Appendix figure 4. *Tableau Map of the opportunities in Wijk C regarding suitability for sustainable roof solutions (Yellow: Solar PV; Green: green roof; Light green: combination green roof and solar PV; Very light green: Intensive sedum roof; Blue: Water retention; Red: In use; Grey: Potential unknown)*

Conclusions (appendix figure 5);

1. Mitros building Nieuwekade and Pastoor van Nuenenstraat is suitable for a combination of solar pv and sedum roofs.
2. Mitros houses at Dirk van Zuylenstraat are suitable for Solar PV.
3. Portaal buildings at Nieuwekade are suitable for solar PV and Oranjestraat is suitable for green roofs.
4. For the mitros buildings in the Rozenstraat there is potential for green roofs and water retention.
5. For many buildings, the potential for the roof is still unknown (grey).

Appendix figure 5. *Tableau Map of the monuments in Wijk C (orange). Along the 'Oudegracht', all the buildings have monumental status, meaning that adjustments to the roof and other outside elements of the buildings are prohibited completely or to some extent*

Appendix figure 6. *Tableau map of Wijk C showing the roofs already used in 2020 (Yellow: Solar PV; Green: green roof)*