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Solar Powers Heat & EVs 2023 *Case Studies*

How solar electrification of home heating and transportation empowers EU citizens to turn down fossil gas and save on energy bills

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Foreword

Welcome to the stories behind our *Solar Powers Heat Report 2023*.

In the wake of another extreme summer for European weather, the next heating season seems far away. Droughts and fires persist, and severe floodings and the world's hottest July are not far behind us. The continent might be tempted to see winter as a relief. Even more as retail energy prices have come down significantly from the 2022 energy crises' peaks. But winter can bring its own set of challenges. Retail gas prices are still about twice as high as they were at the beginning of 2021. And although Europe seems much better prepared, nobody knows what this winter will bring – especially since winter 2022/23 was so mild.

What we do know is that citizens owning a solar PV system in combination with electric heating and transport solutions fared very well during the 2022 energy crises. Published in March, our *Solar Powers Heat Report 2023* modelled that those having a medium-size residential PV system in Germany, Spain or Italy, could save up to 64% on their energy bills last year. If they had owned both a solar PV system and a heat pump, their energy expenses would have decreased by up to 84%. The good news continues: the solar PV + heat pump dream team offers protection in all electricity price scenarios going forward.

This publication complements March's report, providing 10 case studies from actual homes, across six European countries. In bringing the numbers to life, this paper demonstrates that solar electrification of home energy needs is the way to save considerably on a family's energy bill. While different in size and design, depending on individual needs and geographic and policy framework conditions, the examples prove that solar electrification of heat and power works very well across the continent, even in northern European countries. One Norwegian family shows us what's possible – their solar PV + heat pump generates more energy at home than needed over the year. Beyond the single stories, we also see the common theme: people are not just happy to have a higher level of energy security at a lower cost. They're also celebrating the feeling of turning their back on fossil fuels.

However, as our modelling and market research shows, there is still some work to do to make these positive stories the reality for all European homes. Europe needs stable policy, solid incentive conditions, and strong, clear communication to truly and rapidly unleash solar home electrification of heat and transportation.

Enjoy exploring these solar-powered residential heat and transport case studies,

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Abbreviations: Solar Photovoltaic = PV; Heat pump = HP; Battery Energy Storage System = BESS; Electric Vehicle = EV.

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Case 1: PV + HP + EVs

Wuppertal, Germany

Source: Vaillant

The Krüger family built a sustainable home with a compact heat pump installation and electric vehicle charging.

Christian and Nadine Krüger built a well-insulated house in 2018 for themselves and their two small children. They decided to include an air-to-water heat pump for both heating and cooling. In 2020, they invested in solar PV to significantly reduce their energy bill for power, heat, and mobility.

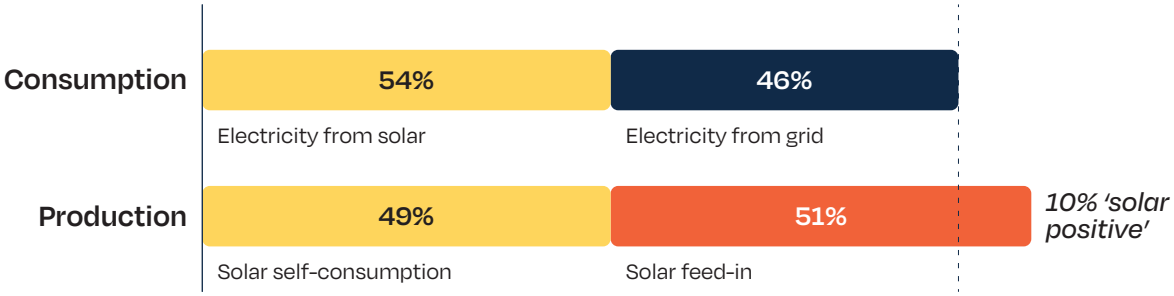
With their 7 kW heat pump, their total electricity demand was around 9.24 MWh in 2022. By investing in a 9 kW PV system, the family produced around 10% more power than they needed that year. A significant independence ratio of 54% could be reached without battery storage by smart steering of electricity demand. Additionally, the heat pump can provide cooling on hot days, where the produced solar electricity matches demand most of the time. Besides this, the family has two electric vehicles which they partially charge at home. In total, the PV system produces 10.13 MWh of which they could feed in 5.13 MWh in 2022 as another source of income.

While prioritising sustainability in the building of their home, the family also paid attention to effective use of space. In doing so, they opted for a Vaillant installation for both warm water and ventilation. The solution requires less than 2m² of space and suited their plan to avoid building a basement. Thanks to 20cm reinforced concrete floor slabs with 10cm insulation, a 225-litre large water tank could be installed - big enough to meet their heating needs.

The **Krügers produce nearly**
10% more solar electricity
than they need to supply their power requirements at home.

For the installation of the heat pump, the family received around €5,000 in government support, which covered one third of the total costs. However, they did not receive subsidies for the installation of their PV system. Adding the cost of both installations, the simplified payback term (without discounting) is 16.5 years without subsidies, and 14 years with financial support.

Case 1



Technical information

Project	PV + HP for single family household
Living space	220m²
Heat pump	7 kW
PV capacity	9 kW
PV production per year	10,130 kWh
Electricity consumption	9,240 kWh
Electric vehicle	2 x type undisclosed

Financial information

Total PV costs gross (incl. installation) (2020)	€18,000
Total costs HP gross (incl. installation) (2018)	€15,000
Total cost air conditioning gross (incl. installation)	No need, cooling included in HP installation
Total public support	€5,000
Estimated savings per year	€2,000

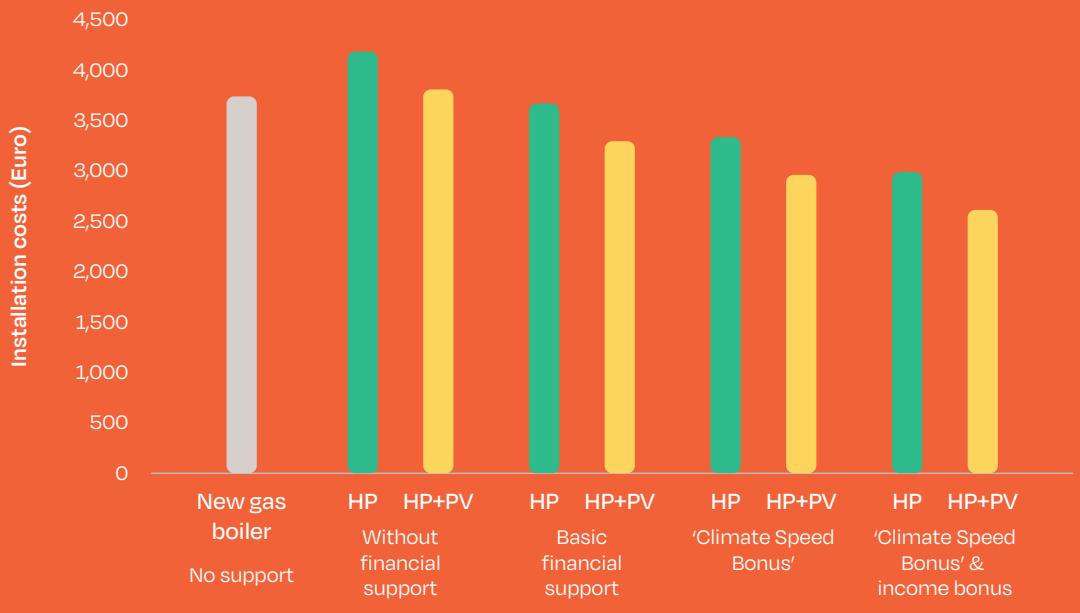
Did you know?

A recent study by WWF Germany and Prognos AG showed even for the 20% worst energy-efficient houses, a heat pump installation can reduce energy spending by €400 annually. If this installation is combined with a solar PV system, savings can almost triple.[1]

Solar PV and heat pumps make a dream team. According to SolarPower Europe's latest *Solar Powers Heat report*, in Germany, a typical household can save 67% more with an air-to-water heat pump and solar PV compared to solar PV alone. In Spain and Italy, these savings can be almost 50% more! [2]

For a more detailed view on the business case of solar PV and electrified heating/cooling, as well as a detailed description of the methodology used, visit the *Solar Powers Heat Report*.

AVERAGE ANNUAL COSTS OVER DIFFERENT INCENTIVES



1 https://www.wwf.de/2023/august/der-hammer-heizungs-deal

2 https://www.solarpowereurope.org/insights/thematic-reports/solar-powers-heat-2023-2

Case 2: PV + HP + EV + BESS

Brandenburg, Germany. *Source: Solarwatt*

The Richter family shows you do not need to build a new house to save money and meet today's energy standards.

When the Richter family bought their dream house in Southern Brandenburg, Germany, it became clear that an upgrade was necessary. The house was built in 1982 and renovated in 1994, but it did not meet today's energy standards. This is why they decided to invest and renovate the building, enabling them to save energy. By combining a solar PV system with battery storage, an electric vehicle, and an air-to-water heat pump, the family has significantly lowered their carbon footprint while reducing their energy bill between €3,400 and €4,000 annually. The family opted for a total technology solution from European solar module and BESS manufacturer Solarwatt.

Realising their electricity usage would ramp up through electrification of heat and transportation at home, the family of three invested in a solar PV system of 19.3 kW with a battery storage system above 19 kWh. Around 75% of the 2022 electricity needs of 23,000 kWh was generated with their own solar system (17,250 kWh). Using a smart energy management system, around 53% of the produced electricity ends up being used for water heating and transportation, the rest of 47% is injected in the public grid for a fixed feed-in tariff.

The family has **significantly lowered their carbon footprint** while reducing their energy bill between **€3,400 and €4,000** annually.

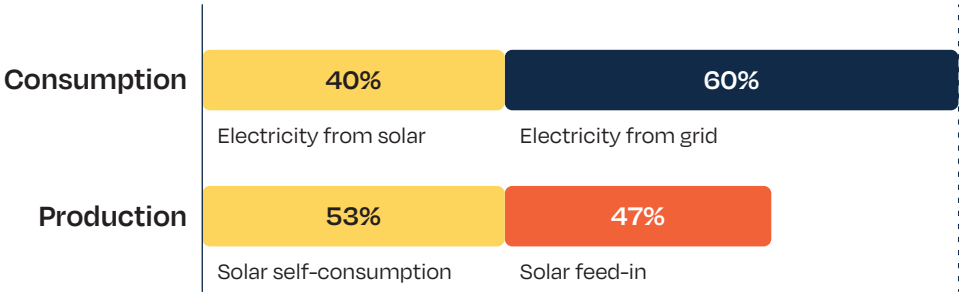
With their heat pump of 12.8 kW, the family can meet the heating needs of their 320m2 house. In doing so, they replaced their annual consumption of 3,500 liters of oil (equal to about 35,000 kWh) with 11,500 kWh of electricity consumption. This is about half of their annual energy demand. Now, the family saves around €1,350 per year compared to oil heating.

The total cost linked to the electric heating system alone was almost €37,000. The family could count on a subsidy of nearly 50% (45% for the replacement of the oil system, and 5% for the creation of a roadmap related to the refurbishment of their energy system). The total heating system cost ended up being around €18,475.

Case 2

A large part of the remaining electricity consumption is linked to charging their electric vehicle. Using a smart energy management device, the family can significantly lower the cost of charging. It is estimated that the cost can be as little as €5 per 100km.

The case of the Richter family clearly shows electrified heating can find its place in the older building stock. If the heat pump is subsidised, like in this example, the investment should be amortised in 16 years.



Technical information

Project	PV + HP + EV + BESS for single family household
Living space	326m²
Heat pump	12.8 kW
PV capacity	19.3 kW
BESS capacity	>19 kWh
PV production per year	17,250 kWh
Electricity consumption	23,000 kWh
Self-consumption ratio	53%
Electric vehicle	Type undisclosed

Financial information

Total costs HP gross (incl. installation)	€36,950
Total public support	€18,475
Estimated savings per year	€3,400 – 4,000

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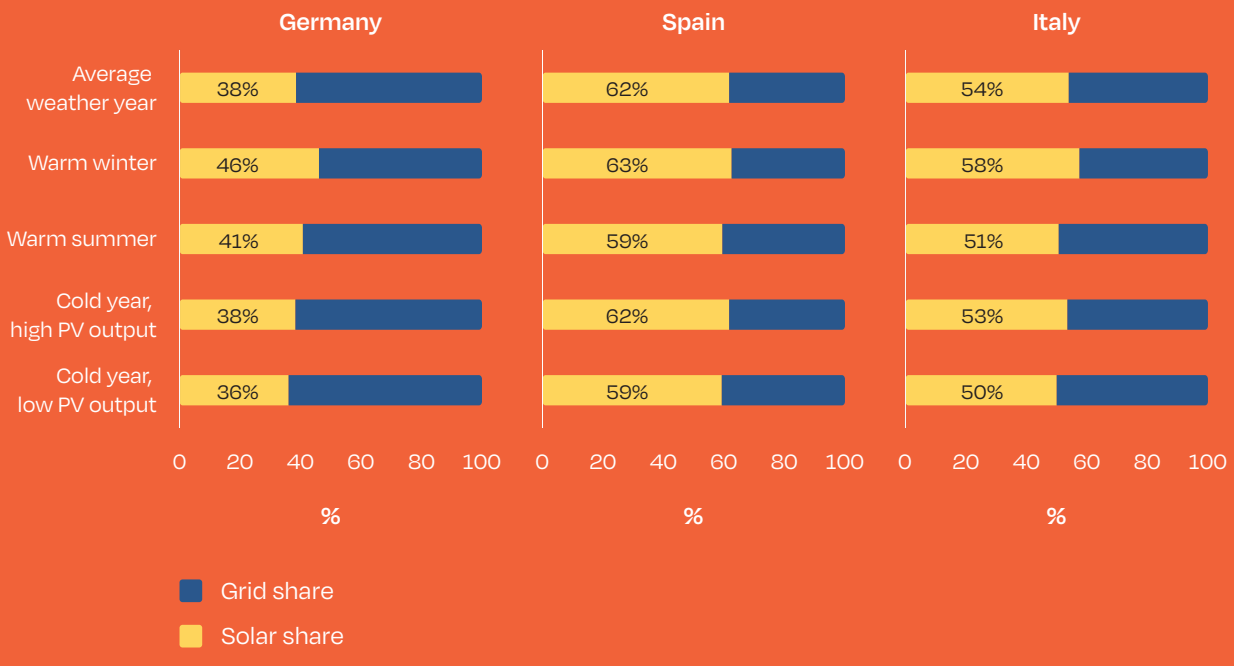
Did you know?

Solar PV can cover a significant part of the power demand of a heat pump over the course of a year, regardless of the climatic conditions. In Spain for example, solar electricity can cover nearly two thirds of the power demand of an average air-to-water heat pump yearly. In Italy, on average, at least 50% of the power needs can be covered even in cold winters. Less sunny countries like Germany still achieve between 36% and 46%. This is because the water can be heated when the sun is shining, and slowly release this heat as needed throughout the night.[3]

SHARE OF HEAT PUMP ELECTRICITY DEMAND COVERED BY SOLAR PV GENERATION, IN GERMANY, SPAIN, AND ITALY



3 https://www.solarpowereurope.org/insights/thematic-reports/solar-powers-heat-2023-2

"I am proud to say that my gas consumption is now zero. I am no longer panicking about how high my next gas bill will be, especially in winter."

Case 3: PV + HP

Madrid, Spain

Source: Natural Home

Saving money and gas: This Spanish eight-person household no longer needs gas, cutting their energy costs.

An eight-person household in Madrid saw their gas bills steadily rise during the energy crisis and decided to invest in an electric solution to provide power and heat. They opted for a 9.66 kW solar PV system in combination with a 15 kW heat pump, which makes them fully independent from gas, saving them a significant sum annually. The system was installed in early December 2022.

Before the installation, their electricity consumption was 23,720 kWh and their gas consumption 56,920 kWh. Now, the house is fully heated without fossil fuels, and all their needs are fulfilled with 37,950 kWh of electricity alone. This is less than 60% additional electricity demand for a 100% reduction in gas consumption. The new, higher demand is for a large part covered by their solar PV installation that heats the 300-litre hot water tank during the day. From December 2022 until February 2023, they were able to consume 79% of the electricity produced by PV directly. This covered more than a fourth (27%) of their new, higher electricity needs.

Now, the house is fully heated **without fossil fuels**, and all their needs are fulfilled with 37,950 kWh of electricity alone. This is less than **60% additional electricity demand for a 100% reduction in gas consumption**.

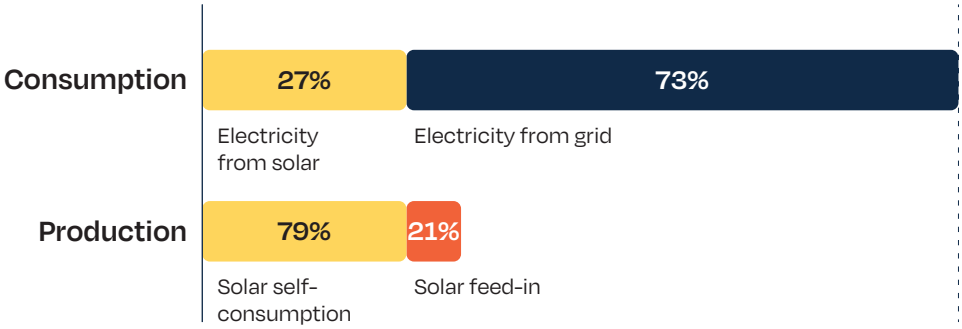
The household is rewarded for their contribution to Spain's energy transition. In total, the installation of the system cost €30,269, but the family was able to get 29% of that amount paid for with public funding. Moreover, they will be able to deduct a significant part of the costs from this year's taxes. While the system was installed after the price peak of the 2022 energy crisis, the household was still able to capture significant savings on their energy bills. After the first two months of using the system, the estimated annual savings will be around €4,830 for 2023. With prudent energy price evolution assumptions, this would result in a simplified payback period (without discounting) of 5-7 years.

Case 3


© Natural Home


© Natural Home

"Photovoltaic solar panels are not a nuisance at all, so why not take advantage of the amount of energy from the sun on my roof, especially in Spain? Besides, I like my panels to be visible from the street. It's a way of telling my neighbours that I take protecting the environment seriously."



Technical information

Project	PV + HP for the heating of an 8-person household
Living space	-
Heat pump	15 kW
PV capacity	9.66 kW
PV production per year	13,050 kWh
Electricity consumption	37,950 kWh
Self-consumption ratio	79%

Financial information

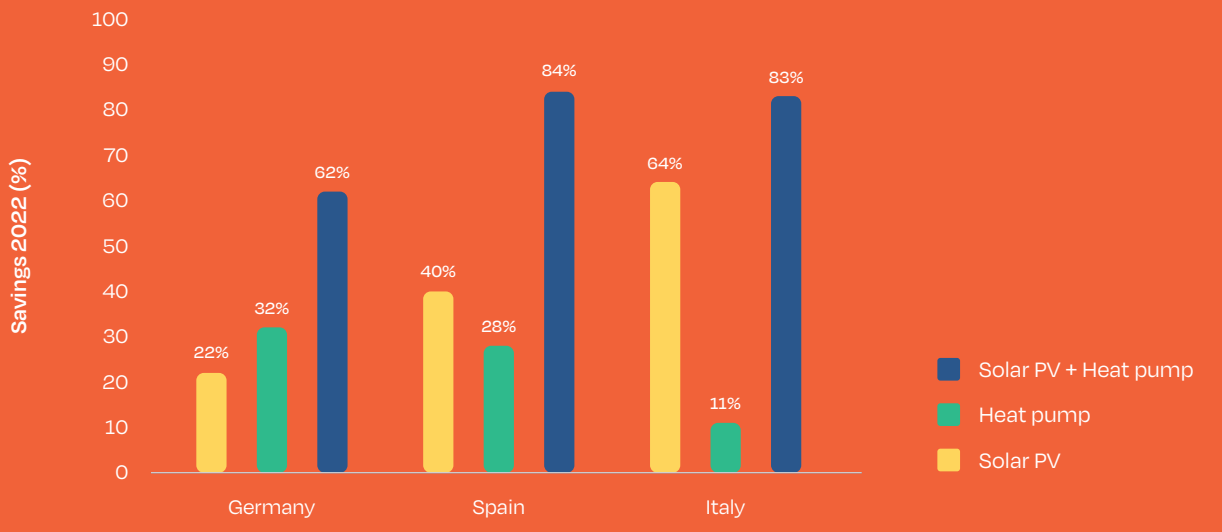
Total PV costs gross (incl. installation) (2022)	€13,970
Total HP costs gross (incl. installation) (2022)	€16,299
Total public support	600 €/kW PV = €5,796 HP = €3,000 Total = €8,796
Estimated savings per year (after first two months of use, Jan 23 & Feb 23)	Savings per year = €4,381

Did you know?

During the energy crisis of 2022, having a solar PV system decreased power costs significantly. Having a heat pump installed also reduced spendings. But combining a heat pump with solar electricity had by far the largest impact on reducing energy expenses, as shown in the *Solar Powers Heat Report*.

German households who operated a typical size solar system at home were able to cut costs by 22%, while homes with an air-to-water heat pump saved aproximately 32% on their energy bills in 2022. In Italy and Spain, households saved relatively less with heat pumps, 28% and 11%, respectively. The reasons are clear: on average, heating demand is much higher in Germany than in Spain and Italy. Additionally, Italian households were burdened with the highest electricity prices amongst the three countries in 2022, which resulted in lower savings. However, in all three countries, solar PV unleashed the full savings potential of heat pumps: the solar-heat pump dream team reduced energy expenses by around 62% in Germany and between 83-84% in Italy and Spain.[4]

ANNUAL SAVINGS IN EUROS OF HOUSEHOLDS WITH DIFFERENT POWER & HEATING TECHNOLOGIES IN GERMANY, ITALY, SPAIN IN 2022



4 https://www.solarpowereurope.org/insights/thematic-reports/solar-powers-heat-2023-2

Case 4: PV + HP

Vercelli, Italy

Source: AREA & Centro Studi Galileo

How even a small solar PV and heat pump system has a significant positive impact on an Italian family’s energy bills.

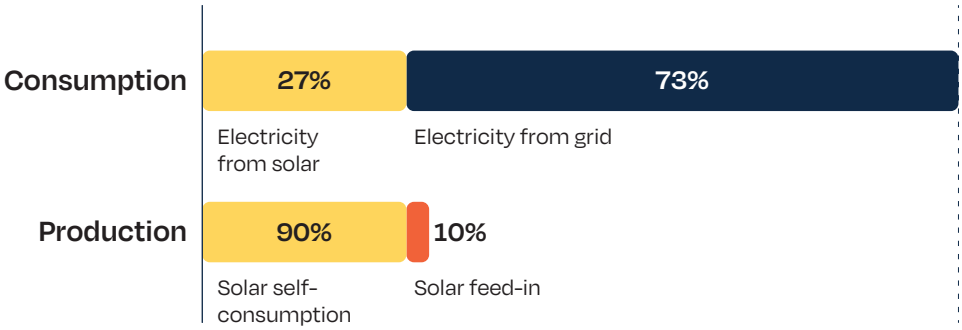
A family of five in Vercelli, Italy, decided on complementing their existing 11-year-old PV system with a heat pump in 2022. In doing so, they completely removed the need for fossil gas to heat their home, lowering their gas expenses by 90%. They were rewarded with significant savings on their energy bills. Additionally, they were able to receive €15,000 in public support, representing more than 70% of their investment. In general, the family actively tries to optimise their energy usage and has recently subscribed to a green electricity supplier.

Their 3 kW PV system produces around 3,300 kWh per year. Monthly, it can cover up almost 30% of the household’s electricity needs. It is estimated that 90% of the electricity is used in-house. By early 2023, the estimated reduction in energy bills already accumulated to at least €2,000, and the family is expecting significant savings to continue. Their quick response to the energy price crisis has resulted in a quick repayment of their initial investment. In early 2023, their energy bills have more than halved compared to 2022.

They **removed** the need of **fossil gas** for space heating entirely, **lowering their gas expenses by 90%.**

Case 4

"Our annual gas expenditure before the crisis was around €900, and following the crisis, this would have become at least €2,100. … Currently, we only pay roughly €100 per year."



Technical information

Project	PV + Heat pump in Italy
Living space	125m²
Heat pump	10 kW
PV capacity	3 kW
PV production per year	3,300 kWh
Electricity consumption	11,000 kWh
Self-consumption ratio	+/- 90%

Financial information

Total PV costs gross (incl. installation) (2011)	€9,500
Total costs HP gross (incl. installation) (2022)	€9,500
Total boiler costs gross (incl. installation)	€2,500
Total public support	€15,000

"The only limitation is the size of my roof; I consume nearly 100% of my produced solar electricity myself."

Case 5: PV + HP + EV

Flanders, Belgium

Source: AVERE

Philippe complemented his solar installation with an electric vehicle and heat pump to see his self-consumption skyrocket.

About eleven years ago, Philippe bought a house in Flanders, Belgium that needed a complete renovation. The foundations of the house, build in 1969, were good, and no major structural changes were foreseen. With his background in electronics, he was able to make some specific changes for which he sees the benefits daily. To lower his energy and transportation costs, a 7 kW solar PV system was installed, combined with an air-to-water heat pump, and electric vehicle.

There are many ways to make a house more energy efficient. Philippe started by installing home automation systems. Although he prioritised this, the family also renewed their insulation and windows to match today's energy efficiency standards.

Philippe's career switch to the e-mobility sector made him eager to invest in one himself. In doing so, he replaced his €125 fuel bill with a €35 electricity cost.

"It requires combining technical skills and creativity to design and install home automation systems that should be both easy and intuitive. Since I don't have a 9 to 5 job, the heating and light could be controlled through an app as well"

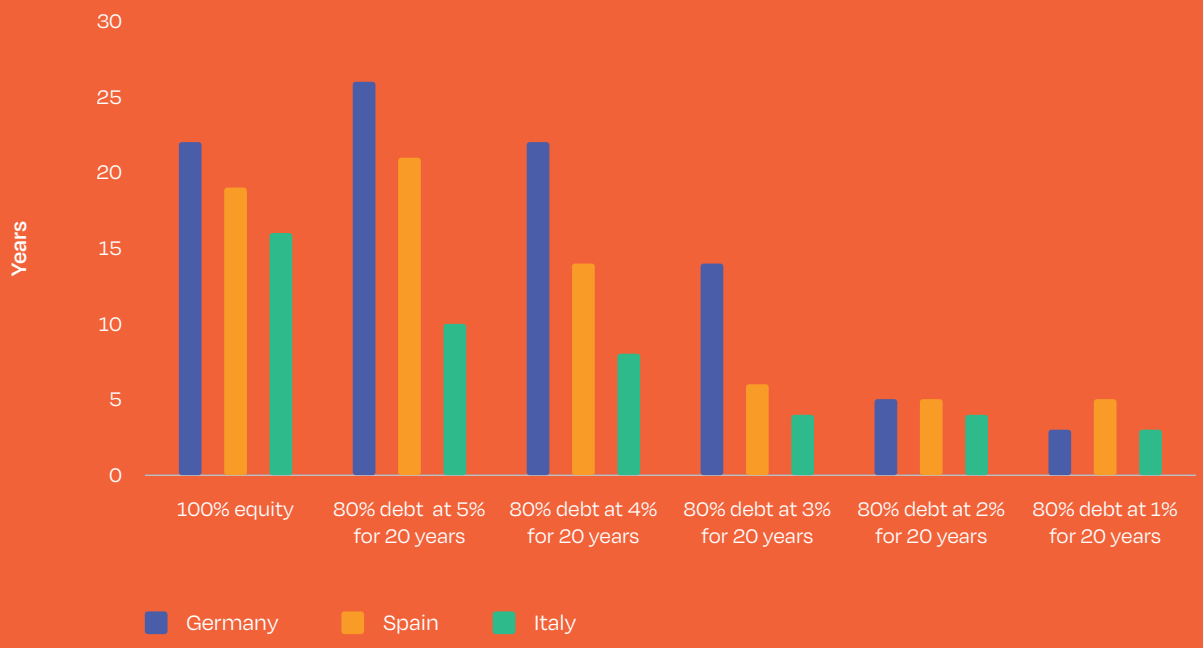
A smart charger makes sure as much solar electricity is used as possible. When overproduction occurs, the car charges automatically. Finally, after comparing options, the family decided to turn in their gas boiler for an air-to-water heat pump with a 200-litre water tank. Thanks to his investments, Phillippe's self-consumption of solar electricity has skyrocketed, and his monthly energy bills plummeted.

Did you know?

Direct subsidies, covering part of capital or operational expenditure, can significantly lower the payback time of sustainable home investments. While the business case can be compelling without these incentives, the high initial investment barrier often hinders low-income households in their efforts to invest in sustainability. Implementing "green loans" at a low interest rate is a key policy for making sustainable home solutions more accessible to lower-income households. These financial products can significantly lower the economic dent of installing solar, heat pumps, and other green technologies, by spreading out the cost over time.

Estimates from Germany, Spain, and Italy show that households who invest in an air-to-water heat pump with solar PV can reach a break-even point 10-15 years earlier if they borrow 80% of the invested capital at 2% interest.[5]

TIME BEFORE BREAK-EVEN IN THE NEW NORMAL SCENARIO



5 https://www.solarpowereurope.org/insights/thematic-reports/solar-powers-heat-2023-2

Case 6: PV + HP + EV

the Netherlands

Source: Solarwatt

The Karramass family are proud of their energy efficient home.

When Mohammed Karramass and his wife decided to build a house for them and their four children, the vision was clear: building an energy efficient home without gas connection. In the Netherlands, new buildings are required to be built without the need for gas since July 2018. Mohammed went for the most obvious solution, a heat pump in combination with a 17 kW solar PV system. Besides this, heat recovery, qualitative insulation, and LED lighting ensure excellent energy efficiency. This leaves sufficient PV-produced electricity to charge two electric vehicles.

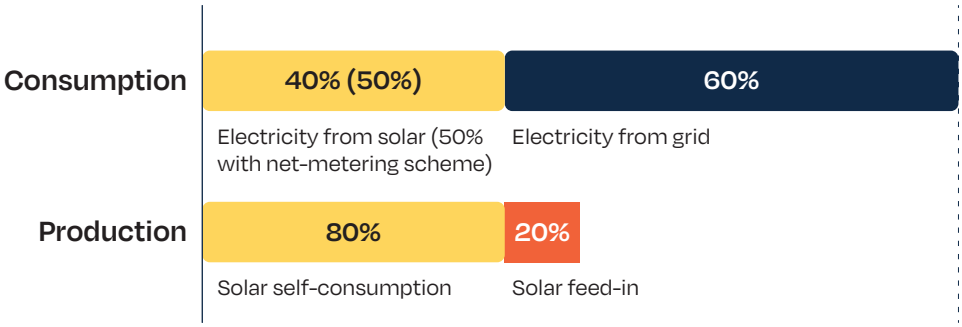
Since the house was built in early 2020, the family was able to largely avoid the negative financial impact of the energy price crisis. Karramass is convinced everyone should invest in making their home more sustainable, claiming people do not have sufficient awareness of the government support available to them. In this instance, the family opted for a "SVn" loan which is a government-backed loan at low interest with no additional costs linked to early remuneration.

For **four months per year**, the Karramass family **produces more electricity than they consume.**

Indeed, the Karramass family is being rewarded for their smart investment. Owners of solar PV installations can rely on a beneficial net-metering scheme. In this case, the family can utilise close to 80% of the produced electricity immediately. The 17 kW system generates about 15,300 kWh annually, which covers close to 50% of their average annual energy consumption (30,750 kWh). For four months per year, the Karramass family produces more electricity than they consume. As they do not have a battery storage system, here the net metering incentive has been helpful.

Case 6

"You can earn back the invested sum quickly by the huge savings on the energy bill. Everyone should look into this, otherwise they are a 'thief of their own wallet."



Technical information

Project	PV + HP + EVs for single family household
Living space	278 m²
Heat pump	Undisclosed
PV capacity	17 kW
PV production per year	15,300 kWh
Electricity consumption	30,750 kWh
Self-consumption ratio	80%
Electric vehicles	Two battery electric vehicles

Case 7: PV + BESS + EVs

Bavaria, Germany. *Source: Fronius*

The Anzi family are energy independent for at least 6 months per year.

Decoupling themselves from fossil fuels as much as possible was a key aim for the Anzi family when they thought about their own house. When Ralf and Antje Anzi finally decided to build their own home in Bavaria, they took solar PV into account by ensuring the optimal orientation and maximising the useable surface of the rooftop. Thinking ahead, the family installed a fairly large rooftop system of 23.76 kW combined with 22 kWh of battery storage. The system meets nearly 100% of their electricity needs for at least half of the year, and significantly reduces their energy bill in the winter months. When interviewed in September 2022, Ralf mentioned they did not have to rely on externally produced electricity for the past 6 months.

In addition to the large PV system, the family relies on electricity for transportation. Ralf Anzi is convinced: "If you assume an average of 20,000 km driven per year, our fuel costs last year would have been about €5,000. With electric mobility, we currently pay only about €350 for the same number of kilometers, and we are also doing our part to reduce carbon emissions." The PV system is set to charge the vehicle when there is excess solar power. However, when Ralf and Antje would like to ensure a charged vehicle at a certain time, the "Next Trip" mode can be used to draw additional power from the grid if needed.

The system meets **nearly 100%** of their electricity needs for at least half of the year.

Due to the family's large, well-oriented PV installation, they generate excess power which can be used for water heating. Using a smart energy management system from Austrian inverter manufacturer Fronius, the amount of power going towards water heating can be automatically regulated. A 300-liter water tank is sufficient to meet the hot water requirements during the evening, without needing to access the battery storage.

Ralf and Antje are happy to do their part in ensuring a more sustainable future for their son, Fabio. They realise the importance of their investment, as well as the position of luxury they are in: "There should be supportive schemes, which enable young families who just built a house to invest in a solar system. In many cases the initial investment is too high even if they know it would save a lot of money over the years."

Case 7

"Since March 2022 – which means for a good six months – we haven't had to purchase any energy from external sources."

Technical information

Project	PV + Electric water heating + EV for single family household
Living space	Undisclosed
Heating system	Undisclosed
PV capacity	23.7 kW
PV production per year	19,000 kWh
Battery storage capacity	22.2 kWh
Electricity consumption	Undisclosed
Self-consumption ratio	Undisclosed
Electric vehicle charging	2 x type undisclosed

Case 8: PV+HP(air-to-air)

Pedro, Spain

Source: AREA & CNI Confederación Instaladores

Pedro demonstrates how air-conditioning and solar PV are a match made in heaven.

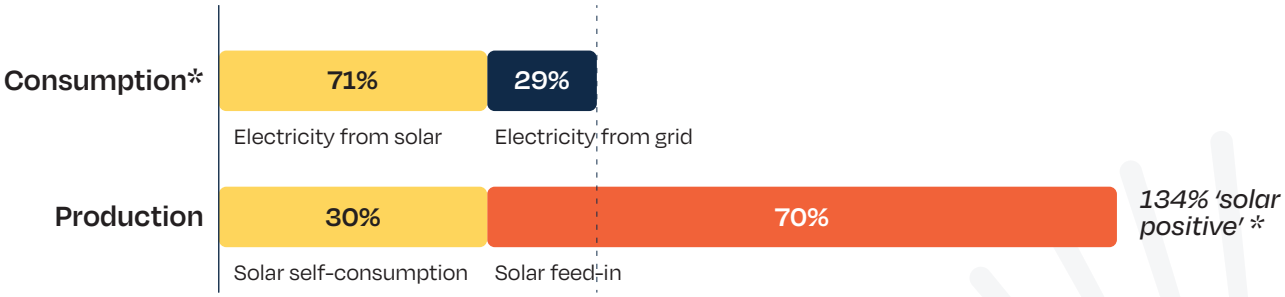
Pedro is part of a three-person family in central Spain. In November 2019, they decided to invest in a 4.27 kW PV system to reduce energy costs at home. Despite the lack of public funding, they made the decision to invest as they felt that leaving their money in the bank, would be "less productive". Without public support, they calculated at the time a payback period for the PV system of 10 to 12 years. The energy crisis in 2022 improved the business case significantly. Depending on how much energy prices normalise, it looks like the family could watch their investment break-even in the next 3 to 5 years.

By optimising their electricity usage, the family estimates it uses 30% of the electricity produced directly. The remaining 70% is fed into the grid and has generated around €450 in revenue over the course of 2022. Following their estimation, they rely on the grid for only 29% of their electricity. As the air conditioning units are also used for heating and in combination with this year's better thermal insulation, the family will decrease their diesel consumption for heating even further. Thanks to these savings, their energy bills were already reduced by €1,456 over the past year.

Depending on how much energy prices normalise, it looks like the family could watch their investment break-even in the **next 3 to 5 years**

Case 8

"In total, the system was priced at €7,600. Over the past 3 years, 35% of this has already been recovered."



*Still using diesel for heating

Technical information

Project	PV + AC + oil heating for family of 3
Living space	160m²
HP (Air-conditioning)	2.6 kW cooling; 3.6 kW heating
PV capacity	4.27 kW
PV production per year	6,800 - 7,000 kWh
Electricity consumption	2,900 kWh
Self-consumption ratio	30%

Financial information

Total PV costs gross (incl. installation) (2019)	€7,600
Total costs AC gross (incl. installation)	Undisclosed - Already installed
Total public support	None
Estimated savings per year	€800 - €1,400 (in 2022)

"Our income from this installation was just under NOK 20,000 (> €1,750) after paying the electricity bills for the winter (2023). This covers municipal taxes, cleaning, and most of the insurance on the house."

Case 9: PV + HP (geothermal)

Norway. *Source: Minenergi.no*

Christoffer not only saved but also earned a lot of money in his warm "plus house" in Norway.

Back in 2021, Christoffer Karlsen and his family moved into their very own "plus house". What happened out of his interest in technology turned out to be a very smart decision. Right before the energy price crisis started, the Karlsen family had 52 solar panels installed on their sustainable home. The large solar PV installation is complemented by a geothermal heat pump. After nearly 2 years (716 days) of using the installation, Christoffer provided an update on his situation.

A "plus house" is defined as a house that produces more energy than it consumes over its entire lifetime, including construction and demolition. The house of the Karlsen family does exactly that. Over the 700+ day lifetime of the house, it has produced 30,800 kWh of electricity, with the family's power demand being 18,630 kWh over that same period. This means, the house was 'solar positive' by 57%. Annually, this equates to roughly 15,700 kWh of electricity produced, of which around 2,700 kWh is consumed directly. The remaining >80% of the electricity is exported. So far, the solar electricity production is estimated to have earned the family around to €2,000 (latest data: NOK 20,000 after past winter).

Around 85% of the Karlsen family's electricity demand is linked to their geothermal heat pump. The heat pump

>80% of the electricity is exported

covers all their heating needs while a fan convector makes sure the heat is quickly spread across the house. Additionally, the same installation cools down the house efficiently in the summer. Although the house is detached, its energy efficiency is remarkable. The house is well insulated, has a smart energy management system, and faces south. Thanks to the floor heating system, the Karlsen family can walk barefooted through their house while requiring less than 10,000 kWh per year. The developer of this project was Flaget. Project leader Torger Terum estimates the additional cost of a "plus house" to be between €20,000 and €25,000 (250,000 NOK). To cover cost of construction, a "green home loan" was used at a favourable interest rate from Sparebanken Øst.

Case 9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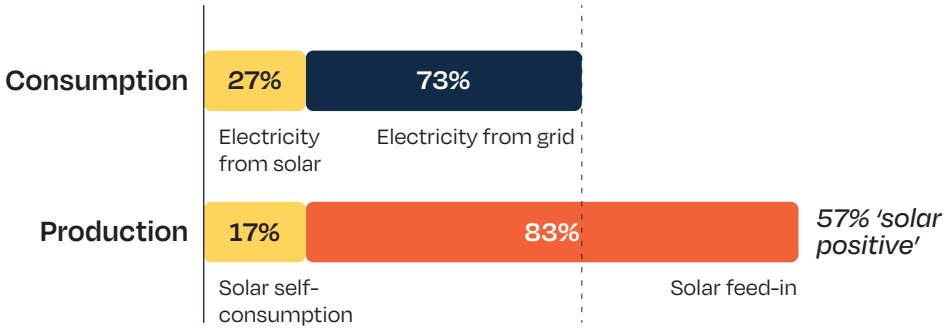


Technical information

Project	PV + HP (Geothermal)
Living space	147m²
Heat pump	6 kW (Geothermal)
PV production per year	+/- 15,700 kWh
Electricity consumption	8,000 – 10,000 kWh
Self-consumption ratio	17%

"In the long-term perspective, the investment in a fully electric house pays of – and it was comfortable from day one."

Case 10: PV + HP (geothermal)

Düsseldorf, Germany. *Source: EHPA*

As a heat pump expert, Thomas Nowak shares his energy efficient house.

In Düsseldorf, Germany, The Nowak family of 6 decided in 2014 to try and limit their energy usage. The ultimate goal was a "plus house" (see definition in Case 9). In aiming for a highly efficient home according to the German energy efficiency standards at that time (kfW-55), they decided to invest in a geothermal heat pump, a ventilation system with heat recovery, and 17 solar PV modules. At the time, there was no significant public support for these installations, making the choice a costly investment. However, the family was motivated by more than economics, and the project went forward as planned. Under the new global energy situation, this decision is paying of nicely.

The choice of a geothermal heat pump was made due to space constraints and the aim to achieve the highest possible efficiency. At the time of construction, geothermal heat pumps still had an efficiency advantage over aerothermal units, but the initial investment was higher.

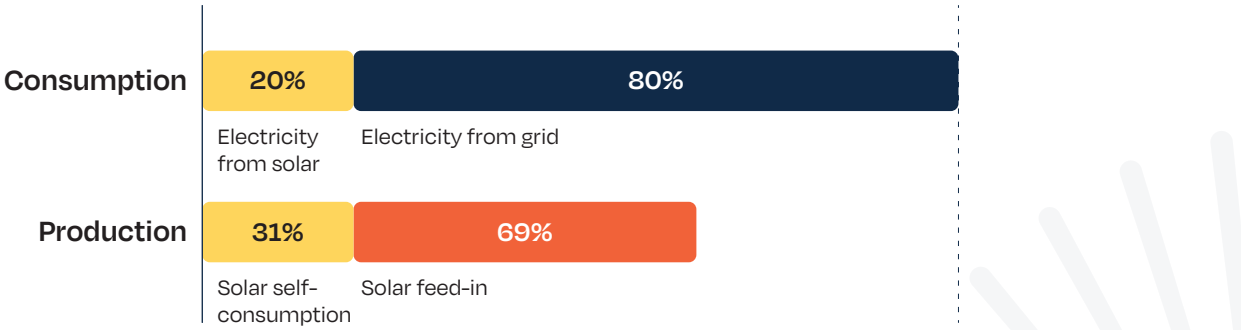
In this case, the total investment in the heat pump was €19,000, of which €5,000 went towards the drilling alone (roughly 1/4th). Thanks to the higher efficiency of both the building and the installation, the household requires only 7,000 kWh of electricity per year. Of this relatively low consumption, 20% is supplied by solar energy which saved around €470 in 2022. Roughly 69% of the electricity produced is fed into the grid, providing them with another €400 annually. It became obvious that maximising self-consumption is economically more attractive than feeding the electricity into the grid, especially with today's high electricity prices. As the roof was not big enough for a larger PV array, the remaining electricity was purchased from the grid, choosing a 100% renewable energy tariff.

Thanks to the higher efficiency of both the building and the installation, the household requires only **7,000 kWh annually.**

To complete the picture, an electric vehicle was added to the set of solutions in 2021, and the decision to replace the gas oven with an induction version was taken in 2022 – without any regret. Cooking with electricity felt as comfortable, and even faster, than cooking with gas.

After nearly 10 years of living in the house, Thomas concludes that the decision taken in 2014 was the right one. The result is a building with high indoor air quality and high thermal comfort, without the disadvantage of CO_2 emissions. In the future, he plans to take a flexible green electricity tariff and make better use of the heat pump's thermal battery (for water storage). Additionally, the PV installation will soon be repowered to increase the capacity on the family's roof. Finally, the addition of an electric battery should increase self-consumption and lower the family's energy bills even further.

Case 10



Technical information

Project	PV + HP for single family household
Living space	250m²
Heat pump	7 kW (Geothermal)
PV capacity	4,6 kW
PV production per year	4,600 kWh
Electricity consumption	7,000 kWh
Self-consumption ratio	31%

Financial information

Total PV costs gross (incl. installation)	€10,277
Total costs HP gross (incl. installation)	€14,000 + €5,000 for drilling
Total public support	None
Estimated savings per year	€400 Feed-in-tariff €420 Savings from self-consumption Total: €820

SolarPower Europe

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