City of Amsterdam



Zonbank Amsterdam

Used solar panels to tackle energy poverty
Lessons and insights from pilot projects, and practical guidance

Hoptille pilot project 2025



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1. Summary



Zonbank Amsterdam (Amsterdam Solar Bank) shows how used solar panels can be given a second life. This is sustainable, and good for the environment and for residents.

The benefits are threefold:

- Solar panels that are still usable are not thrown away.
- Roofs are put to better use.
- Households in energy poverty get help to lower their energy costs.

It started with a few pilot projects, and there is now a subsidy scheme for Amsterdam housing associations. The scheme can support about 700 Amsterdam households in neighbourhoods with high levels of energy poverty in 2026-2027.

The used solar panels are checked first. If they are in good condition, they are installed free of charge for residents who have no way of buying solar panels themselves. Tenants pay no service charges for this.

Amsterdam also wants to help other local authorities start a similar project. **This step-by-step plan** can be found in. Municipalities can use this step-by-step plan to get from an initial idea to a workable project.

Key figures

From pilot projects to programme	Zonbank Amsterdam has since evolved into a subsidy scheme for housing associations, aimed at about 700 households in neighbourhoods with high levels of energy poverty in 2026-2027.
Funding	The City is contributing € 1.5 million from the municipal Klimaatfonds (Climate Fund) and is topping this up with € 414,000 from SPUK funding. This extra money is for solar-powered boilers (which use solar power to heat water), where technically feasible.
No service charges for tenants	The entire installation is funded. Housing associations contribute € 32.50 per panel towards maintenance.
Indicative saving	During the pilot in Hoptille, residents saved about € 159 a year. An average single-family home with 6 used panels saves about € 211 a year, assuming 35% self-consumption. With a solar-powered boiler, the saving can rise to about € 325 a year.
CO_2 benefit	A single-family home with 6 used panels, a new inverter and new mounting frames saves about 5.3 tonnes of CO_2-eq over a service life of 15 years.

Why reuse is needed

Solar panels are increasingly being replaced while they still work well. This happens not only to save costs, but also because of things like renovation, changes to installations, or new or different plans for roofs or sites. These are often fairly new panels that still work well and can be used for years to come.

Sending these panels straight to recycling is a waste, because they are still worth a lot. Recycling currently focuses mainly on bulk materials such as glass and aluminium. Valuable materials in solar cells are often downcycled. Reuse keeps materials in use for longer. This is better for the environment than recycling too early.

Amsterdam contributes to a regional reuse chain. In this chain, panels are collected, visually checked, cleaned, tested and stored so that they can be reused where they are a good fit. The City does not need to run this chain itself, but it can create demand and bring parties together.

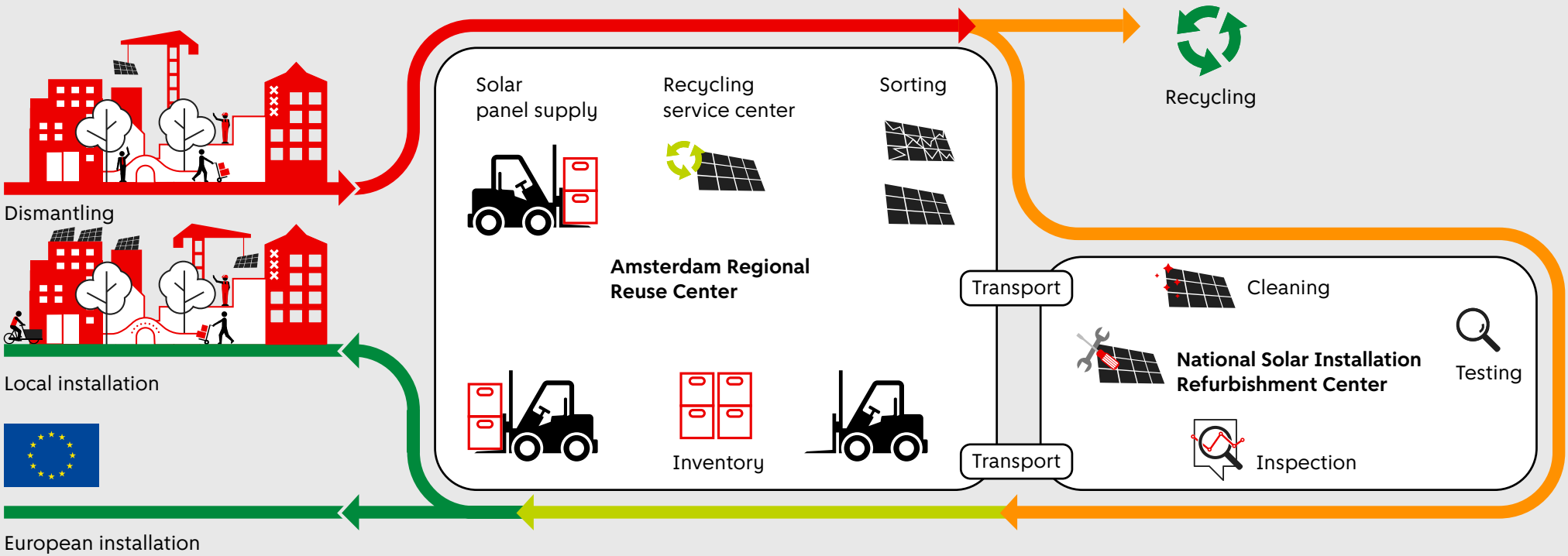


Figure 1: Visualisation of the existing regional reuse chain. It supplies inspected solar panels ready for reuse in projects like Zonbank Amsterdam.

Why used solar panels help tackle energy poverty

Energy poverty affects people with low incomes, high energy costs and poor-quality housing. There is usually nothing they can do about this themselves. Tenants and low-income households in particular often benefit less from solar panels, even though they are more vulnerable to rising energy costs.

This makes used solar panels a good choice. For small installations, the extra output of new panels is often limited. Especially once net metering (offsetting the electricity fed into the grid against the electricity used) has ended, what matters is not only total generation but, above all, how much electricity residents can use directly.

The used panels from the reuse chain are reliable and still deliver good output. They can be a particularly good fit for low-consumption households, where much of the solar power is fed into the grid. The added social value therefore lies not in maximum production per square metre, but mainly in using solar panels that still work well and would otherwise be lost. This way, the output goes where it is needed most.

Solar panels do not fully solve energy poverty. It is also important to work on long-term housing improvements, energy coaching and income support. However, used solar panels can be an additional direct measure, especially on roofs that would otherwise remain unused for the time being or where no other plan is feasible.

Amsterdam is currently focusing mainly on housing associations. Three things come together here: the target group, the roof area and contact with residents. The housing associations know which roofs are suitable and what the renovation plans are, and they are in contact with residents. They can organise a project faster and in a more targeted way than is possible with individual applications from private households or owners' associations (VvEs).

Financial and political considerations

The financial business case is not immediately clear. With the net-metering scheme ending in 2027, how much residents save depends on their electricity use. The analysis shows that households with free solar panels do not end up paying more because of feed-in charges. However, the annual saving varies considerably between households and between energy contracts.

Offering used panels alone is not enough at present. That is why the Amsterdam subsidy scheme funds the entire installation. Tenants pay no service charges. As a result, they will still pay less for their energy after the net-metering scheme ends. Housing associations help support the reuse chain and organise monitoring and maintenance.

The total saving is not always higher than the investment. The service life is limited if there are plans to demolish or renovate buildings. Zonbank Amsterdam is not just a financial measure, but also a political choice to invest unequally so that more people can take part in the energy transition.

Key lessons from the pilot projects

- Start small and local. The pilot in Hoptille, Amsterdam-Zuidoost, could go ahead more quickly thanks to direct contact with a local property manager. A general top-down route is slower.
- Make quality assurance explicit. There must be proof that used panels have been inspected and found fit for safe reuse. For residents and housing associations, confidence in quality is a precondition.
- Take a personal approach to residents. In Hoptille, about half of the households took part. Some residents did not immediately trust a free offer. Personal explanations through contact people work better than written information alone.
- Arrange aftercare from the start. Residents appreciate personal conversations, but they may also need help after installation. Monitoring, insight into how much the panels generate and a clear point of contact are important for the project.
- Solar panels are the start of further energy savings. The pilot projects show that understanding their consumption can help residents save in other ways too.

Implications for scaling up

Zonbank Amsterdam shows that used solar panels can be more than one-off solutions. They can become part of a standard approach. Besides the panels, this requires:

- a reliable reuse chain
- a clear target group
- long-term funding
- quality control
- cooperation with local parties that are in contact with residents

The approach does not replace long-term sustainability improvements or income support, but it is a valuable building block in tackling energy poverty. The key lessons for other municipalities are:

- Build on existing policy goals and work with the partners in the chain.
- Start with a pilot that has a good chance of success.
- Put agreements clearly in writing.
- Use the results to gain support for expansion.

2. Introduction



This report sets out lessons, insights from pilot projects and practical tips for municipalities, housing associations and organisations that want to work with used solar panels.

At its heart is Zonbank Amsterdam. This is an initiative of the City of Amsterdam with three aims:

- Using materials sustainably, by giving working materials a second life.
- More solar energy on roofs.
- Tackling energy poverty by making used solar panels available free of charge to the Amsterdam residents who need them most.

Inspected used solar panels are made available free of charge to the Amsterdam residents who need them most. This gives working materials a second life, and residents benefit directly from locally generated electricity.

What started as a number of pilot projects has grown into a subsidy scheme for housing associations. This will help about 700 households in neighbourhoods with high levels of energy poverty in 2026-2027. The first projects show that this approach is technically feasible, but growing it takes more than available panels and suitable roofs. The conditions for success are:

- A committed roof owner.
- Clear checks on quality assurance.
- Good communication with residents.
- Links with neighbourhood initiatives that residents already know and trust.

Installing used solar panels on roofs that would otherwise remain unused for the time being combines three things: keeping valuable materials in use, generating sustainable electricity and supporting residents. The approach fits Amsterdam's goals for:

- A circular economy.
- No roof left unused.
- Unequal investment for equal opportunities.

Programme Zon therefore looks beyond simply increasing the number of solar panels in the city. The task is also to scale up solar energy in a circular and inclusive way. With this report, Amsterdam aims to share the knowledge it has gained, so that other municipalities and partners can make similar decisions faster and with better information.

2.1 Background: from waste stream to reuse chain

The growth of solar energy means not only that more solar panels are needed, but also that we must handle the materials in those panels with care. Solar panels are increasingly being removed while they still work well. This chapter explains why the City of Amsterdam has helped build a regional reuse chain and how this approach is growing into a national one.

2.2 Premature disposal of solar panels

Research by TU Delft, Leiden University and the AMS Institute shows that it is better to use solar panels for longer. Premature replacement and recycling usually cause more environmental damage than reuse. Using well-functioning solar panels for longer is better for the environment.

Recent research by Copper8 concludes that mass repowering, in which solar farms are replaced early for financial reasons, is not yet happening. Real-world examples show that many solar panels are becoming available for a variety of reasons. Stichting ZonNext observes that these are often relatively new panels that still work well and even deliver much of their original capacity.

In Groningen, almost 100,000 solar panels less than eight years old will soon make way for an expansion of the high-voltage grid. In Amsterdam, 3,000 four-year-old panels were removed to make way for wind turbines with a higher energy output. One housing association replaced 19,000 well-functioning panels when it installed new inverters. In addition, thousands of unused panels are in storage at various companies. There is no profitable use for them. These panels eventually end up being recycled.

The reasons for getting rid of solar panels vary widely from case to case. These are often fairly new, well-functioning panels that can still be used for a long time. There are three reasons why they often end up at the recycler:

1. New solar panels are currently cheap.
2. New panels produce more electricity.
3. The costs of dismantling, transport, inspection and reinstallation are high. This makes it difficult for used panels to get back onto the market.

Downcycling

Current solar panel recycling focuses mainly on recovering large volumes of material, such as glass and aluminium. The most valuable components are usually crushed and used as filler in concrete or asphalt. This applies, for example, to the solar cells, which contain strategic materials such as silver and pure silicon. There is not yet an industrial recycling process that can recover strategic materials at high purity and on a large scale. Promising techniques are being developed, such as TNO's laser technology. However, technical and economic constraints mean it may take years before such methods are scalable and cost-effective, and before the recovered materials are actually put to high-value use.

2.3 A regional reuse chain for solar panels

In recent years, a regional reuse chain has been developed to stop good solar panels from disappearing into recycling too soon. This chain brings together the steps needed for reuse:

- Careful collection, sorting and cleaning.
- Technical inspection.
- Storage.
- Matching with a new use, and reinstallation.

Figure 1 shows these steps. More information is available in the infographic on openresearch.amsterdam.

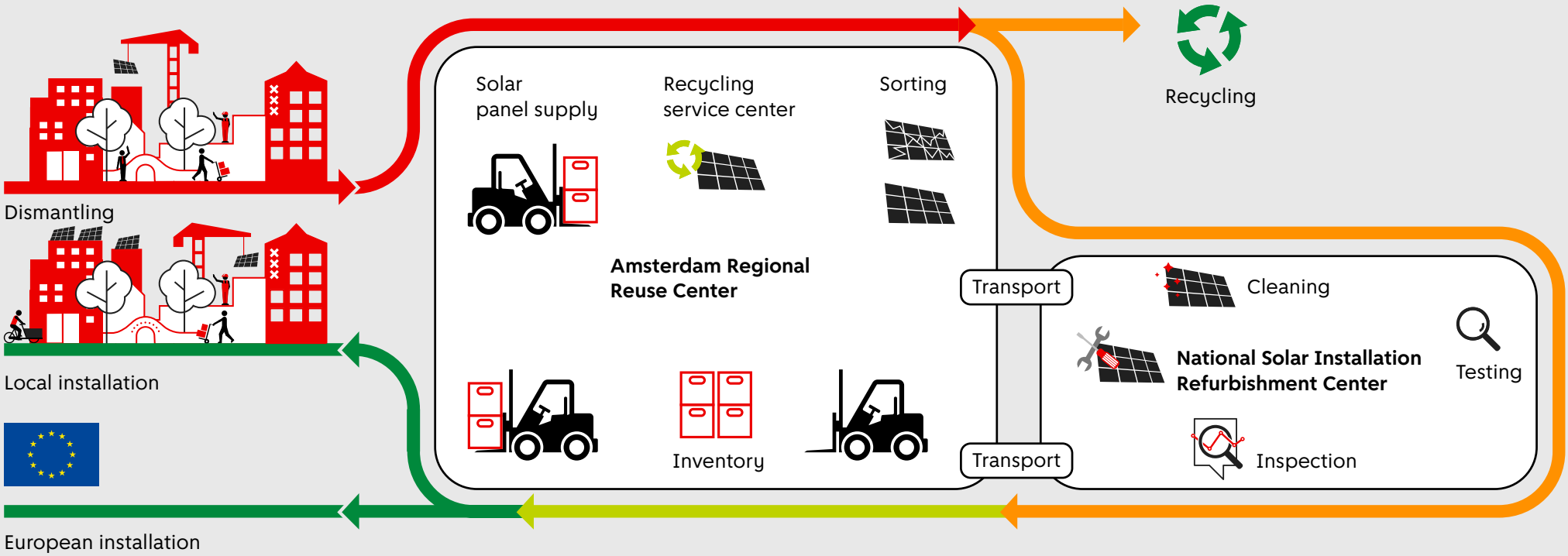


Figure 2: Visualisation of the existing regional reuse chain. It supplies inspected solar panels ready for reuse in projects like Zonbank Amsterdam.

The City of Amsterdam brought the chain partners together, made an initial local stock of used panels possible and created demand for used solar panels. The link between the Recycling Service Centrum and Milieuwerk Amsterdam is an important part of this regional approach. The panels are brought there locally, where they are checked, prepared, packed and stored. Technical inspection and certification take place at Refurn in Apeldoorn. Here, the panels are cleaned and checked for minor damage, and their output is assessed. Panels that are fit for reuse receive a test report. They can then be reused. Both Milieuwerk Amsterdam and Refurn provide social employment (PSO Trede 3).

This way of working solves an important problem from earlier reuse projects: having to bring supply and demand together again for every project. Previously, it was unclear whether there were enough panels, whether the sizes were right, whether the quality was good and whether the schedule worked. A buffer stock of inspected, ready-to-install panels in Amsterdam made it easier to match panels with projects. As a result, projects could be prepared more quickly: when a suitable roof became available, there was no longer any need to search for the right batch of panels first.

The local chain has also helped to make reuse tangible and workable, and to test what works well. Aspects such as logistics, storage, quality, ownership, installation and take-back could be tested and refined in projects. This turned reuse from a purely circular principle into a workable route for new uses in the city.

The next step: reuse at national level

The reuse chain for solar panels is growing from individual projects into a national collaboration. Reuse is increasingly being integrated into the existing collection and recycling system. WEEE Nederland, Stichting ZonNext, Refurn, Gebruiktepanelen, Green Teams Europe and Stichting OPEN are working together on this. They are looking at whether solar panels can be reused at an earlier stage. They are also improving how the steps in the process are organised.

This development is important because increasingly large batches of solar panels are becoming available from housing projects, commercial roofs and solar farms. These volumes require better organisation than the first local projects did. Refurn remains important for cleaning, testing and certification. Gebruiktepanelen and Green Teams Europe play an important role in handling larger numbers of panels. They organise dismantling, transport, storage, technical preparation and reinstallation. Stichting ZonNext acts as the link between supply, demand and social uses.

A complete package makes reuse more attractive

An important next step is to combine the reuse chains for solar panels, mounting systems and inverters. In many projects, it is not just about the panel, but about the whole system. When the panels, mounting materials, inverters and installation work are arranged separately, this adds costs and makes scheduling harder. This creates uncertainty for clients and installers. Bringing these components together more effectively makes it possible to offer a complete used PV system.

The chain then supplies a complete package rather than just individual used panels. This includes careful dismantling and damage-free transport, inspection, certification, matching sets, supplying extra parts and installation at the new location. When these steps are well aligned, costs fall and risks are lower. This also makes reuse more financially attractive. This is needed for reuse to grow. Reused solar panels could even become part of the regular solar panel market.



3. Background

Used solar panels in neighbourhoods with energy poverty



The reuse chain ensures that well-functioning solar panels, mounting systems and inverters can be reused.
The question is where these installations deliver the most social value. For Zonbank Amsterdam, the answer is households in neighbourhoods with high levels of energy poverty. Used solar panels are not a complete solution, but a direct measure that complements existing support, such as energy coaching.

Unequal access to solar energy

Energy poverty is about more than a high energy bill. TNO and Statistics Netherlands (CBS) describe energy poverty as the combination of a low income with high energy costs and/or a home with poor energy performance (LIHE and/or LILEK). According to TNO's provisional estimate, about 503,000 households in the Netherlands were affected by energy poverty in 2025, roughly 6% of all households. Within this group, the number of households with a low income and high energy costs also increased.

Not everyone can generate their own energy. In recent years, people with enough money and their own home have been able to buy solar panels fairly easily. For many tenants and low-income households, the situation is different. They depend on a landlord, housing association or owners' association. Yet they are often the ones who are hit by rising energy costs.

Solar panels are no substitute for renovation

Used solar panels do not fully solve energy poverty.
The causes are often a low income, high energy costs, poorly insulated homes and little scope for residents to make changes themselves. Research into energy coaching and smart energy technology in Amsterdam shows that more measures are needed. These include affordability, better housing and help with energy use. The study also stresses that larger interventions, such as renovating and improving poor-quality housing, remain essential.

Solar panels are a supplementary measure. They can help residents during the period before major renovation takes place, or when standard sustainability improvements are hard to get off the ground. Sometimes roofs stay empty for years, for example when it is unclear when a building will be renovated or demolished. Inspected and approved used panels can be put to use there temporarily.

Why used panels are a good fit

In this application, the aim is not maximum output per square metre. What matters is that residents can generate part of their own electricity. Now that the net-metering scheme is ending, it is even more important for residents to use the electricity they generate directly.

Used solar panels often have a slightly lower capacity and are sometimes smaller than new panels. For commercial projects, this can be a disadvantage, but for small homes with limited electricity consumption or roofs with little space, it can in fact be a good fit. The value then lies not only in the amount of electricity, but also in using existing materials. This means the panels go to residents who would otherwise find it difficult to access solar energy. The next chapter contains a detailed cost-benefit analysis comparing used and new solar panels.

Putting used materials to work for residents

Used solar panels in neighbourhoods with energy poverty link two policy goals:

- Using good materials for longer.
- Sharing the benefits of the energy transition more fairly.

This does not happen by itself. The market for used solar panels is still new, and vulnerable households need simple solutions that do not cost a lot of money.

The municipality has an obvious role to play. It can kick-start demand for inspected used panels, bring parties together and make sure that social and circular benefits are taken into account alongside the financial side. Reuse therefore not only helps to prevent waste and the loss of materials; it also becomes a way to tackle energy poverty.

4. How much do residents save on their energy costs?



From 2027, people with solar panels will no longer be able to use net metering for the solar power they generate. They will get less money back for the electricity they feed into the grid. As a result, many housing association tenants will save less on their energy bills, while still paying service charges to their landlord. In some cases, these charges are higher than the saving.

Households that receive solar panels through the Zonbank Amsterdam subsidy scheme pay no service charges or other contributions. They do not pay back the investment in the solar panel installation. As a result, they keep the benefit of a lower energy bill after the net-metering scheme ends.

4.1 How much does a used solar panel installation save?

Two examples were used to investigate this: Hoptille and a typical single-family home. For both examples, the analysis looked at how much residents save with different energy contracts and different patterns of electricity use.
The results are shown in Table 2.

Case study 1, Hoptille pilot project: In the latest pilot project in Hoptille, Amsterdam-Zuidoost, four 320 watt-peak (Wp) solar panels were installed on each of 52 homes. The panels are connected to the meter in the home. The installation generates about 1,100 kWh a year. Research by CML Leiden shows that residents in Hoptille use an average of about 53% of the solar power themselves. In some cases, this rises to as much as 85%. See **Figure 3** for the results. This level of self-consumption is higher than the average used by MilieuCentraal. This is because residents use a relatively large amount of electricity compared with what the panels generate.

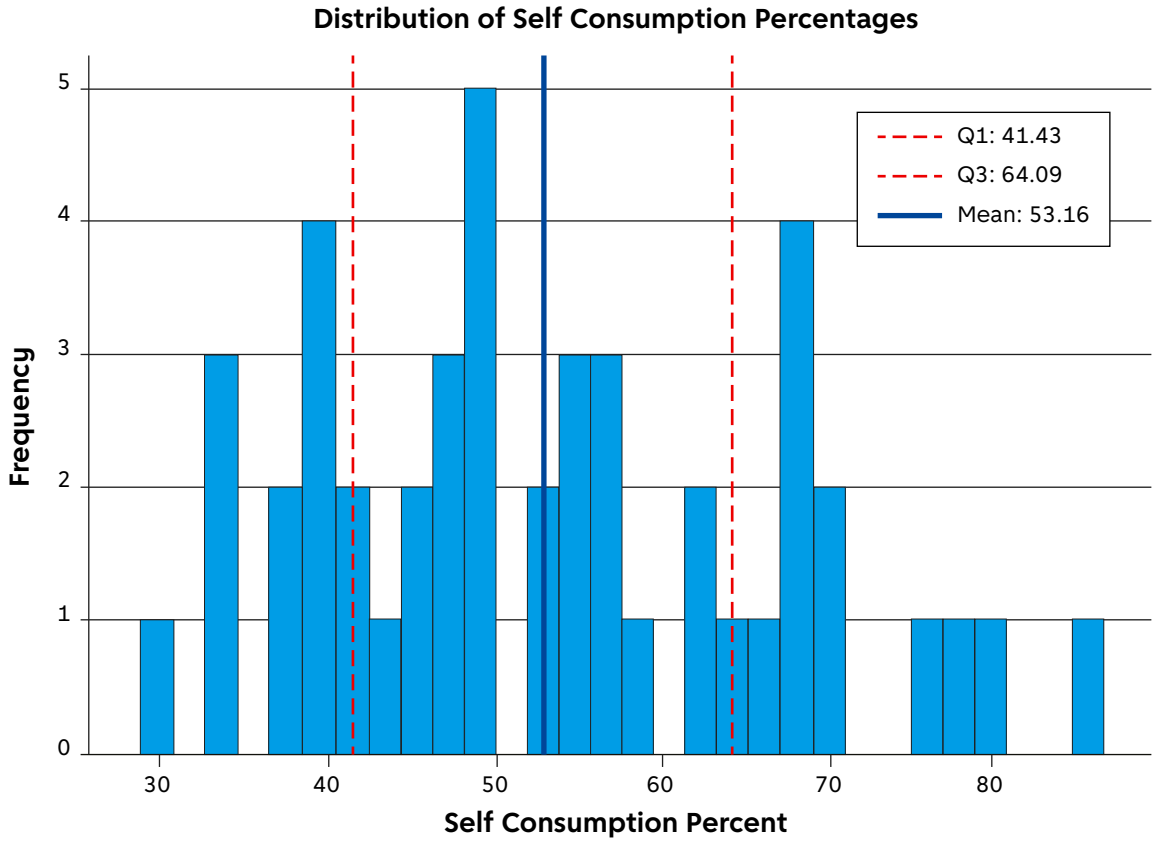


Figure 3: Distribution of self-consumption in Hoptille

Case study 2, single-family home (EGW): many single-family homes that are suitable for Zonbank Amsterdam have more roof space than the homes in Hoptille. For this reason, the study also included an example home with 6 panels of 380 watt-peak each. Together, these panels generate about 2,000 kWh a year. The panels are in stock in the reuse chain. They will soon be used for Zonbank Amsterdam. Assuming consumption similar to Hoptille but slightly higher, average direct self-consumption is about 35%.

Energy contract (*see also * on page 15*): the final saving also depends on the energy contract. Based on the tariffs currently known for 2027, feed-in charges do not appear to be higher than the compensation for electricity fed into the grid. This means that feeding electricity into the grid will not lead to extra costs. For many contracts, the net feed-in compensation is likely to remain low.

Three example contracts were used to show the possible savings. These are one-year contracts for the situation from 2027, when net metering ends. The example contracts are based on the tariffs listed on Energievergelijk.nl. The reference date is 14 August 2026.

4.2 Scenarios used

Table 1 shows all the scenarios used. Several representative scenarios were calculated for both case studies. For Hoptille, an average self-consumption of 50% was used, with a favourable and an unfavourable scenario of 35% and 65%. For the single-family home, an average self-consumption of 35% was applied, with a favourable and an unfavourable scenario of 25% and 45%.

In the favourable case, the contract delivers the largest saving. This is because it has the highest net feed-in compensation, combined with the corresponding electricity costs. In the least favourable case, the net compensation is lowest. The electricity costs also differ in this case. The average lies between these two. This scenario uses the average electricity costs and average net compensation of the other two scenarios.

Scenarios	Generation/ year	Self-consumption	Electricity costs	Net feed-in compensation (2027)*
Favourable Hoptille	1,100 kWh	65%	€ 0.279/kWh	+ € 0.0250/kWh
Average Hoptille	1,100 kWh	50%	€ 0.276/kWh	+ € 0.0138/kWh
Unfavourable Hoptille	1,100 kWh	35%	€ 0.272/kWh	+ € 0.0025/kWh
Favourable EGW	2,000 kWh	45%	€ 0.279/kWh	+ € 0.0250/kWh
Average EGW	2,000 kWh	35%	€ 0.276/kWh	+ € 0.0138/kWh
Unfavourable EGW	2,000 kWh	25%	€ 0.272/kWh	+ € 0.0025/kWh

Table 1: Generation, self-consumption and energy contract scenarios

*** Note:** On 14 August 2026, energievergelijk.nl listed several energy contracts with negative net feed-in compensation. The energy suppliers concerned have not yet announced their tariffs for 2027. These contracts have therefore not been included in this comparison.

Annual saving for Hoptille and a single-family home

These scenarios were used to make a rough calculation of how much a home in Hoptille and a typical single-family home (EGW) can save.

Scenario results	Self-consumption	Net feed-in compensation	Saving per year
Favourable Hoptille	€ 199.49	+ € 9,63	€ 209,12
Average Hoptille	€ 151.80	+ € 7,59	€ 159,39
Unfavourable Hoptille	€ 104.72	+ € 1,79	€ 106,51
Favourable EGW	€ 251.10	+ € 27,50	€ 278,60
Average EGW	€ 193.20	+ € 17,94	€ 211,14
Unfavourable EGW	€ 136.00	+ € 3,75	€ 139,75

Table 2: Savings results by case study and scenario

From 2027, households with free solar panels from Zonbank Amsterdam will not end up paying more because of feed-in charges. Even so, how much solar power they use still matters. The more electricity residents use at home, the greater the saving. It is also important that residents compare energy contracts every year and receive good information about feeding electricity into the grid, smart electricity use and possible costs.

Saving more with a solar-powered boiler

Housing associations can receive a subsidy for solar-powered boilers through the *Used Solar Panels on Amsterdam Housing Association Roofs (Gebruikte zonnepanelen op Amsterdamse corporatiedaken)* scheme. A solar-powered boiler uses surplus solar power to heat tap water. This means residents use more of their solar power. Self-consumption can rise to 80%, compared with 35% without a boiler. Residents also save considerably on gas. However, solar-powered boilers do need extra space. They do not fit in every home.

Table 3 shows what an 80-litre solar-powered boiler delivers in a single-family home, compared with a home with solar panels only. Both situations were calculated using the average energy contract from **Table 1** and a gas price of € 1.45 per m³. In this example, the solar-powered boiler provides an extra saving of about € 114 a year.

Installation type	Self-consumption	Feed-in	Saving per year
Solar panels only (EGW, 2,000 kWh, 35%)	€ 193.20	+ € 17.94	€ 211.14
With solar-powered boiler (EGW, 2,000 kWh, 80%)	€ 319.35 (87 m³ of gas)	+ € 5.52	€ 324.87

Table 3: Indicative saving for an average single-family home with a solar-powered boiler

What are the costs per installation?

For the Used Solar Panels on Amsterdam Housing Association Roofs subsidy scheme, the City of Amsterdam uses the following amounts:

Home type	Roof type	3 panels	4 panels	5 panels	6 panels
EGW	Schuin	Not applicable	Not applicable	€ 2,110.00	€ 2,190.00
EGW	Plat	Not applicable	Not applicable	€ 2,335.00	€ 2,425.00
Multi-family home (MGW)	Schuin	€ 1,900.00	€ 1,950.00	Not applicable	Not applicable
MGW	Plat	€ 2,010.00	€ 2,080.00	Not applicable	Not applicable

Table 4: Indicative costs per installation under the subsidy scheme

The prices were set in consultation with installers. They take into account:

- the cost of materials, such as inverter(s), mounting materials, cables and monitoring equipment.
- the work needed to complete the installation, such as a roof inspection, resident outreach, hoisting and mounting on the roof.
- the cost of permits.

For the solar panels themselves, the housing association pays the reuse chain € 32.50 per panel. This keeps the stock of used panels topped up. The housing association also arranges monitoring and maintenance. This costs about € 30 per home per year.

The budget for installing the solar-powered boiler is € 1,815 per home.





4.3 Why the City is investing

The net-metering scheme ends in 2027. As a result, it takes longer for the savings on energy costs to exceed the investment. In Hoptille, homes may be demolished before the investment in the solar panel installation has been recouped. In that case, the total saving on the energy bill is not always greater than the cost of the installation. For an average single-family home, it takes about 13 years for the savings to equal the investment (including monitoring costs).

Other measures can sometimes ease energy poverty more quickly. For example, an Amsterdam study on energy coaching shows that relatively simple interventions, such as energy advice, small energy-saving measures and feedback on energy use, can save a great deal. The households that took part in the study reduced their energy bills by an average of € 104 per month. That is more than they can achieve with solar panels alone.

Zonbank Amsterdam is not only about the payback period. It is also a political choice. Guided by the principle of unequal investment for equal opportunities, the City of Amsterdam has chosen to give access to the benefits of the energy transition to households in temporary housing or in housing situations where the investment pays back less. Without public support, it is precisely these households that would often be overlooked.

Solar panels are not the fastest or the only solution to energy poverty, but they can be an additional long-term measure. They make residents less dependent on electricity from the grid. They also combine well with energy coaching, monitoring and other measures that save money directly.

Do new solar panels deliver greater savings?

New residential solar panels produce more electricity, but they are often larger. The solar panels inspected for Zonbank Amsterdam in 2026 deliver 320-380 watt-peak and measure 1.68-1.77 m². In 2026, a new panel delivers about 450 watt-peak and measures about 2.0 m². This means the output of new panels is currently about 5-18% higher.

On small or fragmented roofs, the smaller size of the used panels can even be an advantage. They often fit more easily, so the roof area can be used more effectively (personal communication, Norm Zon).

The comparison below assumes the same available roof area. The baseline is the single-family home with 380 watt-peak panels generating 2,000 kWh per year. Direct self-consumption is 35%. The average energy contract from **Table 1** (middle column) was also used. For panels of 320 watt-peak and 450 watt-peak, self-consumption has been adjusted to reflect the lower or higher output.

In this comparison, new solar panels deliver an extra saving of about € 4.60 per year. That is a small difference compared with the used 380 watt-peak panels.

	320 Wp used	380 Wp used (EGW reference)	450 Wp new (2026 benchmark)
Panel area	approx. 1.68 m²	approx. 1.77 m²	approx. 2.00 m²
Power density	190 Wp/m²	215 Wp/m²	225 Wp/m²
Annual generation (same roof area)	1,774 kWh	2,000 kWh	2,096 kWh
Relative self-consumption**	37%	35%	34%
Direct self-consumption	656 kWh	700 kWh	713 kWh
Feed-in	1,118 kWh	1,300 kWh	1,383 kWh
Saving from self-consumption	€ 181.16	€ 193.20	€ 196.69
Net feed-in compensation	€ 15.42	€ 17.94	€ 19.09
Total saving per year	€ 196.58	€ 211.14	€ 215.78
Difference compared with 380 Wp	-€ 14.56	Not applicable	+€ 4.64

Table 5: Indicative difference in energy cost savings with new panels

** For this comparison, it is assumed that self-consumption falls as generation rises: 37% at 1,774 kWh, 35% at 2,000 kWh and 34% at 2,096 kWh. This is a conservative estimate. CE Delft and TNO (2024, Figure 20) show that, with constant electricity demand, relative self-consumption rises from about 40% to almost 70% when the number of solar panels is halved.

The market price of new solar panels fluctuates sharply due to factors such as raw material prices, stock levels and developments in international trade. In August 2026, the selling price of a new solar panel is around € 80 per panel. The price of used panels from the reuse chain is currently € 32.50 per panel. With 6 used solar panels, the saving on material costs in 2026 is about € 285.

5. CO_2 impact of used panels



Solar panels generate sustainable electricity and so reduce CO_2 emissions. However, solar panels also cause CO_2 emissions, for example during the production of components, transport and installation.

This works differently for used solar panels than for new panels. The panels have already been produced and are given a second life instead of being downcycled. That is why the original emissions from producing the solar panel do not count when it is reused. In the calculation, we look at two things: the climate impact of putting the panels back into use, and the CO_2 emissions avoided because the panels generate sustainable solar power. This shows how much CO_2 is saved by reusing solar panels.

5.1 What is the net CO_2 benefit per installation?

A CO_2 calculation method was developed for Stichting ZonNext, based on the expertise of the AMS Institute and CML Leiden. This method makes it possible to calculate, for each project, the climate impact of putting used solar panels back into use. The appendix gives more information on how the calculation was carried out. Table 6 shows the CO_2 reduction for the situations below.

Home in Hoptille: For this home, the calculation assumes 4 used solar panels of 320 watt-peak each. The panels were installed in 2026. The system has a new inverter and uses mounting frames for a flat roof. The panels are expected to be in use for 10 years.

Single-family home: For this home, we assume 6 used solar panels of 380 watt-peak each. These panels were also installed in 2026. The system is on a pitched roof and has a new inverter and new mounting frames. These panels are expected to be in use for 15 years.

	CO_2-footprint	CO_2-reduction	CO_2-benefit
Home in Hoptille (1,100 kWh, 10 years)	93.4 kg CO_2-Eq	2677 kg CO_2-Eq	2584 kg CO_2-Eq
Single-family home (2,000 kWh, 15 years)	327.7 kg CO_2-Eq	5579 kg CO_2-Eq	5251 kg CO_2-Eq

Table 6: CO_2 reduction per case

5.2 What is the social value of the CO_2 reduction?

Reducing CO_2 also has a social value. Emitting fewer greenhouse gases helps prevent damage to the climate. Different studies and policy frameworks use different shadow prices for this.

In its 2023 *Application Rule for Sustainable Investments (Toepassingsregel duurzame investeringen)*, the City of Amsterdam uses a value of € 480 per tonne of CO_2 equivalent in 2027. This amount rises to € 1,052 per tonne in 2050. A recent scientific study arrives at a much higher value. That study points to a shadow price of USD 1,013 per tonne of CO_2 in 2020. If this amount rises by 2% a year, it reaches about USD 1,835 per tonne in 2050.

The amounts therefore vary widely. The calculations show that the CO_2 reduction has value. Even a small project, such as the one in Hoptille, helps prevent climate damage. Every kilogram of CO_2 saved contributes to this.

5.3 Do you save more CO_2 with new solar panels?

In some cases, it may be better to use new solar panels (provided they are sustainably produced). New, sustainably produced panels can have lower CO_2 emissions and so deliver a greater climate benefit than used panels. Stichting ZonNext's CO_2 calculation method can be used to compare used and new solar panels. For each project, this shows which option delivers the greatest climate benefit.

For example, the tool shows that used panels with a remaining capacity of 270 watt-peak do not always deliver a greater CO_2 benefit than new panels. For this reason, used panels with a capacity of less than 300 watt-peak that enter the reuse chain are generally not put back into use in the Netherlands. These panels usually go to a recycler.



6. Insights from the pilot projects and the preparation of Zonbank Amsterdam



6.1 Why does Zonbank Amsterdam focus on housing associations?

Zonbank Amsterdam currently focuses on housing associations. That is where much of the target group lives, and there is also a great deal of available roof area that is still unused. In Amsterdam, energy poverty is common in social rented housing. Housing associations own 40% of Amsterdam's roofs. In 2025, only an estimated 13 to 20% of suitable roofs had solar panels (source: Readar scan analysis). So there is still plenty of room for solar panels.

Housing associations are also important partners in practical terms. They manage many homes, have information on whether the roofs are suitable and know the maintenance schedule. They can also reach residents easily. Neighbourhood support workers are often active in neighbourhoods with high levels of energy poverty. Working with them makes residents easier to reach and installations easier to organise than approaching each resident individually.

When the *Used Solar Panels on Amsterdam Housing Association Roofs* subsidy was being prepared, other target groups were also considered. These include private homeowners, tenants of private landlords and owners' associations (VvEs). These groups are harder to reach on a large scale. Their homes are more scattered and the residents are harder to approach. In owners' associations, several parties have to agree to a decision. This often takes more time. In Amsterdam, working with housing associations is the best way to help households in energy poverty quickly and in a targeted way.

There is one important point to bear in mind when extending Zonbank Amsterdam to larger numbers of homes. Housing associations often already have buildings with solar panels. Households in energy poverty may live there too. The tenants there often pay service charges for these panels. In new Zonbank projects, tenants get the use of the solar panels free of charge. Energy poverty alone is not sufficient grounds to approve a new project. The choice of a particular building or home must be easy to explain to the other tenants.

A different target group

There are also examples of other municipalities offering used solar panels to private homeowners. One example is the Municipality of Haarlemmermeer.

Start with a small pilot project

The City of Amsterdam initially approached housing associations mainly at executive and policy level. That proved difficult. For the housing associations, Zonbank Amsterdam is a new initiative. The housing associations have questions about quality, ownership, maintenance, communication with residents and possible risks. Having to combine it with existing renovation, sustainability and new-build projects can also make it harder to start a new project.

The pilot in Hoptille, Amsterdam-Zuidoost, showed that starting locally works better. Direct contact with a property manager at Ymere made it possible to establish quickly which homes were suitable and what was going on in the neighbourhood. A successful pilot has the advantage of showing whether the approach works. It makes clear what practical arrangements are needed, and it gives the parties involved the evidence and confidence to make follow-up projects possible.

6.2 Funding and subsidy scheme

Funding for Zonbank Amsterdam is in line with the Amsterdam Coalition Agreement 2022–2026. The agreement states that the City will explore whether an Energiebank (energy bank) can be set up with financial partners to help people pay their energy bills. Zonbank Amsterdam can be seen as putting that concept into practice: rather than financial compensation after the event, it is a physical measure that helps households make lasting savings on their energy costs.

The pilot project in Hoptille was funded from the budget of the City of Amsterdam's Programme Zon team, with a contribution from the CNCA Game Changer Fund.

Additional funding was needed to scale up.
On 25 November 2025, the City Council decided to make € 1,500,000 available to Zonbank Amsterdam from the municipal Klimaatfonds. On 17 March 2026, the College of Mayor and Alderpersons decided to make a further € 414,000 of SPUK funding available for installing electric boilers. These boilers are installed in households where this is technically possible. They are only installed in combination with used solar panels. That way, a larger share of the electricity generated can be used directly in the home.

To make use of the money from the Klimaatfonds, the City drew up the Used Solar Panels on Amsterdam Housing Association Roofs subsidy scheme. The College approved this scheme on 19 May 2026. From that point on, housing associations could apply for the subsidy. The scheme is open up to and including 31 December 2027.

The subsidy from the Klimaatfonds covers the cost of the solar panels. Tenants do not pay service charges for the solar panels. As a result, they will still have lower energy costs after the net-metering scheme is abolished. The housing associations do, however, pay € 32.50 per solar panel to the reuse chain. They are also responsible for monitoring and maintaining the panels.

6.3 Outreach and communication approach: build on personal contacts

In Hoptille, about 50% of households ultimately chose to take part. This was despite clear information, a personal approach and several rounds of contact. Conversations with residents revealed that some of them remained suspicious of the free offer from the City and Ymere. They wondered why the panels were free.

Outreach clearly requires more than just a letter. Residents may have questions or doubts, especially when free solar panels are on offer. It is important to build on contacts in the neighbourhood. Examples include the housing association, resident liaison officers, energy coaches, neighbourhood teams or other organisations that know the residents. They can explain the offer and pass on residents' feedback to the project team.

Personal contact works better

A letter may be needed to explain the offer formally, but it is usually not enough to convince residents. Door-to-door visits, phone calls or conversations at existing drop-in sessions often work better than large meetings. Residents can then ask their questions in a calm, unhurried conversation. A large information meeting does not always work well. A single critical or negative question or comment can set a negative tone for the whole group.

In Hoptille, the project therefore joined an existing neighbourhood information fair run by Ymere. Instead of organising a separate information evening about solar panels, the project team had its own stand there. This made the offer more accessible and gave residents the opportunity to ask questions when it suited them.

It is important that communication is clear and honest. Tell residents what they can expect, but do not promise too much about what they will save on their energy bills. Being clear about what is not yet certain is precisely what builds trust. The key message is that residents do not have to pay anything for the solar panels and will not face any extra service charges. They can, however, save money by using the electricity directly at home.

It is also important that residents can choose for themselves whether to take part. They also need to know that they can have the panels removed later if they wish. This makes it easier to take part, especially for residents who are hesitant or who have heard negative stories about solar panels.

Arranging quality assurance

The subsidy scheme ensures good quality in two ways:

- The used panels are checked by a certified company. This company assesses whether the panels are suitable for safe reuse.
- The quotes must show that the panels will be installed by a professional installer.

The solar panels from the reuse chain are cleaned, checked for micro-cracks and tested for their power output. Once approved, the panels can be safely reinstalled.

6.4 Monitoring and maintenance

Monitoring and maintenance are needed to check that installations continue to work properly and to detect faults in good time. The subsidy scheme does not prescribe a detailed monitoring model, but applicants must include a brief description of monitoring, resident communication and participation. The additional costs of monitoring, maintenance and aftercare are not included in the fixed subsidy amounts. The applicant must organise this themselves. During the pilot period, monitoring and maintenance cost € 30 per year per installation.

It is important to distinguish between technical monitoring and residents' consumption data. The installer can track how much the installation generates to check that the system is working properly. Data on residents' electricity consumption is privacy-sensitive. Residents must give their consent for this data to be used. At the same time, information about generation, consumption and savings can help residents. A simple app or monitor can show how much benefit the panels provide. Making this visible can encourage residents to use more solar power.

The Balkoncentrales (balcony solar systems) pilot project opted to install a HomeWizard meter. This allows residents to see their current generation and electricity consumption directly on a small screen. In the Hoptille pilot project, residents get access to an app from the installer that shows their generation and consumption day by day.

7. Residents' views



A researcher from CML Leiden spoke to people from 11 households. They had been offered used solar panels. Three households took part in the balcony solar pilot in Amsterdam-West. Six households had solar panels installed on their roofs in the Hoptille pilot project in Amsterdam-Zuidoost. Two households in Hoptille that had deliberately chosen not to have solar panels were also interviewed. As the number of interviews is small, the results should be seen mainly as a first impression. They show what residents experience and what they are concerned about.

7.1 High energy costs are the main motivation

All the residents interviewed have high energy bills. Since the Russian invasion of Ukraine and the rise in energy prices, more households have been paying close attention to their energy consumption. The main reason for getting solar panels was the expected saving on the energy bill.

Knowledge of energy use and energy saving varied widely from resident to resident. Not everyone knew how much solar panels can save, what feeding electricity into the grid means or which other measures sometimes deliver more. One resident who lived alone set the heating to 25 degrees all day in winter. His gas use cost about € 8 a day. Although energy coaches had visited him before, it remained difficult to get across that smarter heating saves more than the solar panels on his balcony. This example shows how important it is to explain things in person. It is important to explain that installing solar panels is part of a broader approach to saving energy.

7.2 Residents are positive about used solar panels

The project made residents with solar panels more involved in the energy transition. One resident said: 'It makes sense to use the sun for free electricity. Why would you burn coal?'

None of the interviewees minded that the solar panels had been used before. Two households actually preferred used panels, because reuse is less harmful to the environment. One resident compared her panels with a project in another municipality. New panels, which she considered better, had been installed there. Even so, she too was satisfied with the free installation.

For most households, saving money was more important than the climate benefit. Some residents did not fully understand what solar panels meant for them, or considered this less important. For this target group, a clear, reliable message about the energy bill works best.

Concerns about safety and costs

One resident did not want solar panels installed because he was afraid of the fire risk. There was also distrust because of reports about high feed-in charges. Such concerns must be taken seriously and discussed during the outreach phase. Solar panels do not benefit every household equally. In particular, residents who live alone and use little electricity sometimes save very little. That is why it is important to check in advance whether the solar panels will really benefit each household.

Personal explanation works, but aftercare is still needed
In Hoptille, residents received a personal explanation before the installation. The housing association and the installer worked together on this. All the residents interviewed liked this approach, but five of the six households with solar panels also said that they received too little help after the installation.

Residents wanted to know how the installation works, how to monitor it, how to read the output and how to use electricity smartly. They had been promised an app from the installer, but it was not yet available at the time of the interviews. Many residents found the energy suppliers' apps difficult to use. Graphs showing consumption, generation and electricity fed into the grid were hard to understand.

In a few households, the researcher had to explain again how solar panels can lower the energy bill. Some residents continued to have doubts because of negative reports about feeding electricity into the grid and about service charges. This shows that explaining things once is not enough. Good aftercare, in the form of simple tools and a dedicated point of contact, should be available immediately after installation.

Outreach: small groups or a large group meeting?

During outreach in Hoptille, the project had a stand at an information fair. Residents received information in small groups and could ask questions. One resident suggested giving the explanation to everyone at the same time instead. That way, they would all get the same information. Residents would then not have to answer their neighbours' questions afterwards.

The housing association deliberately chose smaller groups. Previous experience had shown that one or two critical residents tended to dominate larger meetings. As a result, incorrect information and negativity could spread quickly. Conversations with one or a few residents leave more room for personal questions and make it easier to address concerns.

Do solar panels make residents more energy-conscious?
The interviews show that residents think more about their energy consumption after taking part. Two households bought a small electric hob. They mainly use it in the afternoon, when the solar panels are generating electricity.



They often cooked at that time anyway, but now they do so more deliberately to save money.

In the balcony solar pilot, residents were also given a HomeWizard meter to see in real time how much electricity they use and what the solar panels' output is. The device also showed them how much electricity appliances such as old incandescent bulbs or plasma TVs use. Clear information helps residents find even more ways to save energy. Taken together, small changes to the home and to behaviour sometimes save more than the solar panels alone.

7.3 Key lesson

The conversations show that solar panels do more than just save money. They also offer a good opportunity to talk to residents about their energy consumption and ways to save energy.

Their main added value appears to go beyond the electricity they generate. Combining the installation with personal explanation and good aftercare gives residents a better understanding of, and more control over, their energy bills. The pilot projects show that residents need clear explanations. They want to know what the solar panels will and will not deliver, and which other measures can help them save even more in their situation.

Appendix

Reducing CO_2 with used solar panels



Used solar panels can generate sustainable electricity again. This helps reduce CO_2 emissions. Because the panels have already been made, the CO_2 emissions from their original production are not counted again. The calculation answers two questions:

- What is the CO_2 footprint of reusing the system?
- How much CO_2 does the solar power generated by the system avoid?

The CO_2 calculation tool draws on previous research by the AMS Institute and CML Leiden. That research looks at the climate impact of using solar panels for longer. The tool was then developed further for project-level calculations and uses up-to-date EPD data for the relevant system components.

How the calculation works

The tool first calculates the CO_2 emissions of the system. For used solar panels, the emissions from production do not count again, but the emissions caused by reusing the system do. These include transport, installation and additional components, such as inverters, mounting materials and cables.

To calculate the CO_2 emissions of components, the tool uses EPDs (Environmental Product Declarations). These declarations record the environmental impact of a product in a standardised way. Where available, EPD data is used for all components of the system.

The tool then calculates how much electricity the system is expected to generate during its use phase. This takes into account the estimated generation in the first year, the service life and the annual degradation of the panels.

Next, it calculates how much CO_2 is avoided because this solar power replaces other electricity production. This is based on the marginal electricity mix: the electricity production that additional solar power displaces in practice. This electricity mix is expected to become increasingly clean. The tool therefore follows the approach of the VEKI scheme and uses an emission factor for electricity that moves towards fossil-free by 2040. The CO_2 reduction therefore depends on the year in which the solar power is generated: electricity generated earlier avoids more CO_2 than electricity generated in later years.
Net CO_2 reduction = CO_2 emissions avoided by solar power - CO_2 footprint of the system

What the result shows

The result shows how much climate benefit a project with used solar panels is likely to deliver. The tool can also compare the project with an alternative scenario, such as an installation with new solar panels. This shows, for each project, which option delivers the greatest CO_2 benefit: used or new panels.

The calculation tool provides a well-founded estimate for the project. The result depends on the data entered. Examples include output, remaining service life and the system components chosen.

Would you like to know how much CO_2 your project saves?

Would you like to know what your solar panel project means for CO_2 emissions? Or would you like to know which option will deliver the greatest CO_2 benefit in your situation?

If so, please contact Stichting ZonNext. They will be happy to discuss your project with you. Using the CO_2 calculation tool, they can show you how much CO_2 your project is likely to save.

Colophon

This report was prepared by Programme Zon, Energy Department, City of Amsterdam. The content is based on lessons from pilot projects, conversations with residents, data analyses and knowledge sharing with partners from the reuse chain, housing associations, installers and research institutions.

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