

Mounting on tracker, on/into a roof and on façades



Generates electricity for household, car charger & electricity storage

Generates heat for heating, water, pool ... also at night, in the rain & in winter

Use solar energy without limits.

- ▶ approx. 20 % higher electricity yield due to cooled PV modules
- ▶ unbeatable service life: year-round heat generation, even at night, in the rain and snow
- ▶ unrivalled efficiency for heat pump systems
- ▶ extremely effective and responsive with *Acclimation Technology* by res

Combined heat & power collector for the intelligent generation and use of electricity and heat

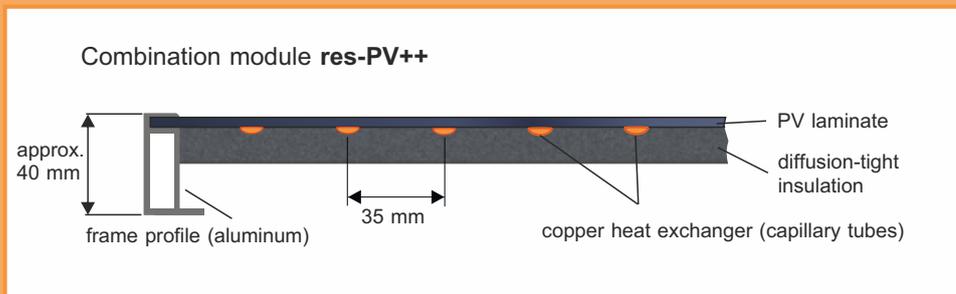
res-PV++

(res)
regenerative
energietechnik und -systeme

Beautiful & efficient: res-PV++ integrated into the roof cladding



High performance thanks to outstanding technology



The photovoltaic front side of the res-PV++ combination module generates electricity – just like “normal” PV modules. We have equipped the back of the module with a specially developed heat exchanger with highly efficient **Acclimation Technology**. It consists of fine, densely arranged copper capillary tubes with an optimally designed cross-section. The resulting large exchange surface and capillary effect guarantee extremely fast heat transfer. Heat energy is thus quickly dissipated from the modules. At the same time, the heat-sensitive solar cells are cooled - this increases the electricity yield by approx. 20 %, while the heat energy gained is available for heating and hot water generation.

Forward-looking: heating, cooling, generating electricity.

The heat energy generated by res-PV++ combination modules can be used directly with a heat pump. Based on this outstanding technical feature, we have developed res-solAutark, our energy systems for buildings, which heat, cool, warm water and generate electricity without fuel and without CO₂ (see page 6). Especially in the production and consumption* of thermal energy in the building sector, res-PV++ make a decisive contribution to heat recovery and climate protection (decarbonisation) – and they save energy costs. res-PV++ are therefore not only extremely energy-efficient and economical, but also simply future-oriented.

Beautiful & flexible.

res-PV++ combination modules are not only technically convincing, they also ensure aesthetics on the roof or façade. We offer suitable photovoltaic modules (res-PV) for the combination modules, together they result in harmonious and highly efficient surfaces.

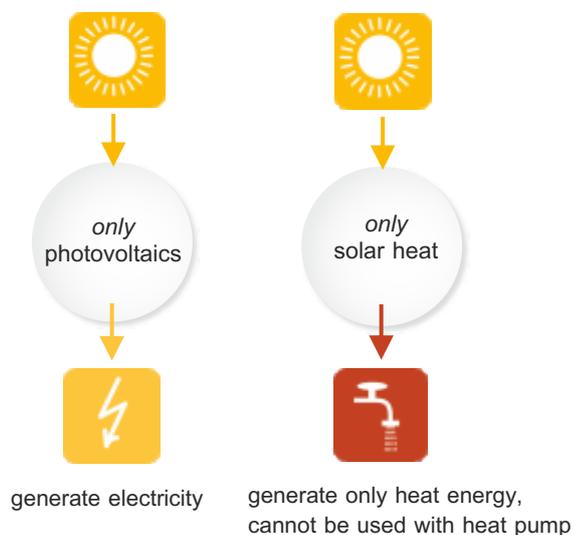
*Surface heating with sunshine principle

For low-temperature systems, we have developed the fastest reacting panel heating / cooling res-KlimaPaneele. It is also equipped with **Acclimation Technology** by res. More in the KlimaPaneele brochure and at www.res-energie.de/Produkte/

Much more than just the sum of two technologies

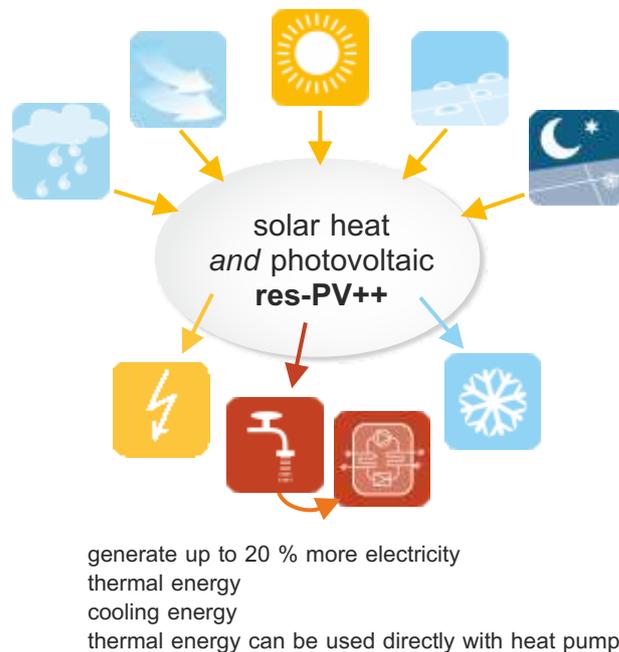
Solar collectors

use only radiant energy from the sun



res-PV++ environmental energy collectors

use radiant energy of the sun and additionally air, rain, dew/ice and cold energy (at night)



Use solar energy without limits.

Generate energy multiple times – profit multiple times.

res-PV++ Combi-modules revolutionize the generation of solar energy. They combine both photovoltaic and solar thermal technologies in a single module, i.e. they generate electricity and thermal energy for heating and hot water with a single surface area. They can also be used for cooling buildings.

No compromises.

res-PV++ do not compromise on the respective technology, but on the contrary are far superior in their performance both to conventional PV modules and to thermal collectors: The cooling of the heat-sensitive PV cells increases the performance of the res-PV++ combination modules by up to 20 % - using highly efficient heat transfer from Acclimation Technology. A further plus: Thanks to their design, res-PV++ can also absorb heat energy from the ambient air, rainwater and downpour in addition to the radiant energy of the sun. Even if moisture freezes to ice on the module surface, the latent heat released is absorbed. res-PV++ are therefore not just solar collectors, but real environmental energy collectors!

Heat whenever you need it.

In winter, bad weather, night & fog.

The fact that the thermal energy “collected” by res-PV++ from the environment (top right graph) can be used at all is due to its ingenious technical properties: even at collector temperatures of up to approx. 0 °C, its thermal energy can be used directly by heat pumps and brought to the desired comfort temperature.

This is why res-PV++ combination modules provide free heating even when it rains, in winter or at night from the roof (façade, tracker), so not only in the mild months of sunshine, but always when heating heat is really needed.

This process is not possible with most thermal collectors and many PV combination modules, which is why they are very limited compared to res-PV++ with its high thermal energy potential.



A perfect duo: res-PV++ & heat pump.

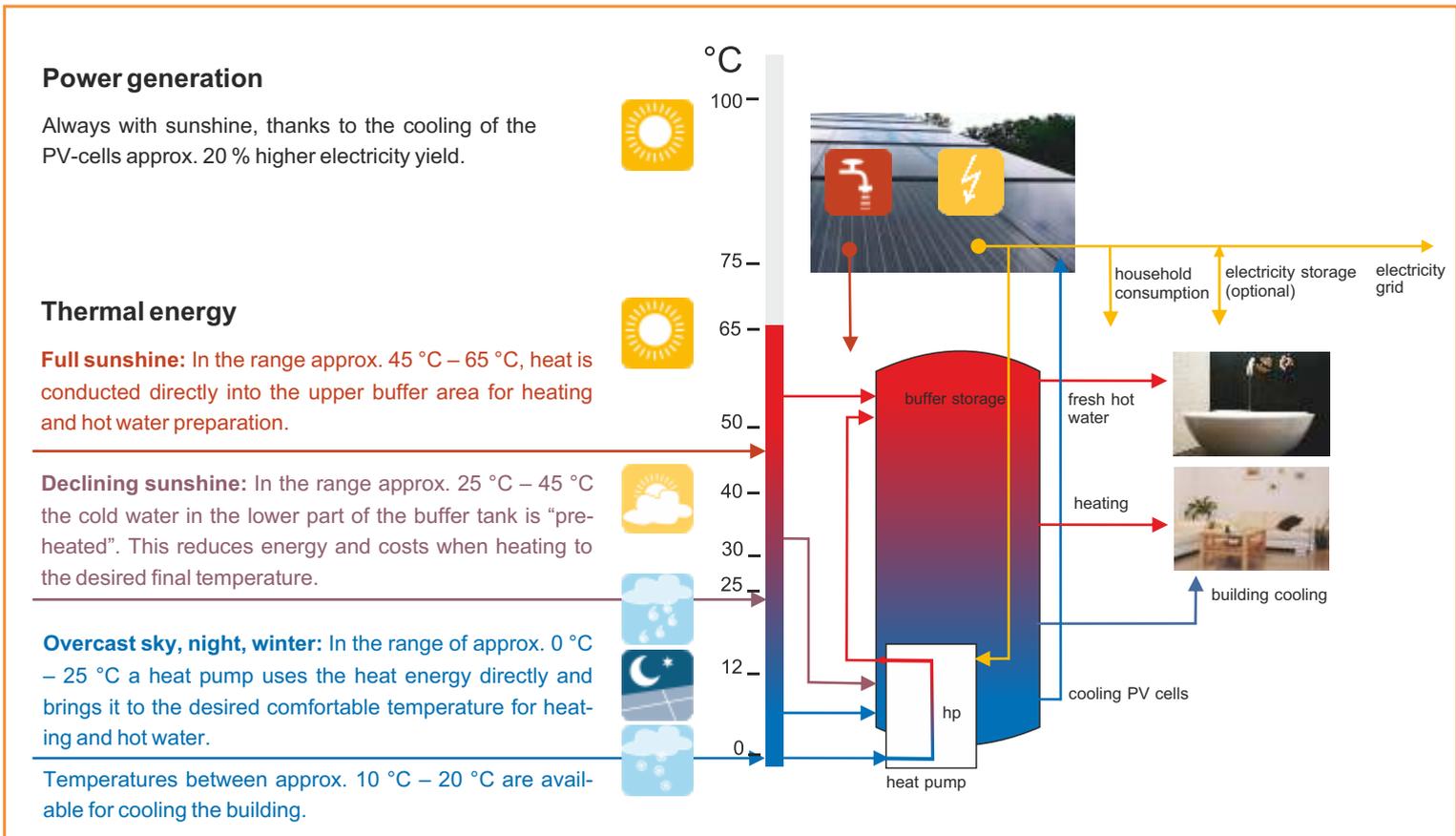
Not only in sunshine.

The outstanding technical advantage of the res-PV++ combination modules is that they generate heat energy in the low temperature range from approx. 0 °C to 65 °C. This temperature range is completely sufficient for heating and hot water production.

However, the possible service life of res-PV++ is significantly extended compared to other hybrid collectors and conventional solar thermal systems. Since the heat energy is used directly with the heat pump, the lower temperature ranges are also available for heat generation - not only in sunshine, but whenever the temperature of the collector surface is 0 °C or higher (see table in the middle right).

Energy generation and use: res-PV++ in comparison

res-PV++ combination modules



Bionics – copied from nature

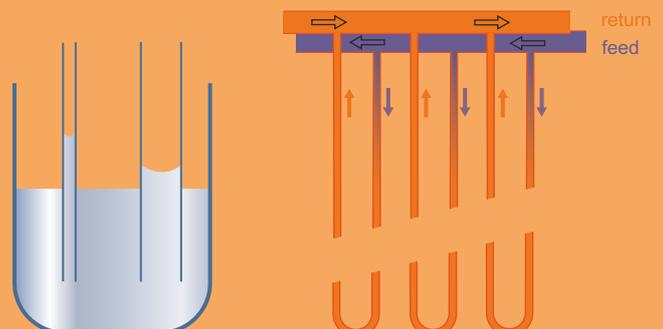
With the Acclimation Technology of our res-PV++ combination modules, we use a process that we have copied from nature: Capillarity. After all, it has proven itself for millions of years!

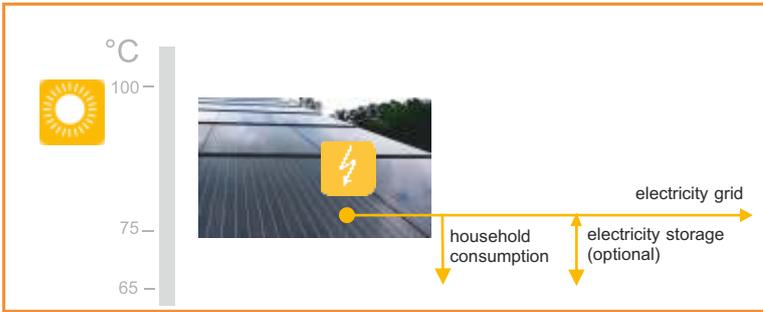
Liquid circulates in a fine network of capillaries and transports heat or nutrients very efficiently, e.g. in the fine blood capillaries of the human body or from the roots to the leaf crowns of trees.

Capillarity – favorable flow behavior, optimum heat transfer

The effect of capillarity is known from the famous drinking straw, in which the drink rises out of the glass against gravity – and the thinner the straw, the higher the effect.

This effect is based on the adhesive force between the tube walls and the liquid. This flows without turbulence, evenly and quickly. Heat transfer is just as uniform and fast. This also reduces the energy consumption of the circulation pump.



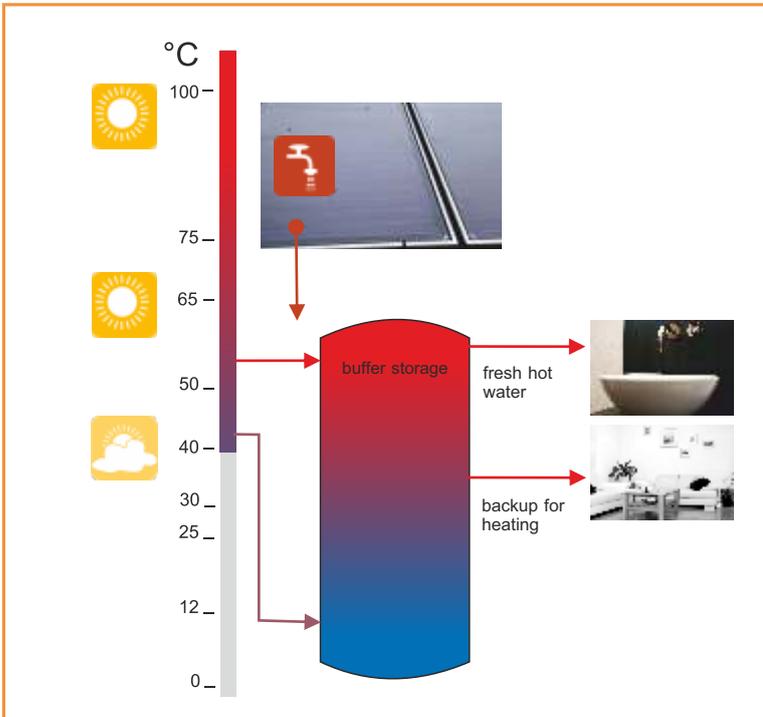


Conventional PV modules

Power generation

Always with sunshine, the electricity yield decreases with high collector temperatures.

Heat generation is not possible



Thermal solar collectors

No electricity production

Thermal energy

Since the thermal energy of most conventional thermal collectors cannot be used with a heat pump or is not sensible, only the upper temperature range is available for direct use (from approx. 40 °C). This means that their useful life is essentially limited to the summer months and is significantly inferior to res-PV++ with its high thermal energy potential.

With conventional thermal collectors, high standstill temperatures can lead to steam formation, high pressure and material loading, while low return temperatures lead to condensate formation, which can damage the collector.

Possible operating hours per year – with *reasonably* usable energy generation

Photovoltaic module	Solar thermal energy	res-PV++ environmental energy collector
1,800 h / year	800 h / year	up to 7,350 h / year*
with sunshine	with sunshine, only when required	not only with sunshine, but always from 0 °C

*Based on the Nuremberg weather data.

Acclimation Technology from res

res-PV++ combination modules owe their outstanding technical properties to the **Acclimation Technology** developed by us. It revolutionizes heat transfer thanks to the intelligent use of capillarity.

Heat is transferred most effectively and quickly when a large transfer surface is confronted with little liquid. Capillaries fulfil this condition. The length of our copper capillaries is more than 25 m/m² collector area. Only approx. 350 ml/m² of liquid circulate in them – making them excellent heat exchangers. The optimized cross-section of our copper capillaries additionally accelerates heat transfer.

Intelligent piping – uniform heat transfer

To ensure that the heat transfer in our PV++ combination modules is not only fast, but also uniform over the entire surface, we connect each individual copper loop one after the other with the forward and return flow (sketch on the left). This uniform cooling across the entire collector surface also avoids the dreaded hotspots.

High-quality materials – quality down to the last detail.

We manufacture our capillaries from copper. Copper has considerably better thermal conductivity properties than plastic, is diffusion-tight and: copper does not age, an invaluable property for materials exposed to large temperature fluctuations.

Exceptionally efficient: intelligent energy systems from res

The outstanding technical properties of the res-PV++ combination modules enable extraordinary solutions for energy systems. For over 10 years, we have been developing and building systems with innovative building energy technology that meets the latest requirements in terms of energy efficiency, sustainability and climate protection.

At the same time, systems from res meet high standards of living quality and ease of use for the people who live or work in the buildings.



► res-solSupport

Ideal for retrofitting existing heating systems, supports them in winter, supplies hot water all year round and protects the boiler in summer.

► res-solPool

The elegant solution for the ecological extension of the swimming season.

For functionality & description see diagram on page 4

Nearly self-sufficient, without heating costs, without fossil or renewable fuels and without CO2

res-solAutark

Complete energy systems that heat, cool, generate hot water and produce electricity – suitable for new construction and modernization. For the thermal energy of res-PV++ further free heat sources from the environment are used, whenever additional heat is needed.

Intelligent technology from a single source

The individual components of our systems are perfectly coordinated in their mode of operation. In all systems, the res-Energie-Manager (hydraulic processes), together with the intelligent res-solControl, ensures that heat and cold arrive where they are needed. They reliably use the heat source that is most efficient for the heat pump, i.e. the mode that saves the most energy, for several possibilities.

► res-solAutark air

An air heat pump uses res-PV++ and ambient air as heat sources.

► res-solAutark terra

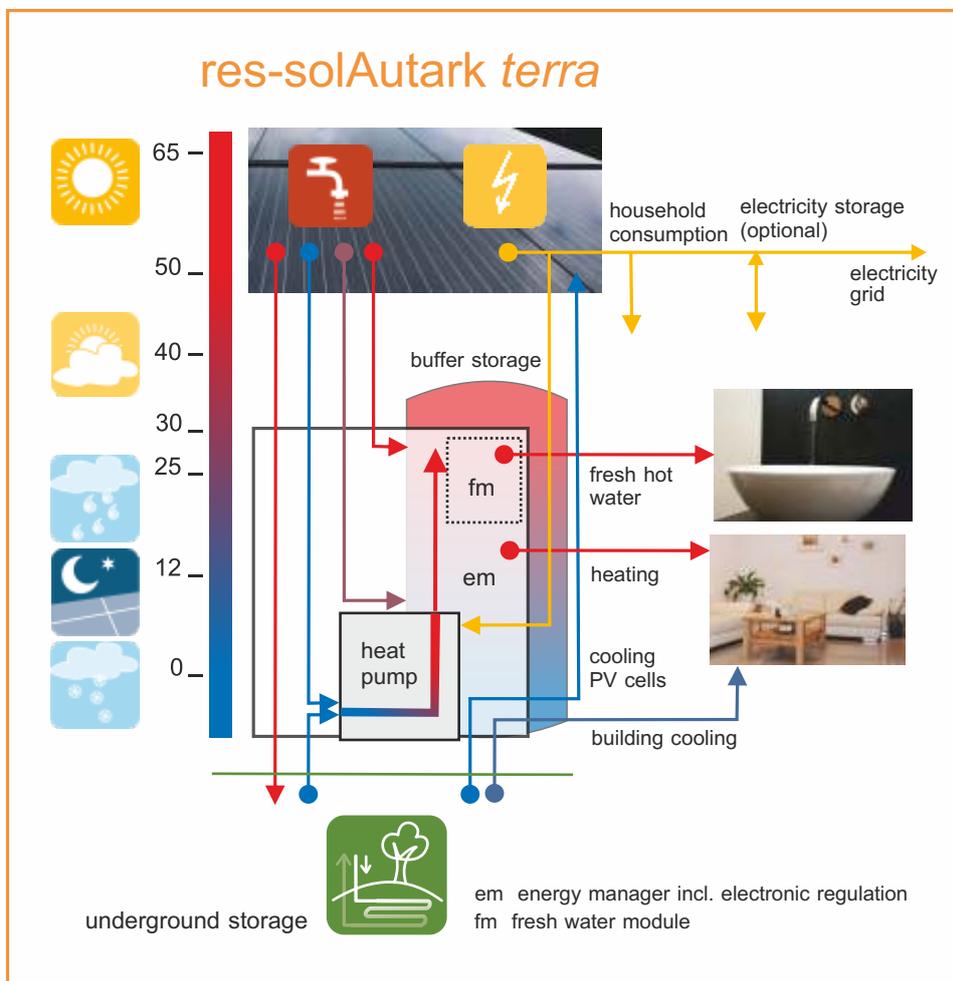
uses geothermal energy obtained close to the surface at res-PV++. The underground storage tank also serves to cool the PV cells and the building. Excess heat energy from the system regenerates the underground storage tank. A particularly efficient synergy effect!

► res-solAutark ice

corresponds to res-solAutark terra. Another energy source in this system is the latent heat of an ice storage tank.

► res-solAutark multiQ

uses several heat sources: ice storage / geothermal heat and air.



Convincing performance: On the roof, into the roof, on a façade or a tracker



Creative use of the façade for energy generation

As a partial roofing of terrace and balcony, res-PV++ becomes an energy-generating “building material”. The straw bale house is supplied with heat and electricity by res-solAutark *multiQ* (res-PV++, air & ice storage).

Always optimally aligned to the sun

A futuristic statement: res-PV++ are installed on a two-axis tracking system next to the representative residential building. res-solAutark terra supplies electricity and heat for buildings, including the pool.

Facts & figures



► High energy yields, high functionality & aesthetics

Harmonious surfaces: For all combination module variants, conventional, pure electricity producing PV modules are available (res-PV). If the entire roof area is not required for heat generation, the remaining area can be covered with these “sister modules”. The result is a uniform and highly efficient roof area.

Electrical power: corresponds to the currently highest power on the market (see data sheets).

Noble black: The Premium design line is equipped with a black frame and black back wall foil, which gives the surface a stylish effect (only res-PV++ Premium and max.).

As an **in-roof variant**, res-PV++ is actually installed into the roof. It can be integrated into the roof cladding or replace the entire roof surface, enabling attractive and interesting architectural solutions.

► Easy to install

Low weight: Only 4 kg heavier than conventional PV modules.

Standard mounting: Roof-mounted and elevated, res-PV++ are mounted on aluminum profiles.

With res-PV++ in-roof modules, the framing is also part of the assembly system. It is mounted on a substructure made of wood.

Photos below from the left: Assembly (the hydraulic lines at the bottom right of the picture). Middle: The collector surface is finished, only the roof tiles are missing. Right: real roof integration – the finished roof.





res-PV++

Combined heat & power collector for the intelligent generation and use of electricity & heat



res-PV++

- ▶ generate electricity and heat
- ▶ gain radiant energy from the sun and additional heat from air, rain, dew/ice
- ▶ more electricity yield by cooling the PV cells
- ▶ extremely fast and effective with *Acclimation Technology* by res
- ▶ unbeatable useful life: year-round heat recovery, up to 7,350 h / year
- ▶ heat energy can be used directly with a heat pump
- ▶ unrivalled efficiency in heat pump systems such as res-solSupport, Pool and res-solAutark
- ▶ beautiful & flexible: installation on the roof and in the roof, can be mounted on tracking systems and on façades

res-solAutark

- ▶ complete energy systems for active climate protection: ecological combustion-free heating and cooling with free environmental energy from the sun (res-PV++), earth, air & ice
- ▶ economical & independent: no fossil or other fuels, no CO₂, no energy costs
- ▶ flexible & adaptable: for new construction, modernization, pool heating and integration into existing systems
- ▶ from a single source: perfectly matched components, hydraulics and control technology by res
- ▶ more than ten years of experience in development, planning and manufacturing



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