U-3ARC TRAINING WEBINAR N°37

Solar Air Conditioning Thermal and Photovoltaic

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Context:

Energy and climate challenges

- Air conditioning accounts for a significant share of global energy consumption, especially in hot regions.
- Dependence on fossil fuels to power these systems contributes to greenhouse gas (GHG) emissions.

- Rising global temperatures are leading to increased demand for air conditioning, worsening the vicious energy and climate cycle.
- The search for greener solutions has become a priority to reduce environmental impact.

Introduction and definition:

Solar energy is a clean and inexhaustible source of energyThis energy is available to the whole world as long as the sun shines.

"Solar air conditioning" refers to all means of air conditioning using as a primary energy resource the energy communicated by the sun's rays.

Decomposition of solar radiation:

54% In the form of infrared heat radiation:these rays are captured by solar panels in order to produce heat, this is “solar thermal”.

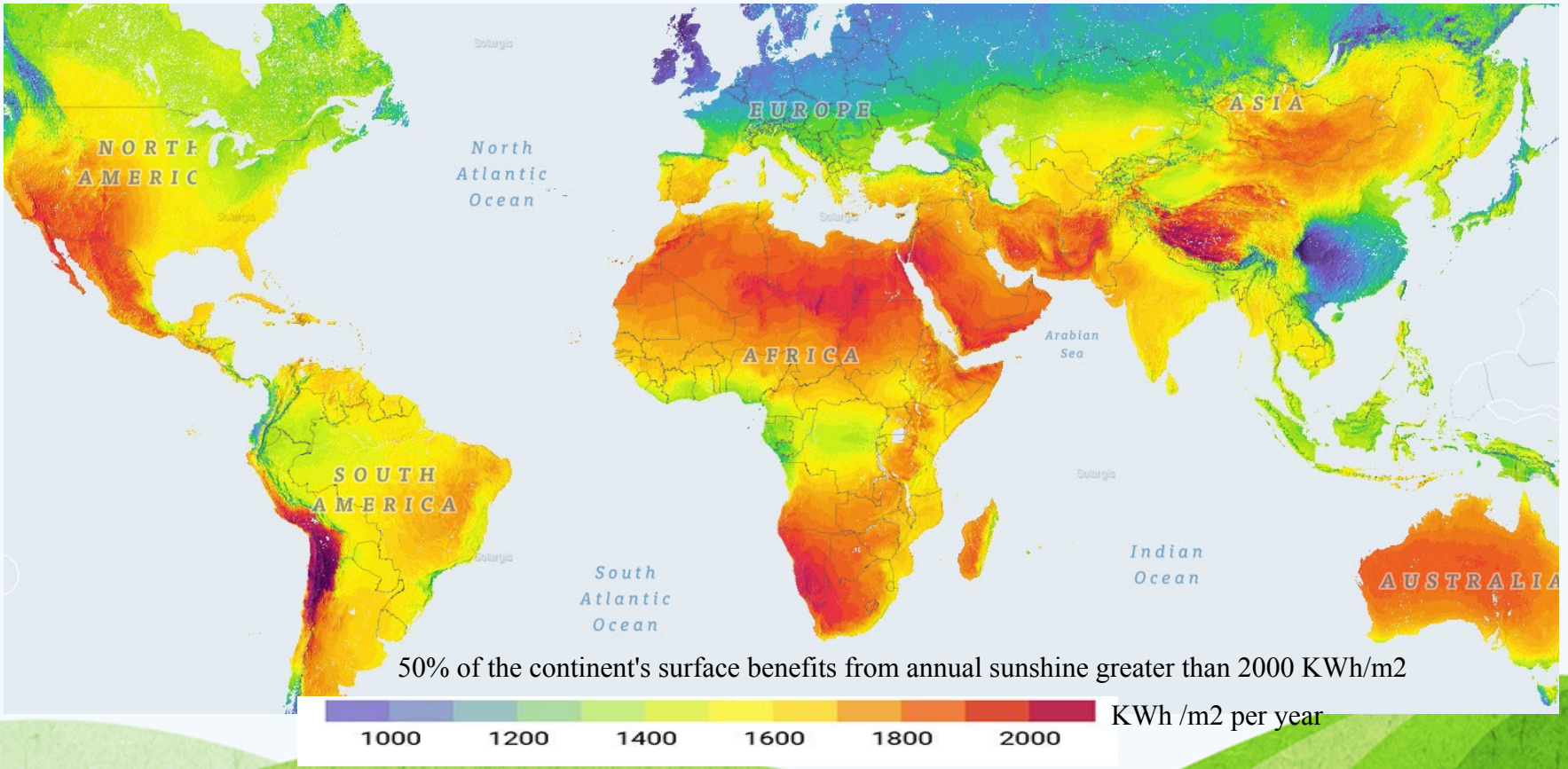
43% In the form of visible light:These rays are captured by panels with so-called photovoltaic cells in order to transform this light into electricityThis is "photovoltaic solar"

The remaining 3% is in the form of ultraviolet rays.

The solar deposit in Africa:

The solar deposit, also called **solar potential**, is the total reserves of solar energy theoretically available on the continent

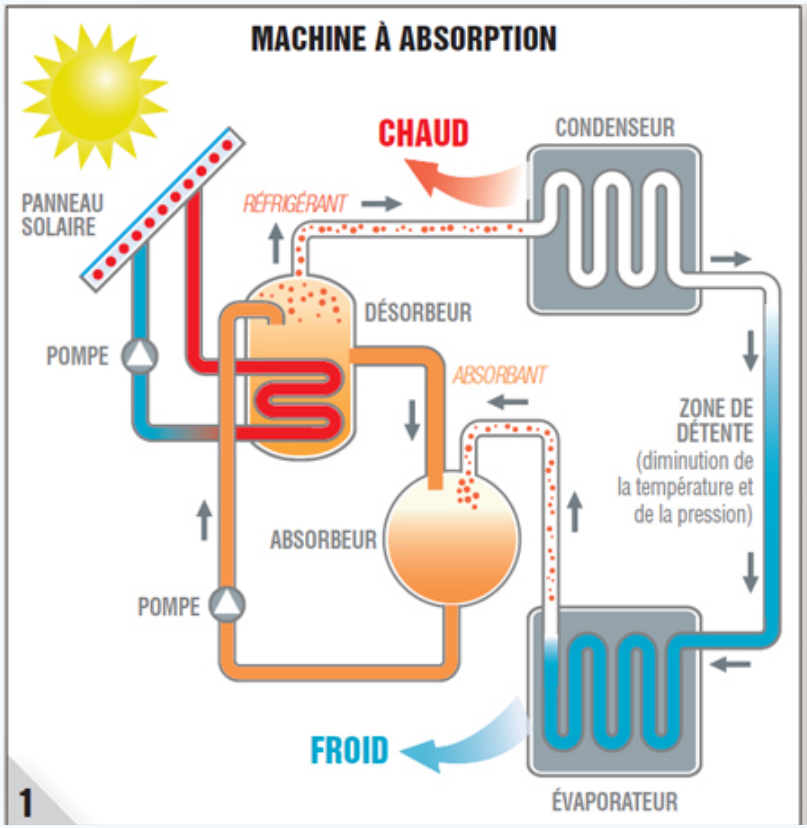
Africa is without a doubt the continent with the greatest potential for solar energy because the solar resource is available in quantity, quality and over a vast area.

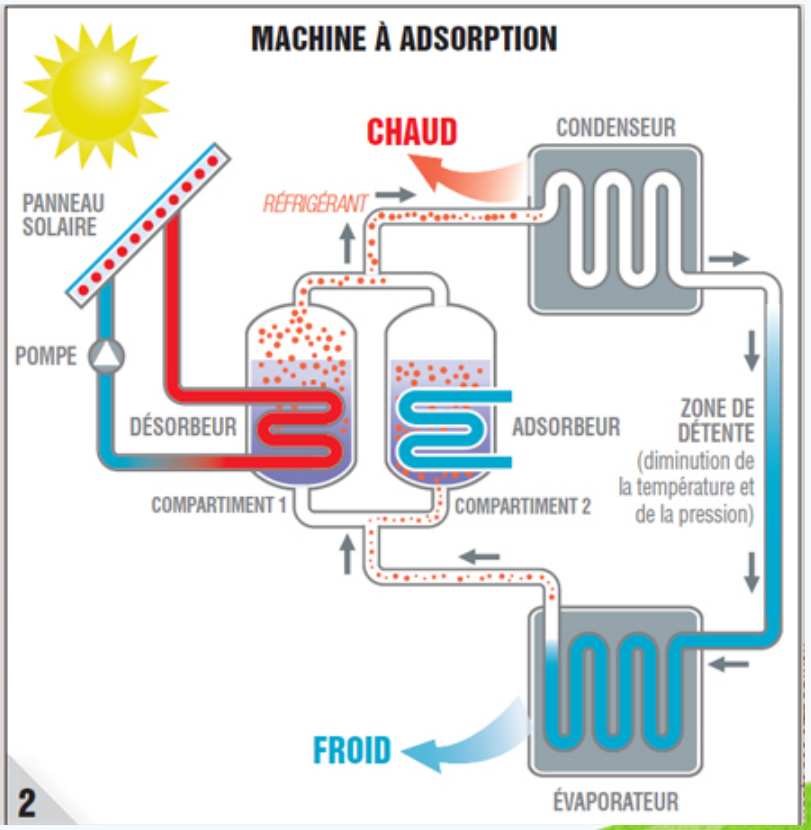


I . Solar thermal air conditioning:

I.1 Absorption and Adsorption systems

The electric compressor is replaced by a thermochemical cycle.Water/ Lithium bromide or Ammonia/WaterThis system uses a Solar heat source

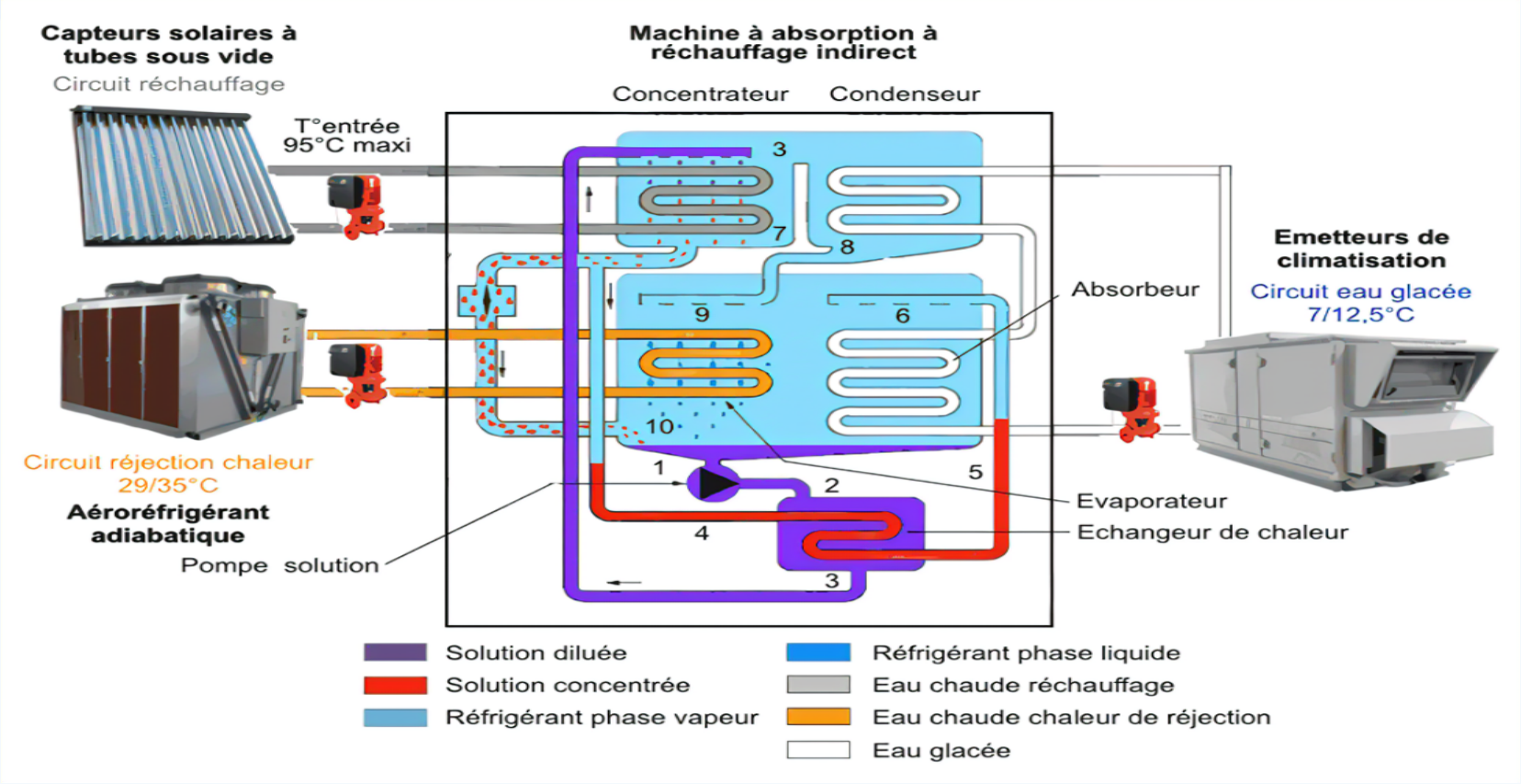




I.1 Absorption and Adsorption systems

Areas of use:

➢ Air conditioning of industrial buildings, hotels and hospitals.



Low power systems (hermetic systems) such as domestic refrigerators use electric resistors or gas as a heating source.

I.1 Absorption and Adsorption systems

Advantages of the system:

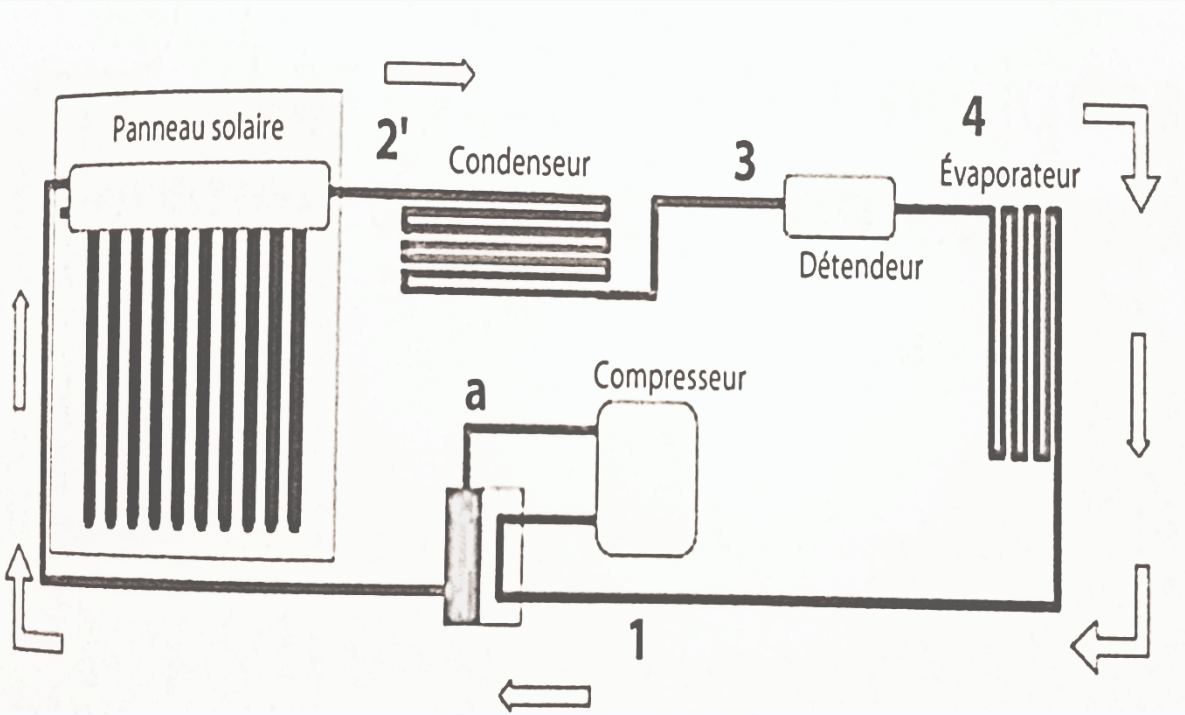
- ✓ Low electricity consumption.
- ✓ Use of renewable energy sources (solar, waste heat).
- ✓ Environmentally friendly (fluid with no impact on ozone).
- ✓ Quiet and few moving parts.

Disadvantages of the system:

- ✓ Higher initial cost than conventional systems.
- ✓ Requires a stable and constant heat source.
- ✓ Less efficient for highly variable climates.

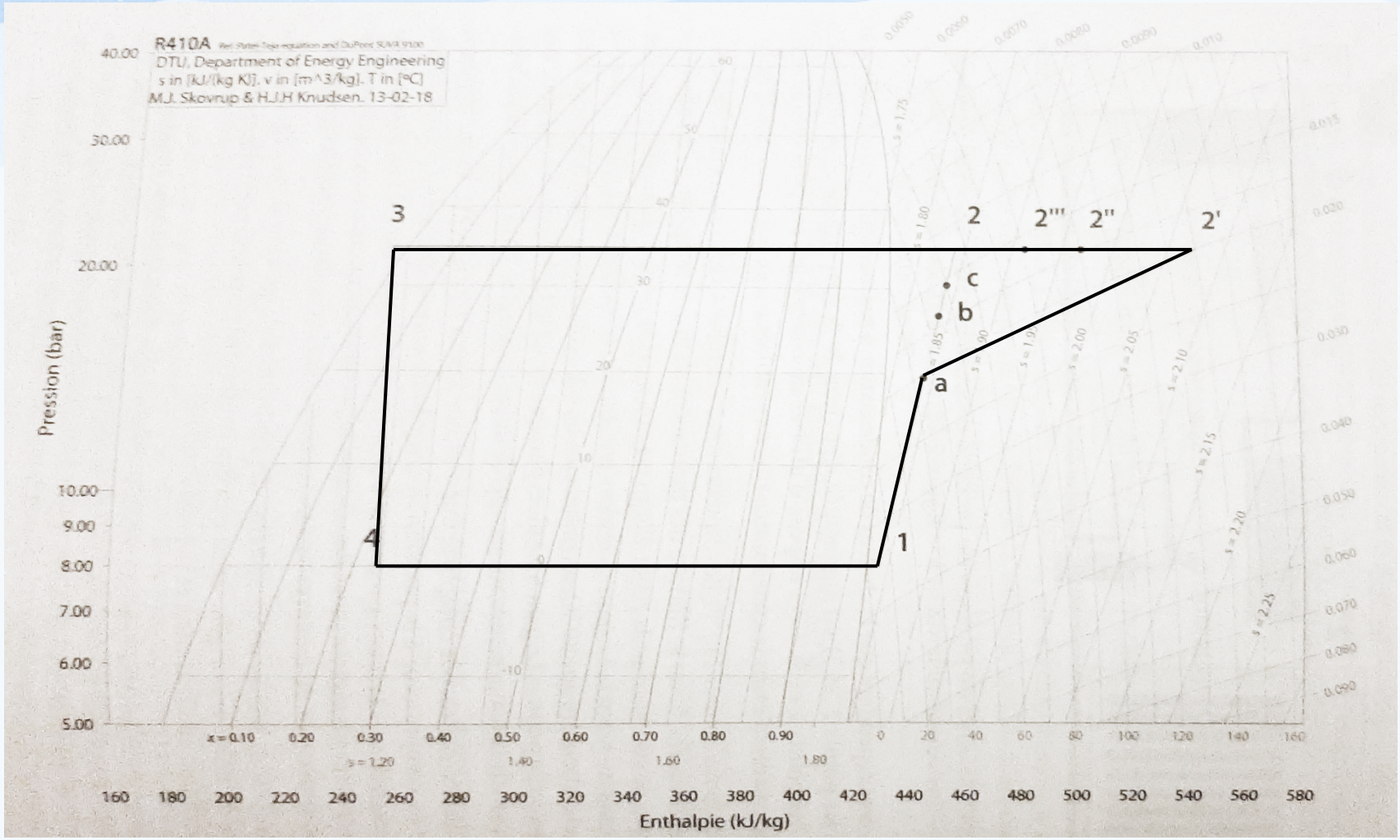
I.2 Air conditioner with solar thermal booster

This model uses solar thermal energy to provide part of the compression of refrigerant vapors in a conventional compression circuit.



Process flow chart numbers refer to explanations and enthalpy diagram

I.2 Air conditioner with solar thermal booster



Plotting refrigeration cycles on the enthalpy diagram

I.2 Air conditioner with solar thermal booster

Referring to the principle diagram and the enthalpy diagram:

1-2-3-4-1 Conventional cycle (without solar booster):compression ensured at 100% by the compressor and maximum energy consumed.

1-a-2'-3-4-1 Cycle with solar booster:the compressor part of the compression (1- a) the rest of the compression is ensured by the thermal solar panel at constant volume (isochore) between the points (a – 2').Gain on the work of the compressor, the compression ratio and the energy consumed

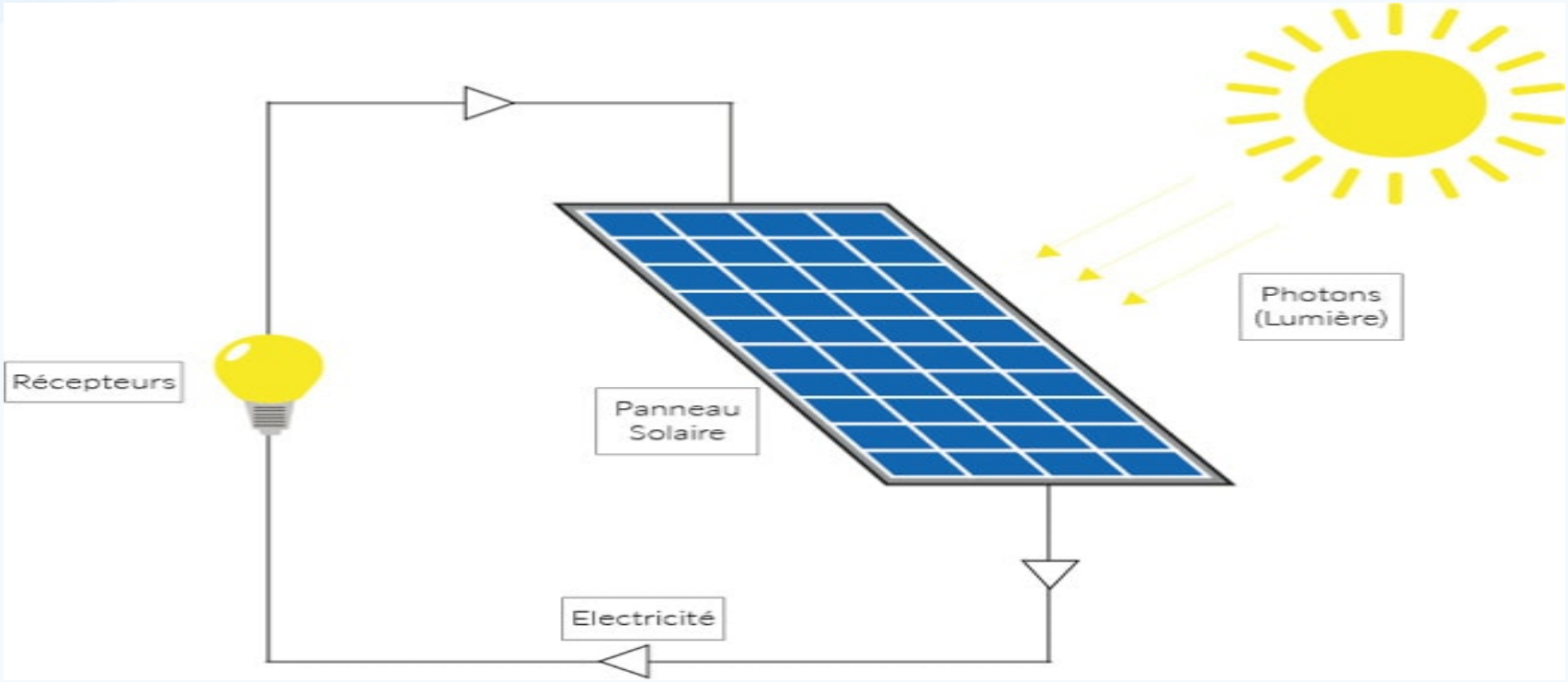
Each time the thermal heat at the solar collector is insufficient, the work of the compressor increases and the points of the cycle will be:1- b - 2"- 3 - 4 -1 or 1- c- 2"'- 3 - 4 – 1Therefore the gains will be less or less important.

II . Photovoltaic solar air conditioning:

Alongside solar thermal air conditioning, photovoltaic (PV) air conditioning is beginning to develop in the same way as the photovoltaic sector.

II.1 Principle of photovoltaics:

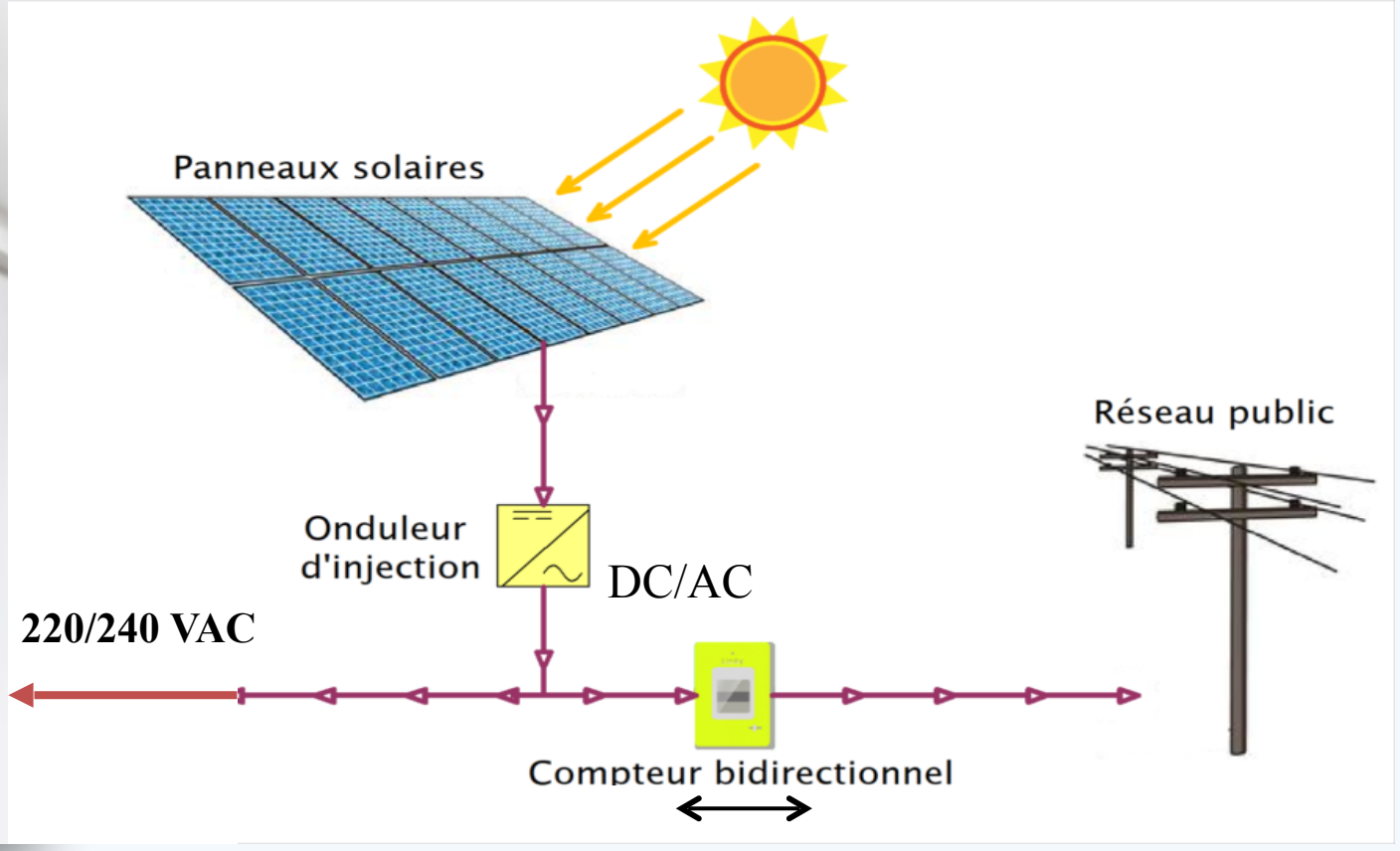
Electricity is produced by transforming part of the solar radiation using a photovoltaic cell.



The photovoltaic cells that make up a PV panel exploit the photoelectric effect to produce direct current "DC" by absorbing solar radiation.

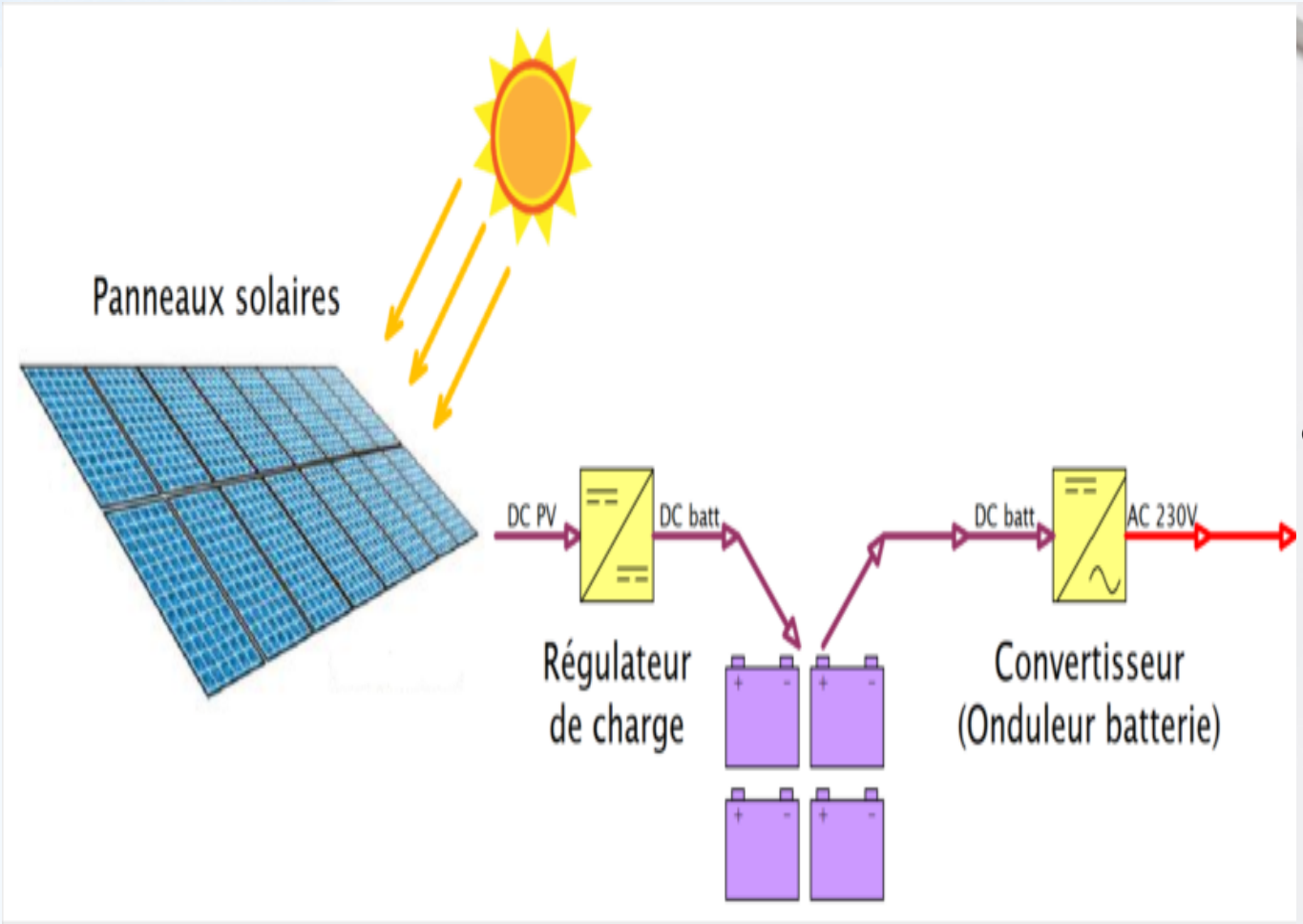
II.2 AC air conditioner powered by a PV-DC installation "PV installation connected to the electrical grid via an AC/DC inverter (converter)"

Climatiseur conventionnel AC



A supply voltage is always guaranteed by the electricity distributor. The PV field is used to reduce the consumption bill by counting the injected KWh.

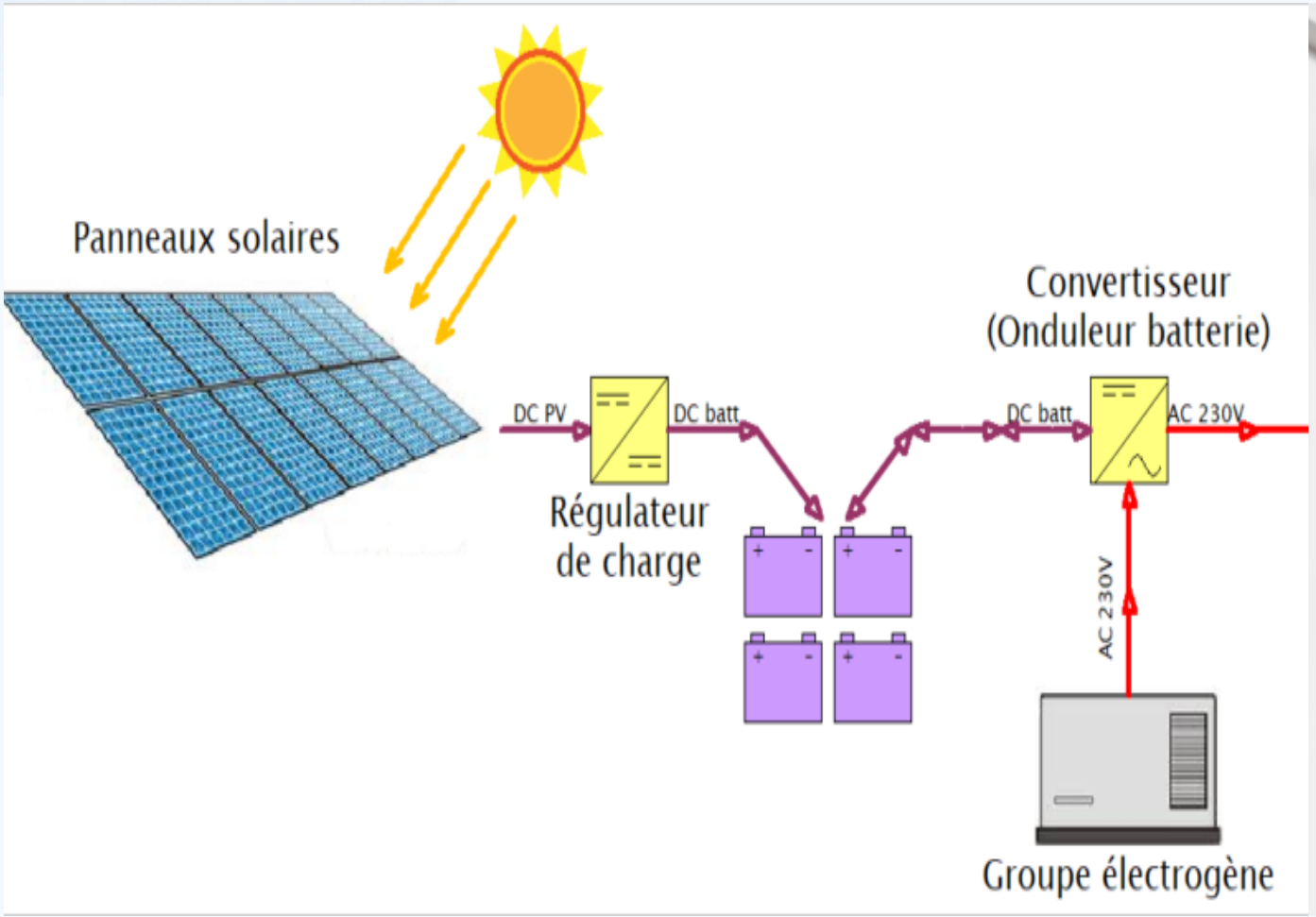
II.3 AC air conditioner powered by an isolated PV installation "DC/AC installation off the electrical grid"



Climatiseur conventionnel AC

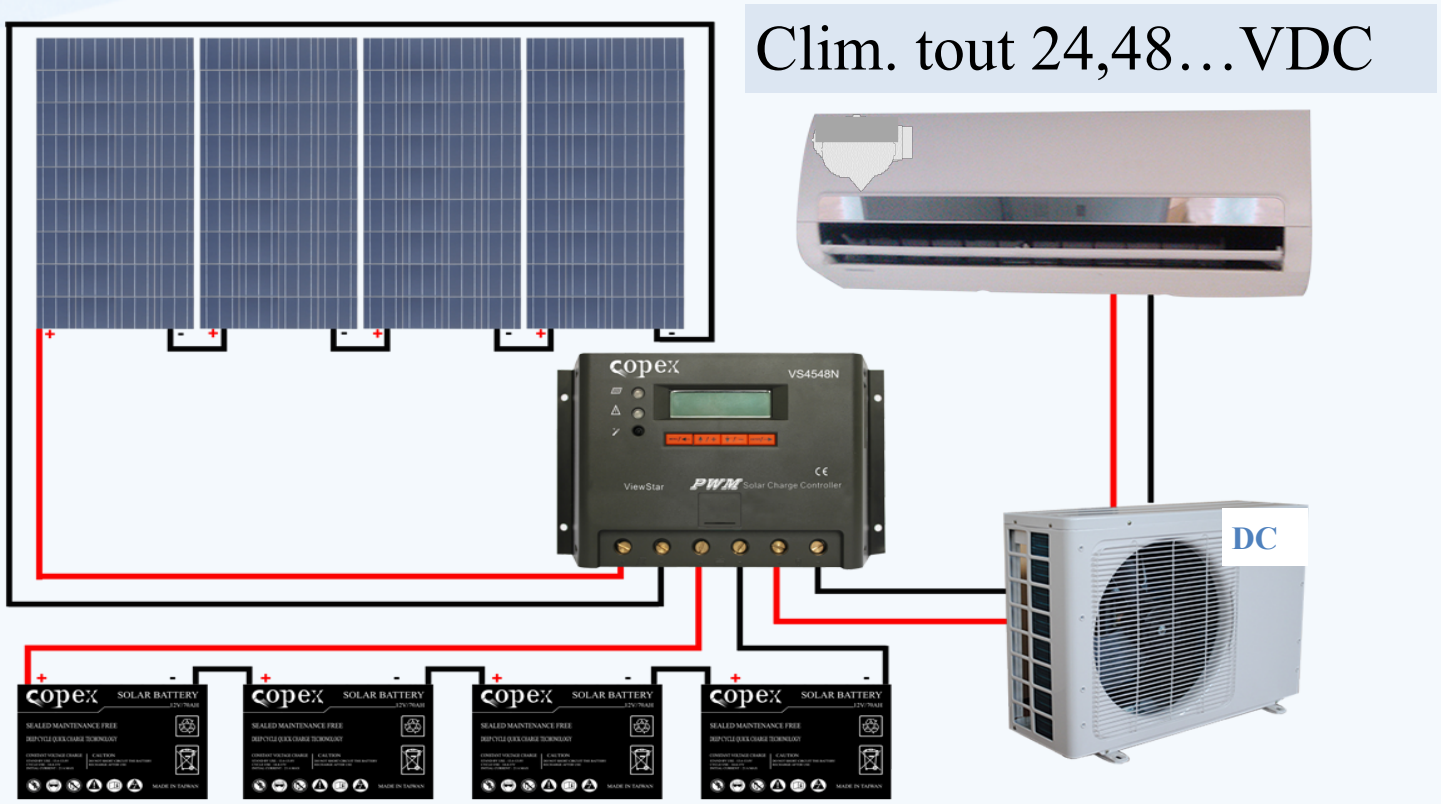
Storage batteries for autonomy in the absence of sunlight

II.4 AC air conditioner powered by an isolated PV installation "DC/ AC installation off the electrical grid + emergency generator"



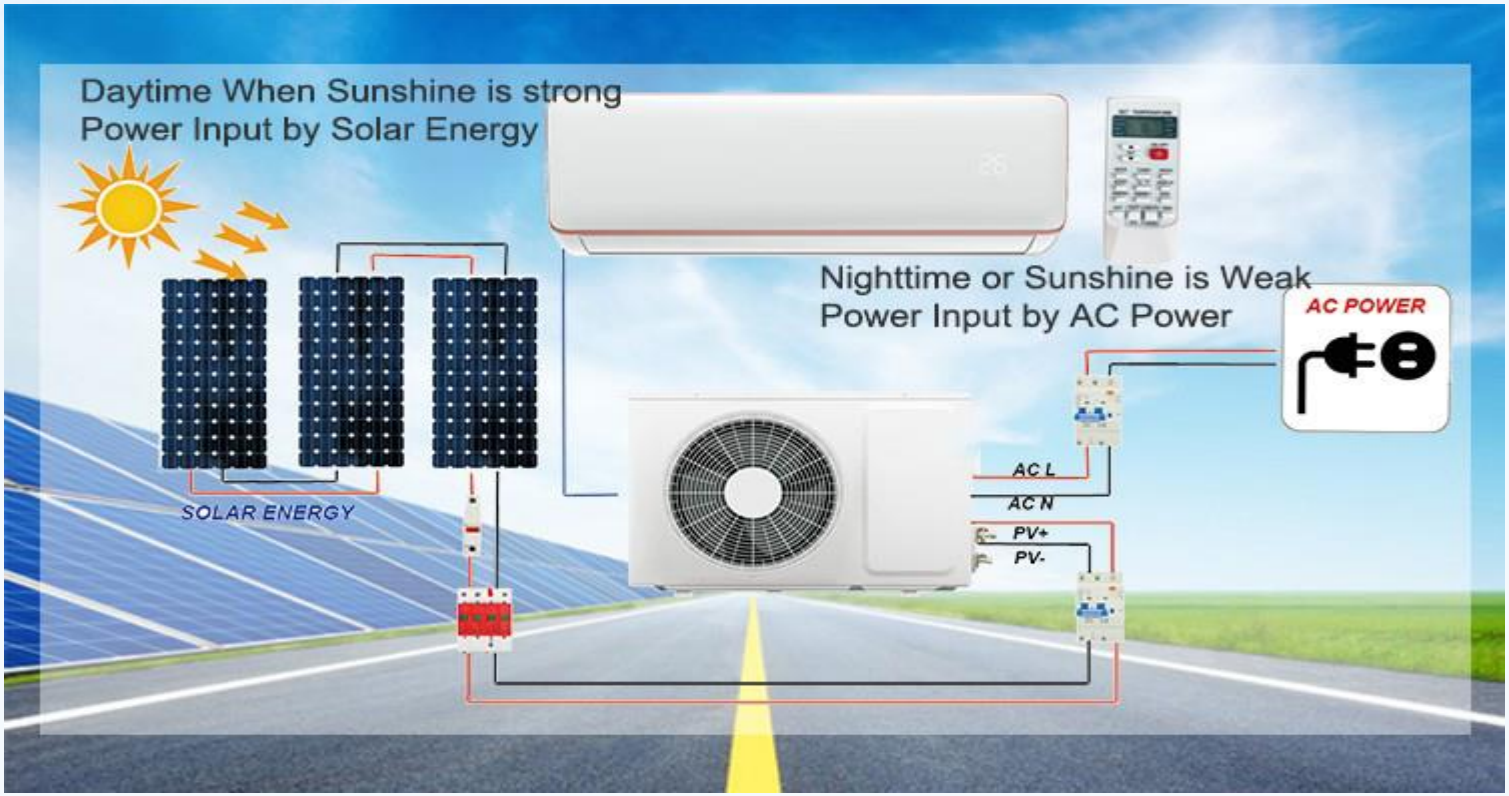
Emergency generator in case of PV system failure

II.5 DC air conditioner powered by a PV installation "DC installation off the electrical grid"



100% DC system, the regulator is used to guarantee a constant DC voltage to power the air conditioner

II.6 Air conditioner powered by a hybrid DC-AC installation "Combined electrical grid and PV installation"



The system operates mainly by solar energy, when the light is not sufficient, standard electrical energy comes in as a backup, the adaptation of this energy mix is done automatically according to the cases

II.7 Advantages of the solar photovoltaic air conditioning system:

- ✓ Reduction of energy bills by up to 70%.
- ✓ Eco-responsible operation with a reduced carbon footprint.
- ✓ Energy independence in isolated areas.
- ✓ Longevity of installations (20-25 years for solar panels).

Conclusion

Solar air conditioning, whether thermal or photovoltaic, meets the dual requirement of comfort and sustainability.These technologies are part of an energy transition approach, reducing fossil fuel consumption and environmental impacts.Choosing between thermal and photovoltaic depends on needs, climate, and budget, but in all cases, the future of air conditioning is solar.

'Investing in solar energy is investing in the future.'