PRACTICAL OPERATION AND MAINTENANCE MANUAL ON SOLAR COOLING SYSTEMS

A Comprehensive Guide to Efficient Solar Cooling Management and Maintenance

Cover image: Storage refrigeration. Credits: Anthony-Ochieng.

Authors: Ngongang Wandji, Moses Kirimi, Anderson Kehbila (Stockholm Environment Institute);
Reviewers: Silvia Assalini, Alina Mures, Alessia Manzato (ICLEI Europe).

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Contents

List of Figures

List of Tables

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Disclaimer

SESA (Grant Agreement No 101037141) is an Innovation Action project funded by the EU Framework Programme Horizon 2020. This document contains information about SESA core activities, findings, and outcomes. The content of this publication is the sole responsibility of the SESA consortium and cannot be considered to reflect the views of the European Commission

The information provided in this guide is for general informational purposes only and **should not replace professional advice**. Always consult and hire qualified professionals to ensure your solar cooling system is installed and maintained safely and in compliance with local regulations.

Introduction

As temperatures continue to rise due to global warming and energy demand increases, especially for air conditioning and refrigeration, it's important to find cleaner and more sustainable ways to stay cool. Solar cooling offers a smart solution by using the power of the sun to cool our homes, schools, hospitals, and other private or public buildings. This guide will help users understand how solar energy can be used for cooling, helping to reduce electricity costs and cut down harmful emissions, whilst also providing cooling opportunities to those not connected to the electricity grid.

Solar cooling is especially useful in areas with abundant sunshine, such as many parts of Africa, Asia, and the Middle East. The demand for cooling is usually highest when the sun is shining strongest. That's also when solar energy is most available, making solar cooling a perfect match.

Instead of relying on fossil fuels or unreliable electricity, solar cooling systems tap into an energy source that's free, renewable, and readily available: the sun. Solar cooling systems reduce dependence on fossil fuels like coal or gas, which produce greenhouse gases. This means less pollution, a smaller carbon footprint, but also access in remote or rural areas and a considerable reduction of risks of unpredictable costs due to volatile prices, on the contrary, possibly leading to savings.

This guide is designed to serve as a practical user-friendly manual for the management, operations and maintenance of solar cooling systems. The manual aims to:

- Clarify the fundamentals of solar cooling systems (section one)
- Empower users with the knowledge of key components of both electric and thermal solar cooling systems (section two)
- Highlight critical safety measures (section three)
- Provide practical guidance on routine operation, maintenance protocols and common issues (section four, five and six)
- Empower users to make informed decisions and understand the economic and environmental benefit of employing solar cooling systems (section seven)

1 Overview of Solar Cooling

1.1 Understanding Solar Cooling Systems

Solar cooling systems are generally divided into two types: **passive** and **active**.

Passive solar cooling does not use any mechanical devices or electricity. Instead, it relies on smart building design and natural processes to keep spaces cool. For example, buildings can be designed to have proper shading, reflective roofing materials, and good air flow through windows or vents. These methods help to reduce indoor heat without using any machines. They are simple, cost-effective, and very useful, especially in areas where access to electricity is limited.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Active solar cooling, on the other hand, uses technology and equipment to convert solar energy into usable power that runs cooling systems as described below. The three main types of active solar cooling include:

1. **Solar absorption cooling**, which uses solar-heated fluids to run absorption chillers; the chiller cools air by using a mix of fluids that work together - often lithium bromide and water. It's good for places with strong sunlight and large cooling needs.
2. **Solar ejector cooling**, which relies on solar thermal energy to power ejectors that produce cooling through pressure differences. This system uses solar heat to drive a *jet ejector* - a simple device that compresses and expands a gas (called a refrigerant) to make it cold. Because of its simplicity, solar ejector cooling is best for small-scale uses like rural homes or remote clinics.
3. **Solar desiccant cooling**, which removes humidity from the air using solar-regenerated drying materials (desiccants, like silica gel). This method is ideal for hot and humid climates.

Note: The three techniques outlined above represent the different systems of active solar cooling. However, for those systems to work, they must be powered by solar energy. Section 1.1 explains the fundamental ways these systems are powered using two main approaches: solar electric and solar thermal to supply the required energy to run these cooling systems.

1.1 Fundamentals of Active Solar Cooling

Active solar cooling is the process of using solar energy (sunlight) to provide cooling in buildings. How can the hot sun help make rooms cooler? It works by turning sunlight into energy that powers a cooling system, just like the traditional air conditioning system that uses electricity.

There are two ways to power active solar cooling:

- **Solar Electric Cooling**: Solar panels (photovoltaic or PV panels) convert sunlight into electricity, which then powers conventional cooling devices like fans, refrigerators, or air conditioners.
- **Solar Thermal Cooling**: This method uses solar collectors to heat water or another fluid (like water or special liquids). That heat is then used to drive machines called **absorption** or **adsorption chillers**, which can cool the air in a building.

In both cases, the energy of the sun collected from the installations built on the rooftop or on open ground is the main fuel that drives the cooling process. Figure 1 shows how these process work.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

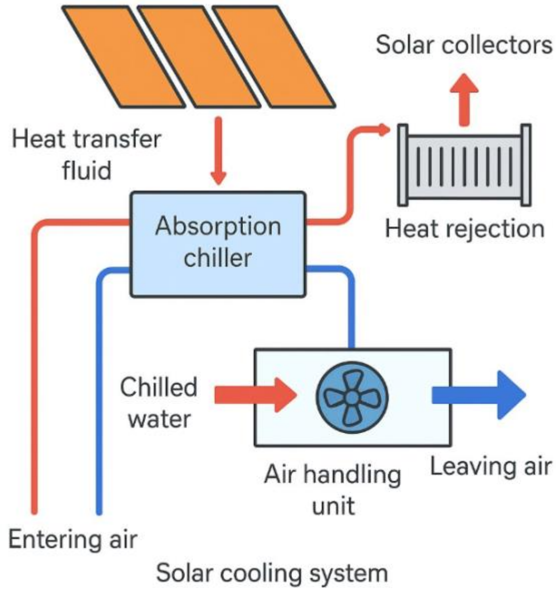

Figure 1: Overview of the Solar Cooling system (source: Stockholm Environment Institute)

1.2 Real-Life Applications

Solar cooling is not just a theory; it's already working in different parts of the world. The example tested in SESA is in the Lake Victoria region of Western Kenya, where communities have long relied on fishing and small-scale farming for both sustenance and income. However, these sectors face a persistent challenge: post-harvest losses due to inadequate cold storage infrastructure. To address this, the SESA project, in collaboration with WeTu and other development partners, has introduced solar-powered cooling solutions tailored to the needs of small-scale fishers, fresh food producers, and traders. A key innovation is the use of the walk-in cold rooms operated under a Cooling-as-a-Service (CaaS) model, which allows users to pay only for the amount of produce or fish they store, making the technology accessible even to those with limited financial resources. The benefits of these solar cooling solutions are substantial as they extend the shelf life of fish and farm produce from just a couple of days to up to several weeks, significantly reducing spoilage rates that previously reached 30–40%. The solar cooling project represents a transformative step toward building a more sustainable and equitable food system in Western Kenya. It empowers local communities with the tools to preserve their harvests, improve their earnings, and contribute to regional food security while harnessing solar power.

2 Components and Configuration of Solar Cooling Systems

At the core of any solar cooling system are three main components:

1. **Solar Collector** that captures solar energy and converts it into heat or electricity. Depending on the type of solar cooling system, those can be:
    - Flat-plate collectors, evacuated tube collectors, and concentrating solar collectors for high-temperature applications in solar thermal cooling
    - Photovoltaic (PV) panels are also used in some systems to generate electricity

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

for running electric cooling devices

- PV-T (Photovoltaic-Thermal) panels produce both electricity and heat, enabling a single system to power electric cooling and assist thermal-driven chillers. Those can be integrated in hybrid systems, ensuring continuous operation even when sunlight is low.

2. **Cooling Plant (Chiller or Cooling Unit)**, which is the main unit that produces the cooling effect, powered either by thermal energy (from solar collectors) or electricity (from PV panels). Common types include absorption chillers, and PV-driven vapor compression units.
3. **Heat Sink** to dissipates the unwanted heat from the system, maintaining efficiency. This could be an air-cooled condenser, cooling tower, or ground-based heat exchanger.

This guide will provide an insight on the most commonly used systems, but as solar cooling evolves, new and advanced technologies are emerging to improve efficiency, scalability, and reliability. Key innovations include **high-efficiency and more compact absorption chillers** that require lower driving temperatures, enabling them to work with simple flat-plate solar collectors and uses solid adsorbents like zeolite; **Advanced Concentrating Solar Collectors** that use parabolic troughs, Fresnel lenses, and solar dishes that can generate high-temperature heat (above 200°C) to drive large absorption chillers, enabling cooling to extend into the evening or cloudy periods.

Additional improvements can be sought in methods of storage, using **Phase Change Materials (PCMs) and Thermal Storage** that store thermal energy in the form of latent heat and release it when needed. Other ways to improve its efficiency include **Smart and Automated Control Systems,** that take advantage of AI-driven algorithms and IoT-based monitoring to optimise energy use, predict cooling demands, and automatically adjust the operation of collectors and chillers for maximum performance, also via remote control. Cooling need can also be reduced by removing humidity before cooling with **Solar Desiccant Cooling**, which uses solar energy to regenerate desiccants that remove humidity from the air before cooling.

Choosing the right type depends on the location, climate, and size of the building or space that needs cooling.

2.1 Components and Configuration of Solar Electric Cooling Systems

This system foresees the combination of **solar photovoltaic (PV) systems with traditional electric cooling units**. While absorption chillers use the sun's heat directly to cool buildings, **solar PV systems turn sunlight into electricity**, which can then be used to power regular air conditioners or cooling units. This is often an easier and more familiar solution for many schools, homes, and offices.

In this setup, **solar PV panels** generate **direct current (DC) electricity** from the sun. The electricity then flows through an **inverter**, which converts it into **alternating current (AC)** - the type of power used by most appliances. The electricity can then be used to run **electric cooling**

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

systems, such as **split air conditioners, fans, or water coolers**. Some newer cooling systems can even work directly with DC power, reducing energy loss and improving efficiency. Table 1 summarizes the key components and their function for this system. For more information about Solar PV, readers can check the SESA Practical operation and Maintenance manual for Solar PV (Awopone et al., n.d.).

During the day, this electricity can be used in two ways: it can either run the cooling system right away or be stored in the battery so it can be used later - like at night or when it's cloudy. In this case, the electricity first goes to a **charge controller**, which acts like a **safety guard**. It makes sure the **battery** charges safely and doesn't get too full.

When we turn on the cooling system, the electricity (from the solar panels or battery) powers the **compressor** that works with a special liquid called **refrigerant**, which helps move heat around. The compressor squeezes the refrigerant gas, making it very hot and pressurized. This hot gas then moves to the **condenser**, which is usually outside the building. The condenser works like a heat-releaser. It lets the hot refrigerant cool down by getting rid of its heat into the air. As the refrigerant cools, it turns from a gas into a liquid.

Next, the cooled liquid goes through the **expansion valve**. This valve lets the liquid spread out and lowers its pressure, which makes it even colder. The cold liquid then flows into the **evaporator**, which is located inside the room. Inside the evaporator, the refrigerant turns back into a gas. As it changes into a gas, it absorbs heat from the warm air in the room. A fan helps blow this now-cool air into the room, making it feel nice and cool. After the refrigerant collects the heat, it goes back to the **compressor**, and the whole process starts again. This cooling cycle keeps going as long as there's electricity from the solar panels or battery. Figure 2 presents the process layout.

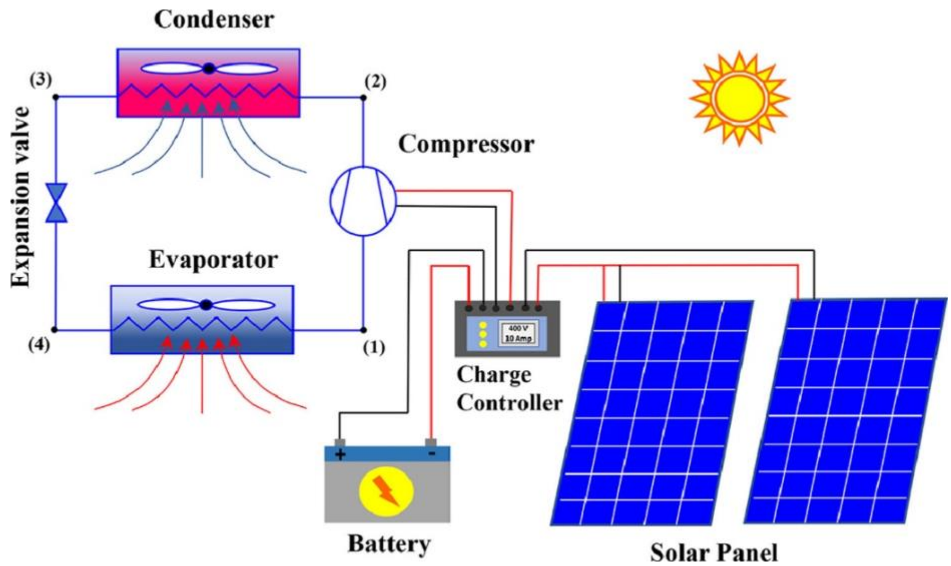

Figure 2: Basic layout of a solar electric cooling system (source: A.Y. Sulaiman, G.I. Obasi, R. Chang et al.,2023).

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Table 1: Description of each component of a solar electric cooling system

Component	Function	Role in the System
Solar Panels	Convert sunlight into direct current (DC) electricity.	Provide renewable energy to power the cooling system.
Charge Controller	Regulates the voltage and current from solar panels to protect the battery.	Prevents overcharging and ensures stable power delivery.
Battery	Stores excess solar electricity for later use.	Powers the cooling system when sunlight is not available (e.g., night or cloudy days).
Compressor	Compresses the refrigerant, increasing its pressure and temperature.	Starts the cooling cycle by pushing refrigerant through the system.
Condenser	Releases heat from the hot refrigerant gas to the outside air.	Converts refrigerant from gas to liquid by cooling it down.
Expansion Valve	Reduces pressure of the refrigerant.	Cools the liquid refrigerant before it enters the evaporator.
Evaporator	Absorbs heat from indoor air using the cold refrigerant.	Cools the air inside the building and sends it back into the room with a fan.
Balance of System	Ensure the proper functioning of the systems with all auxiliary components, such as electrical components (wiring, fuses, conduits), mechanical components (belts, motors, fans), as well as coils, radiators, air filters, nozzles, and drain system.	Ensure safe operation, power distribution, heat exchange, air circulation, and removal of condensate.

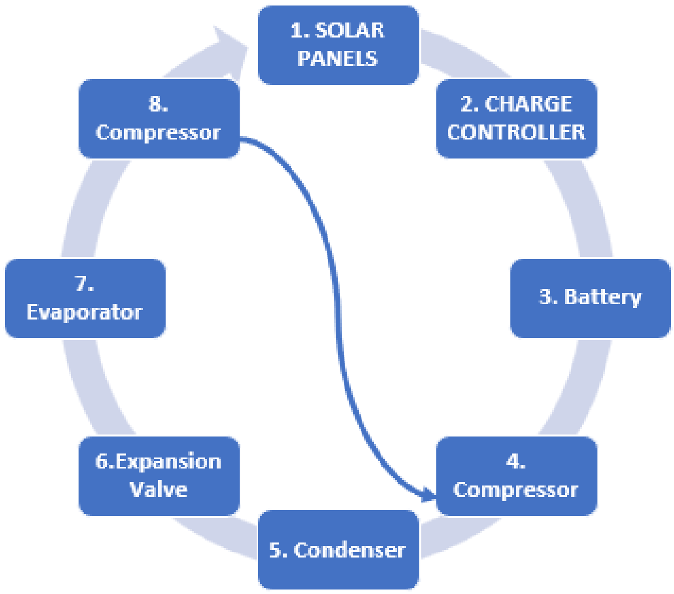

Figure 3: Energy Flow of a Solar Cooling system (source: own elaboration)

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

2.2 Components and Configuration of Solar Thermal Cooling Systems

To really understand how solar thermal cooling systems work, it's helpful to look closely at one of their most important parts: the **absorption chiller**. Unlike regular air conditioners that need electricity to cool things down, an absorption chiller uses heat to do the cooling with a special liquid mixture, usually made of lithium bromide and water. In simple terms, the absorption chiller uses solar heat to move a refrigerant through a cycle that picks up heat from inside a building and releases it outside, giving us cool air or water without needing a lot of electricity. A step-by-step explanation is shown in Figure 4.

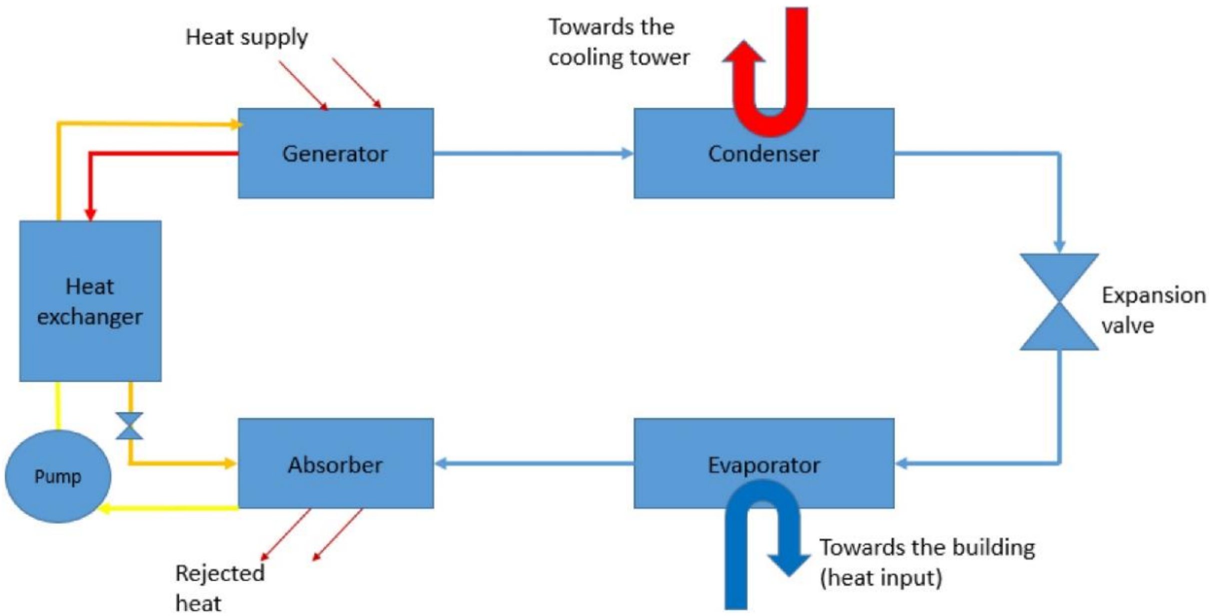

Figure 4: Components of absorption chiller (source: C. Lahoud, M.E. Brouche, C. Lahoud et al., 2021)

First, **solar collectors** capture the sun's heat and send it to the generator. Inside the generator, a special liquid mixture is heated. This mixture is made of two parts: a refrigerant (which helps cool things down) and an absorbent (which helps pull the refrigerant back in later). When the generator gets hot, the refrigerant turns into a gas (vapor) and separates from the absorbent. This refrigerant vapor then goes into the condenser, where it cools down and becomes a liquid again. Next, it passes through an expansion valve, which lowers its pressure and temperature. After that, it enters the evaporator, where it evaporates (turns into gas again) and absorbs heat from the air or water we want to cool. This is where the actual cooling happens. Then the refrigerant vapor goes into the absorber, where it mixes again with the absorbent. This mixture becomes a strong solution and flows through a heat exchanger to warm up a little before going back to the generator, starting the cycle all over again.

Throughout this process, a cooling tower may be used to help get rid of extra heat, and pumps and pipes move the fluids around the system. A control system makes sure everything runs smoothly. The main components and their functions are listed below in Table 2.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Table 2: Description of each component of a solar thermal cooling system

Component	Function / Description
Solar Collectors	Capture solar thermal energy to heat a fluid (e.g., water). Two types: flat plate and evacuated tube collectors.
Absorption Chiller	Uses heat from solar collectors to produce a cooling effect using a solution like lithium bromide and water (see Figure 4).
Storage Tank	Stores hot fluid collected during the day to allow cooling during cloudy periods or at night.
Heat Exchangers	Transfers heat between two fluids without mixing them, improving system safety and efficiency.
Pumps & Pipes	Move heated or cooled fluids throughout the system, connecting all components.
Cooling Tower	Releases excess heat into the atmosphere, especially useful in large systems.
Control System	Manages temperature, fluid flow, and system operation automatically to ensure comfort and efficiency.
Balance of System	Ensure the proper functioning of the systems with all auxiliary components: electrical, mechanical, thermal, hydraulic, and support components

3 Safety Precautions

These systems combine electrical components (like solar panels and batteries) with cooling technology (like compressors and fans). If not handled properly, they can pose serious risks such as electric shocks, overheating, or equipment damage. This session helps you handling these systems safely by understanding the proper safety equipment and following the right practices from installation to operation.

3.1 Personal Protective Equipment (PPE)

In solar cooling systems, Personal Protective Equipment (PPE) is essential for ensuring the safety of workers during installation, maintenance, and operation. The types of PPE required depend on the specific components of the system and the associated risks, which may include electrical hazards, working at heights, exposure to chemicals (e.g., refrigerants), and heat. Below are the main types of PPE used in solar cooling systems:

- When handling PV modules, inverters, batteries, and electrical wiring:
  - **Insulated gloves** to protect against electric shock
  - **Rubber-soled safety boots** to reduce the risk of grounding
  - **Arc-rated face shield or helmet** to protect against arc flashes
  - **Electrical-rated tools** with insulation for safe handling of live components. Never use tools with exposed metal handles.
- During system installation and structural work:
  - **Hard hats** to protect from falling objects

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

- **Safety goggles** or glasses as eye protection from dust, debris, and UV
    - **High-visibility vest** to enhance visibility on busy sites
    - **Steel-toe boots** to protect feet from falling objects or punctures
    - **Work gloves** or general hand protection from abrasions and cuts
- When handling refrigerants or cleaning agents in solar absorption or adsorption cooling systems:
    - **Chemical-resistant gloves** to protect against refrigerants and solvents
    - **Face shield or chemical splash goggles** that prevent eye contact with chemicals
    - **Protective overalls or aprons** that prevent skin exposure to harmful substances
    - **Respirators or masks** (if needed), for refrigerant leaks or poor ventilation
- When working on rooftops or elevated structures during installation or maintenance:
    - **Full-body harness** to prevent falls
    - **Lanyards and lifelines** secured to anchor points
    - **Roof anchors** to provide secure tie-off locations
- When systems include flammable refrigerants or electrical risk:
    - **Fire-resistant clothing** (FR-rated), especially for electrical or refrigerant fires
    - Keep **portable fire extinguisher** nearby (class ABC preferred)

3.2 Safe Installation Practices

Safety tips recommended:

- **Turn off power before you work**. Always switch off the battery or inverter before touching wires.
- **Mount panels properly**. Panels must be fixed securely, especially on rooftops. Use the clamps and brackets provided.
- **Avoid trip hazards**. Arrange cables neatly and away from walkways.
- **Keep batteries in ventilated areas**. Batteries can overheat. Place them in cool, dry spaces with airflow.
- **Label system parts**. Mark the inverter, battery, and switches clearly for easy identification during emergencies.
- **Double-check connections**. Loose wires can spark or overheat. Always tighten gently and double-check.

4 Regular Operation Procedures

Understanding how the system should behave is critical to spot signs of good or poor performance and act, most importantly, to guarantee safe conditions for everyone, and secondly, to act in order to limit, if not completely solve, problems that prevent the system from its regular functioning.

A well-working solar cooling system should:

- Start cooling within a few minutes of sunlight hitting the panels (PV) or the collectors reaching operating temperature (thermal).

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

- Provide a steady stream of cool air without interruptions.
- Maintain healthy battery levels (in PV systems) or stable fluid pressure/temperature readings (in thermal systems).
- Operate quietly and reliably during sunny hours.

To make sure your solar cooling system works efficiently every day, it's important to follow a simple routine of checks that can help prevent problems and keep the system performing as it should.

For Solar Cooling with PV (electric-driven):

- **Inspect the solar panels:** Make sure they are clean and not blocked by dust, leaves, or shadows. Dirty or shaded panels produce less power.
- **Controller check:** Many solar systems show input and output power (how much solar energy is coming in and how much is being used). Check the power production and if it is being used by the cooling unit or stored in the battery.
- **Check the battery level:** Most systems have a digital display showing how full the battery is. A healthy battery level should be above 50% during the day. If the level that's too low might not provide enough power for cooling. If it's too high, it might signal an issue with the charge controller.
- **Listen to the compressor:** A smooth humming sound means everything is fine. If it's too loud, rattling, or not running, there might be a problem.
- **Feel the air:** Use a digital thermometer or your sense of feel near the AC outlet**.** Is the air coming out cool and steady? If not, the system might not be running efficiently.
- **Monitor room temperature:** If the room isn't cooling down like it normally does, or if it´s still warm after 10 minutes, the system may need servicing.
- **Look for warning lights or leaks:** Many systems have indicator lights to show if something isn't working. Also, any liquid dripping from the unit could be a sign of leak.

For Solar Cooling with Thermal Collectors (absorption/adsorption-driven):

- **Inspect solar thermal collectors:** Check that the glass surfaces are clean and free from dust or debris. Look for cracks or damage.
- **Check the circulation pump:** Listen to ensure it's running smoothly and quietly; unusual noise could indicate air in the pipes or mechanical wear.
- **Check fluid levels and pressure:** Many systems have a manometer or level indicator for the heat transfer fluid. Low pressure may signal a leak or the need for maintenance.
- **Check inlet/outlet temperatures:** Place a hand carefully near the pipes (without touching hot surfaces). The temperature difference between inlet and outlet should be noticeable; no difference may indicate a circulation problem.
- **Monitor storage tank temperature:** Ensure the hot water tank is heating up as expected during sunny hours. Too low a temperature could mean poor collector performance or a pump issue.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

- **Look for leaks or insulation damage:** Also, any liquid dripping from the unit could be a sign of a refrigerant or water leak. Any dripping liquid or damaged pipe insulation reduces efficiency and can cause system failure.

5 Routine Maintenance Practices

Regular preventive maintenance is crucial for the longevity and efficiency of solar cooling systems. This section covers routine preventive maintenance activities, including visual and technical unit inspections for the different components and tips for identifying potential issues before they become serious problems.

5.1 Cleaning and Inspection

Dust, dirt, or leaves can block the system and reduce airflow. It is important to keep under control:

- **Filters**: These catch dust and dirt from the air. If they're dirty, the air can't flow properly. Check and clean filters every month. If they're torn or too dirty, replace them.
- **Coils & Radiators**: These helps absorb and remove heat. Wipe them with a clean cloth or soft brush every 2–3 months.
- **Cooling Towers**: These remove heat using water and fans. Remove any leaves, insects, or sludge inside.

5.2 Component checks

It is important to check electrical and other system components. This includes:

- **Wires & Connections:** look for any loose or burned wires.
- **Control Panel/Display**: check if the screen shows any warning lights or error messages.
- **Drain System:** look under the unit for any water leaks or puddles. Clean the drains if they are blocked.
- **Refrigerant Level**: this is the cooling gas inside the system. Too little refrigerant = less cooling. A technician should check this every 6 month.
- **Belts**: these connect motors and fans. Check for cracks, looseness, or strange sounds when the system runs.
- **Motors, Fans, Pumps**: make sure they spin properly. If they are slow, noisy, or not moving, they may need oil or cleaning.

5.3 Cooling Tower Maintenance

Cooling towers use water to remove heat, but dirty water or blocked pipes can stop cooling. Here are some tips:

- Remove dirt and debris: use gloves and a scoop to take out sand, leaves, or algae.
- Inspect nozzles and fans: check if water is spraying evenly and fans are spinning freely.
- Water quality: if the water smells bad or changes colour, it may need to be replaced.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Table 3: Simple maintenance schedule

Task	How Often
Clean filters	Every 1 month
Check refrigerant level	Every 6 months
Inspect belts and fans	Every 3 months
Clean coils and radiators	Every 2 months
Drain and tower cleaning	Every 3–6 months

6 Troubleshooting Common Issues

This is an overview of the most common problems a cooling system may have and what could be the reason for that. Always start with simple checks like looking at sunlight, battery level, and connections. Keep a record of how often these problems happen so you can explain it clearly if you need help.

Table 4: Common issues

Issue Category	Symptoms	Diagnostic Steps	Suggested Actions
System not starting	No lights, no fan, no sound	• Check battery level (should be >20%) • Inspect solar panel cleanliness and sunlight exposure • Look for loose or disconnected wires	• Clean solar panels • Charge battery in full sunlight • Reconnect cables • Try again turning on after 15–20 mins
System on but not cooling	Fan runs but air is warm or mildly cool	• Check battery level • Feel for warm air at exhaust (compressor check) • Inspect filters and vents for dust	• Fully charge battery • Clean filters and vents • Ensure airflow is unobstructed
Strange noises or vibrations	Humming, buzzing, or rattling sounds during operation	• Check for loose screws or parts • Inspect fan for obstructions • Assess battery strain	• Turn off system • Clean around fan (if trained) • Tighten parts • Recharge battery and restart
Battery charging issues	Battery not charging or charging slowly	• Check panel tilt and sunlight exposure • Look for dirt or shade on panels • Inspect charge controller for errors	• Clean panel • Remove shading • Adjust panel angle • Refer to system guide for controller errors

Call the technician if the system:

- Doesn't turn on at all during sunny days.
- Produces warm instead of cool air or can't cool the room properly.
- Runs very noisily or makes unusual sounds.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

- Shows flashing error lights or warning symbols. In this case, it's best to notify your technician, or the system installer for help.

7 Websites and courses to explore

Websites & Portals

1. IEA Solar Heating and Cooling Programme – A global hub for research, R&D efforts, and task groups, including Solar Cooling for Sunbelt Regions and New Generation Solar Cooling https://www.iea-shc.org/solar-academy/webinar/solar-cooling-for-the-sunbelt-regions
2. Solar Energy International (SEI) – Offers online and in-person training in solar thermal and photovoltaic systems, ideal for understanding solar-driven HVAC and cooling systems https://www.solarenergy.org/
3. Clean Cooling Academy ("Go Solar Energy Training") – Africa-focused workshop covering solar energy system fundamentals, sizing, and cold chain applications https://cleancooling.org/academy/training-courses/go-solar-energy-training?

Books & Publications

1. Solar Heating and Cooling Systems: Fundamentals, Experiments and Applications by Ioan Sarbu & Calin Sebarchievici – A comprehensive overview including key cooling technologies https://www.sciencedirect.com/book/9780128116623/solar-heating-and-cooling-systems
2. Advances in Solar Heating and Cooling (Woodhead/Elsevier, eds. Wang & Ge) – In-depth technical review, especially Part III: Solar cooling technologies Elsevier Shop
3. The Earthscan Expert Guide to Solar Cooling Systems (eBook) – An accessible primer on solar-based cooling for buildings PDH Star+3Amazon+3PDHLibrary+3
4. Case Studies of Successful Solar Air Conditioning Design (Wiley) – Practical insights from real-world installations Solar Energy International+5Wiley Online Library+5Udemy+5

Online Courses & Training Programs

Specialized Solar Cooling Courses:

1. M-045: An Introduction to Solar Cooling Systems (PDHStar) – Covers absorption cooling, Rankine systems, desiccant cooling, and system integration (~3 PDH) Wikipedia+5PDH Star+5PDH Star+5
2. Solar Cooling Engineering Online Course – DIY-focused lessons on refrigeration fundamentals integrated with solar systems (~€199) Solar Cooling Engineering+1Solar Cooling Engineering+1

Broad Solar Energy & PV-AC Courses:

1. "A to Z Design of Solar Photovoltaic Air Conditioning System" (Udemy) – Teaches PV-AC design, sizing calculations, components for standalone/grid-connected cooling Udemy

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

2. Coursera – Solar Energy Specializations – Includes courses such as Solar Energy System Design and Photovoltaic Systems from universities like SUNY Buffalo Coursera

Hands-on & Professional Training:

1. SEI Solar Thermal & Cooling Training – Practical workshops and webinars in solar thermal HVAC systems Solar Energy International+1Wikipedia+1
2. Go Solar Energy Training (Clean Cooling Academy/ACES) – Specific to solar cooling in sustainable cold chains (e.g. Rwanda workshop) Clean Cooling Academy
3. SDSU Global Campus – Online Solar Energy Training – Comprehensive PV system design and basics for solar technicians ($1,303 / 3 months) Solar Energy International

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

References

Awopone, A. K., Boateng, I., (AAMUSTED). (n.d.). *Practical Operation and Maintenance Manual for Solar PV Systems.* https://sesa-euafrica.eu/wp-content/uploads/2025/09/SESA-Practical-Operation-and-Maintenance-Manual-for-Solar-PV_v6.pdf

C. Lahoud, M. El Brouche, C. Lahoud, M. Hmadi, A Review of single-effect solar absorption chillers and its perspective on Lebanese case, Energy Rep. 7 (2021) 12–22, https://doi.org/10.1016/j.egyr.2021.09.052.

GIZ. 2024. *Improving food sustainability in the fish and agri-food value chains in western kenya through solar cooling solutions*. https://www.giz.de/en/downloads/giz2024-en-east-africa-WeTu-report.pdf

Mohammad. (2019). Passive cooling techniques in building design: using natural processes (radiation, conduction, convection) without electrical devices. Journal of Environmental Sciences and Resources Management, 11(3). Available at https://www.cenresinjournals.com/wp-content/uploads/2020/06/Page-100-114-1424.pdf

National Renewable Energy Laboratory, Sandia National Laboratory, SunSpec Alliance, and the SunShot National Laboratory Multiyear Partnership (SuNLaMP) PV O&M Best Practices Working Group. 2018. Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems; 3rd Edition. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-73822. https://www.nrel.gov/docs/fy19osti/73822.pdf

Oteplace. (n.d.). PPE for Renewable Energy Safety: A Guide for Wind, Solar, and Nuclear Industries. https://www.oteplace.com/en/blog-ppe-for-renewable-energy-safety-in-the-wind-solar-and-nuclear-industries?

Penn State University. (n.d.). 8.2 Absorption cooling. In EME 811: Solar thermal energy for utilities and industry. John A. Dutton e-Education Institute, College of Earth and Mineral Sciences, The Pennsylvania State University. https://courses.ems.psu.edu/eme811/node/670

Sulaiman, A. Y., Obasi, G. I., Chang, R., Moghaieb, H. S., Mondol, J. D., Smyth, M., ... & Hewitt, N. J. (2023). A solar powered off-grid air conditioning system with natural refrigerant for residential buildings: A theoretical and experimental evaluation. *Cleaner Energy Systems*, *5*, 100077. https://doi.org/10.1016/j.cles.2023.100077

WeTu Impact Report 2024. https://www.siemens-stiftung.org/wp-content/uploads/2025/06/publikation-wetu-impact-report-2024.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037141. This material reflects only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

About SESA

SESA is a collaborative project between the European Union and nine African countries (Kenya, Ghana, South Africa, Malawi, Morocco, Namibia, Tanzania, Rwanda, and Nigeria) that aims at providing energy access technologies and business models that are easily replicable and generate local opportunities for economic development and social cohesion in Africa.

Through a series of local living labs, the project facilitates the co-development of scalable and replicable energy access innovations tested, validated, and later replicated throughout the African continent. These solutions include decentralised renewables (solar photovoltaics), innovative energy storage systems including the use of second-life electric vehicle batteries, smart microgrids, waste-to-energy systems (biomass to biogas), climate-proofing, resilience and adaptation, and rural internet access.

SESA Partners