integraTE

Initiative for the dissemination of PVT collectors and heat pumps in the building sector

PVT collectors supply heat pump with solar energy

Highly efficient Heating system

Photo: Consolar GmbH

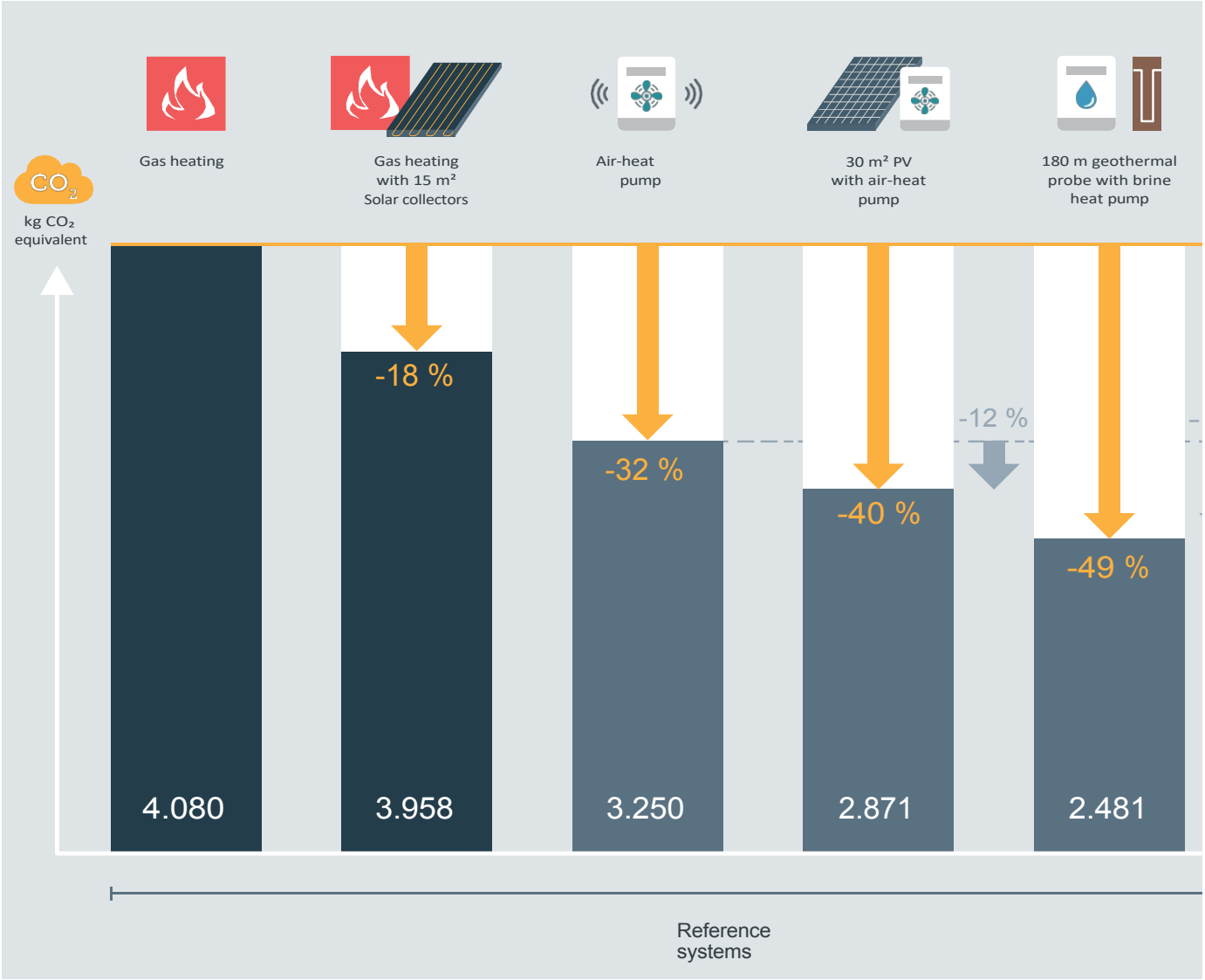
CLIMATE PROTECTION THROUGH PVT HEAT PUMP SYSTEMS

With a PVT heat pump system, CO_2 emissions can be reduced by more than half compared to a gas condensing boiler in an existing detached house. However, CO_2 emissions are also reduced by 25 to 32 % compared to an air heat pump if the house is heated by a brine heat pump with PVT collectors. In order to minimise the use of the electric heating element, the PVT system was designed according to the rule of thumb of 4 m^2 per kW heat pump output.

The simulations of the Institute for Solar Energy Research Hamelin (ISFH) have also shown that a PVT field is sufficient as the sole heat source for the heat pump (second variant from the right). The geothermal probe can be 60 metres shorter if a PVT system i s also available as a heat source for the heat pump and regenerates the ground (first variant from the right).

COMPARISON OF HEATING OPTIONS FOR AN EXISTING DETACHED HOUSE

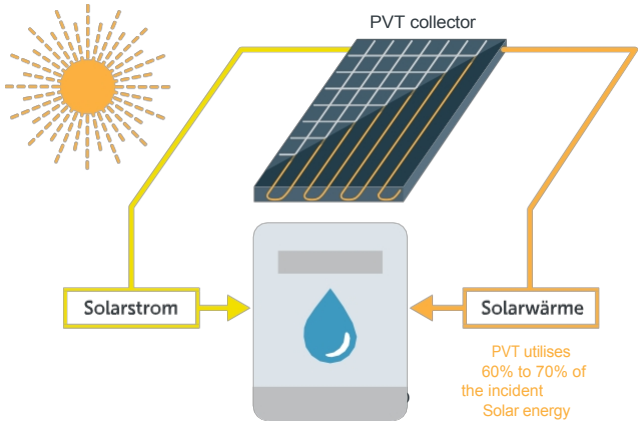
House type: Existing detached house with radiator heating and buffer tank
Heated living space: 140 m^2
Annual heat requirement for heating and hot water: 123 kWh/m^2

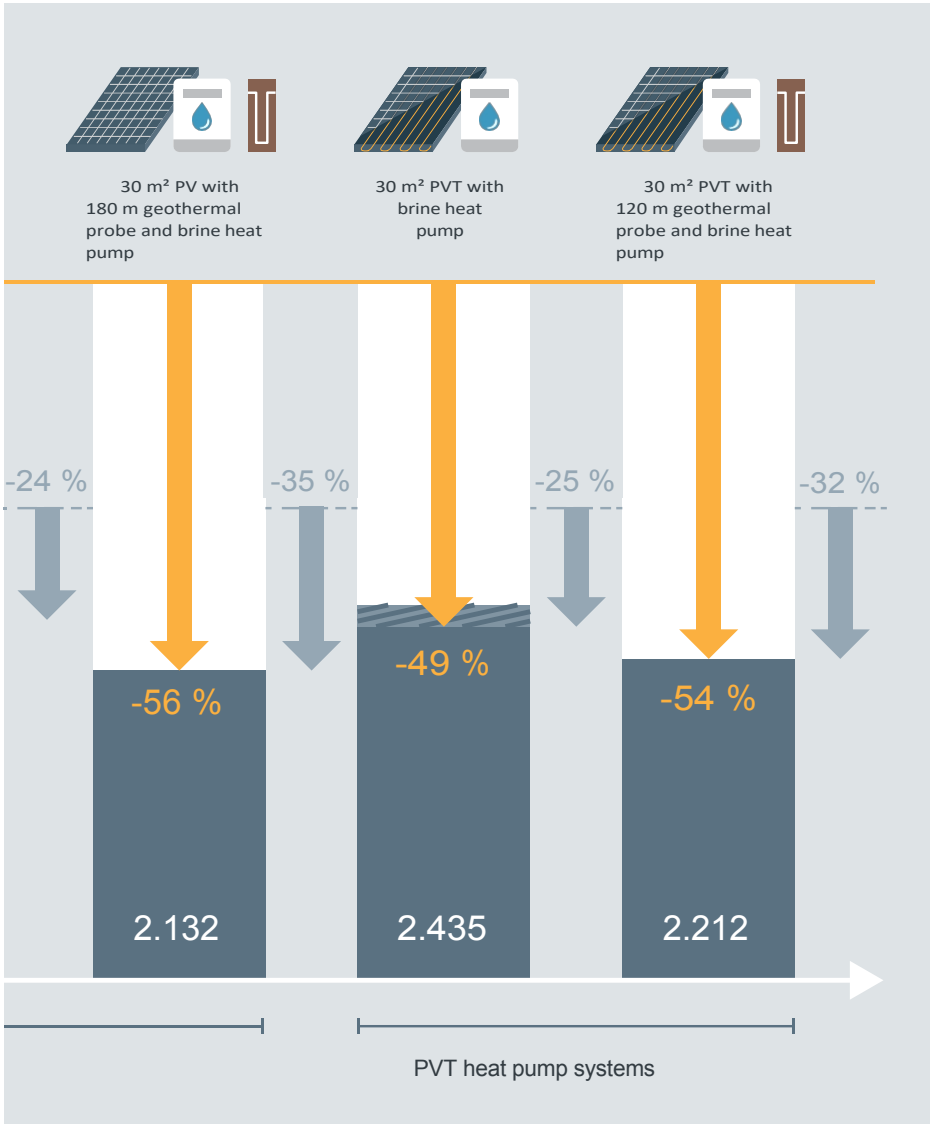


THREE TO FOUR TIMES MORE ENERGY FROM THE ROOF

PV modules alone can only utilise 12 to 15 % of the solar energy radiated in, the most efficient modules up to 20 %. Most of this is lost in the form of heat. PVT elements utilise this energy as well as ambient heat to heat water.

Over the course of a year, PVT collectors produce three to four times more total energy, i.e. heat and electricity, than a PV system on the same area.





kg CO_2equivalent

CO_2savings compared to reference systems

CO_2savings compared to air source heat pump

Range of CO_2savings for various commercially available PVT collectors that serve as the sole heat source for the heat pump.

Emission factors according to GEG (Building Energy Act): Natural gas 0.24 kg CO2-eq/kWh Mains electricity: 0.56 CO2-eq/kWh

The heat pump is operated in such a way that the consumption of the PVT electricity generated at the same time is maximised. The simulations do not take into account the possibility of covering of household electricity through the PVT system and a battery.

Source: Simulations by the Institute for Solar Energy Research Hamelin (ISFH) with DWD data for Würzburg

PVT AS THE SOLE HEAT SOURCE FOR THE HEAT PUMP

Since 2019, a family of five has been heating and cooling their KfW40 Plus house in Harsefeld with a heat pump and PVT system. The wide range of input temperatures of the heat pump from -12 to +30 °C makes it possible to collect heat from the roof via the PVT collector array at almost any time of day or year. The large heat exchanger surface behind the photovoltaic modules provides support here.

Photo: Fraunhofer ISE

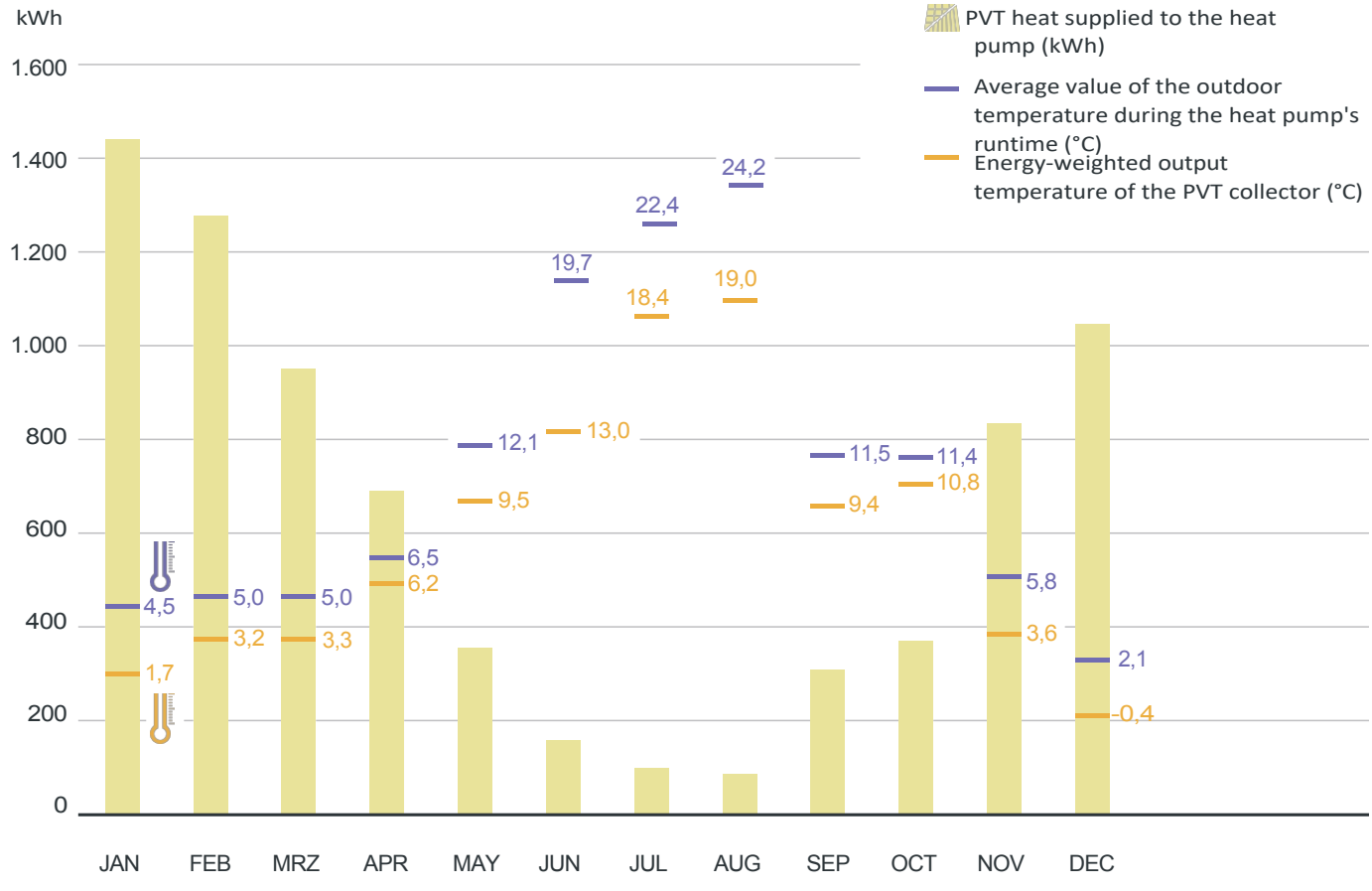
New build detached house

HARSEFELD, LOWER SAXONY

15.9 m(2) (2.88 kW_p)	6 kW
7 kW	190 m²Heating surface

MONTHLY VALUES MEASURED IN 2022 FOR THE PVT SYSTEM OF THE RESIDENTIAL BUILDING IN HARSEFELD

The monthly balance of the PVT system shows the high heat yield that it also provides to the heat pump in the winter months - albeit at consistently single-digit temperatures (data in orange).



OPERATING BALANCE SHEET FOR THE YEAR 2022 IN HARSEFELD

Heat production of the heat pump plus electric heating element per year

$$\frac{9{,}977\ kWh_{th}/a}{2{,}673\ kWh_{el}/a} = 3{,}7\ JAZ$$

Electricity requirement for heat pump and electric heating element

9,977 kWh$_{th}$ /a is supplied by the PVT system to the heat pump and that corresponds to a annual specific yield of 631 kWh/m^2.

The total electricity requirement of the heat pump heating system of 2,673 kW$_h$/a is made up of
79 % for the compressor,
13 % for the pumps and 8 % for the heating element.

Source: IntegraTE measurements from January to December 2022

Like photovoltaic systems, PVT systems with no more than 30 kW are also exempt from of the Federal Ministry of Finance dated 27 February 2023 exempt from value added tax.

PVT COLLECTOR: A pipe register is mounted behind the PV module, through which a heat transfer medium flows. This thermal absorber absorbs the waste heat from the photovoltaic modules and the ambient heat and makes it available to the heat pump as a heat source.

Photo: Giersch

SIX MORE GOOD REASONS

Uniform appearance of the solar surface instead of PV modules and solar panels side by side

Local emission-free heating without particulate matter

Space-saving installation: a hobby room in the cellar instead of a fuel store

Balanced annual climate footprint with reduced use of the electricity grid in winter compared to air source heat pumps or direct electric heating systems

Permanently low operating costs (the sun shines for free)

Silent operation in contrast to air source heat pumps

DAY CARE CENTRE FOR THE ELDERLY HEATS WITH SOLAR AND GEOTHERMAL ENERGY

Caritas Sozialstation St. Stephanus opted for roof utilisation with the greatest possible CO_2savings when building the new Johannesberg day care centre for the elderly (Bavaria).
The roof now supports 32 PVT collectors, which supply the building with emission-free electricity and at the same time provide the heat pump with solar heat.

Photos: St. Johannesverein / PA-ID Process

IN THE GARDEN OF THE NEW SENIOR CITIZENS' DAY CARE CENTRE
four earth baskets are sunk into the ground. They supply the heat pump with heat during the cold season.

SOLAR REGENERATION: When the heat pump extracts heat from the ground, the ground cools down and the efficiency of the system decreases from year to year. Solar energy can be used to "reheat" the ground in summer.

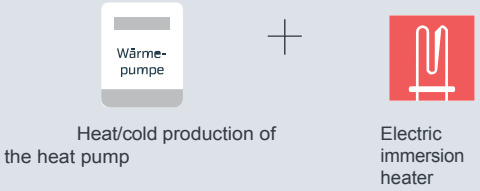
" Thanks to solar energy and geothermal energy, we can supply our new building with predominantly CO_2-neutral electricity and heat. The additional costs of around EUR 30,000 for the PVT collector array on the roof and the earth baskets in the garden are amortised by the electricity cost savings in around 10 years. We will now also use this technology in our two new major projects based on our positive experiences."

Gerhard Zang
Board of the Caritas Social Centre St. Stephanus e. V., Hösbach, operator of the Caritas day care centre Johannesberg

PVT COLLECTORS IMPROVE THE EFFICIENCY OF THE HEAT PUMP

An annual coefficient of performance (COP) of 5 means that for every kilowatt hour of electricity, the user gains 4 units of solar and environmental heat free of charge.

Air source heat pumps in existing buildings typically achieve a SPF of 3.



Heat/cold production of the heat pump + Electric immersion heater

$$\frac{29{,}497\ kWh_{th}}{5{,}997\ kWh_{el}} = 4{,}9\ JAZ$$

Electricity requirement for heat pump and electric immersion heater

Source: Measured values from June 2020 to February 2021 / Faire Wärme GmbH

QUIET ENERGY SOURCE FOR THE HEAT PUMP

PVT heat pump systems heat a wide variety of building types, sometimes as the sole heat source or in combination with geothermal heat from the ground.

Whether terraced houses, school buildings, apartment blocks, mixed-use buildings or listed buildings, PVT heat pump systems ensure a sustainable heat supply in any case. It is important that PVT collectors and heat pumps form a well-coordinated overall system.

www.passivhaus.de

ROOF-INTEGRATED PVT SYSTEM

20 years after Expo 2000 in Hanover, the Danish Pavilion presents itself as an innovative PlusEnergy building with a total of 231 $m^2$of PVT collectors.

eVERA

PVT SYSTEM ON FLAT ROOF

75 PVT collectors as the sole heat source for two 17 kW brine heat pumps supply this KfW 40+ building with four flats and an office in Saarland.

Nassauische Heimstätte

FULLY MODERNISED APARTMENT BLOCKS

At Bürgeler Strasse 9-33 in Frankfurt Fechenheim, around 100 flats are supplied with heat via four PVT heat pump systems.

BPH Ingenieuergesellschaft mbH

PARTIALLY RENOVATED ST. FRANZISKUS SCHOOL

245 m^2PVT collectors supplement a geothermal probe field limited to 40 m in length to supply the two 20 kW heat pumps.

Triple Solar

PVT AS SOLE HEAT SOURCE

Refurbished terraced houses of the housing co-operative De Woonschakel in the Netherlands is heated entirely with PVT collectors and a heat pump.

Pouget Consultants / Thomas Meurville

RENOVATION OF OLD BUILDINGS WITH STYLE

Built in the 1930s, this building in Nantes, France, contains 39 student flats. The
Hot water is generated by 75 PVT collectors as an energy source for the heat pump, which charges two 1000-litre storage tanks.

Metzger GmbH & Co KG

HIGHLY EFFICIENT NEW BUILDINGS

Apartment blocks in Altbach near Stuttgart:
The PVT heat pump systems each comprise 36 PVT collectors with a total surface area of 71 $m^2$and two heat pumps with $_{an}$output of 14 kW_{el}each.