HEATING AND COOLING
KNOWHOW AND SOLUTIONS
HACKS

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Heating and Cooling Knowhow and Solutions Catalogue of Key information topics

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European portal www.topten.eu/hacks

Project partners and websites

Austria, AEA www.topprodukte.at	Belgium, GoodPlanet www.topten.be	Czech Republic, SEVEn www.uspornespotrebice.cz	France, Guide Topten www.guidetopten.fr
Germany, co2online www.co2online.de	Italy, Eliante www.topten.it	Lithuania, LNCF www.ecotopten.lt/	Luxembourg, Oeko-Zenter www.oekotopten.lu
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About HACKS

The objective of the Heating and Cooling Knowhow and Solutions (HACKS) project is to achieve market transformation for heating and cooling (HAC) appliances and improve comfort and health of European citizens.

Across the EU almost half of all buildings have individual boilers that were installed before 1992 with efficiency of 60% or less. The expected energy savings from a speedy replacement are immense.

To achieve this goal, 17 HACKS partners in 15 countries are working together, thanks to the financial support of the European Horizon 2020 programme.

After scanning market actors, current policies and most commonly used products in each country, starting from April 2020 the HACKS partners will implement involvement campaigns to raise awareness of the economic and environmental benefits brought by good HAC products and solutions:

- HACKS will motivate households equipped with old and inefficient devices – boilers, water heaters, air conditioners, certain types of boilers and stoves, etc. – to replace them with new super-efficient equipment.
- In each country, partners will set-up dedicated on-line platforms to assist consumers in their purchasing process. The platforms will propose: tools to assess households' needs and provide customised information; best product lists with technical specifications; direct links to suppliers of most efficient products; and advice on how to use and maintain equipment.
- For those households who need to improve their situation because they feel too hot, too cold, or too humid but who cannot invest in new equipment or can avoid getting equipped, HACKS will propose simple and low costs solutions. It is possible to reduce energy consumption and energy bills while improving winter and summer comfort, air quality and health conditions through the installation of shading devices, thermostats, water saving taps and showerheads, etc.

Beyond households, HACKS will target all relevant stakeholders (“multipliers”) that participate in the decision-making process of consumers by setting up strategic partnerships to facilitate the purchase of energy efficient appliances. HACKS places a strong emphasis on installers but also retailers and consumer organisations because of their proximity to consumers, their capacity to involve them and bring them guidance on energy efficient equipment.

More information on the HACKS project can be found at www.topten.eu/hacks

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Content

Introduction

This document presents the topics that can be covered by the HACKS project partners when they deliver information to citizens on Heating and Cooling solutions and highly efficient products. These key topics were mostly collected from the project partners' websites (accessible from www.topten.eu), the Topten HACKS criteria papers (https://www.topten.eu/private/page/hacks-deliverables), ADEME's documentation and brochures targeting consumers (www.ademe.fr), and from the AZEB project (Affordable Zero Energy Buildings) Best practice manual for users (https://azeb.eu).

It is a living document which will be enriched as the HACKS / Topten websites develop and partners contribute. A second consolidated version will be published at the end of the project, mid 2022.

How to use this catalogue

This catalogue presents key topics that can be conveyed to consumers, in the "Advice and recommendation pages" of the national HACKS / Topten websites, in brochures and leaflets, etc.

It is organised in 4 sections, like a progression from understanding the stakes, avoiding the use of heating and cooling, if it is still needed, choose well the necessary equipment and finally use properly this equipment:

- **Section 1** assembles topics on **comfort and air quality**: what determines comfort, main pollutants relating to heating and cooling (HAC) equipment, various solutions to live in a good indoor air quality.
- **Section 2** gathers topics helping to reduce the use of heating, hot water production and cooling**. These cover low cost and no cost solutions to save energy and save money while improving comfort and indoor quality** without investing in a new equipment.
- **Section 3** assembles information and advice to **help citizens choose energy efficient HAC equipment** when they need it.
- **Section 4** gathers advice and tips on **how to use these HAC equipment** in an efficient way.

In each section, key topics are stated, with only one or two sentences of explanation: it is up to the HACKS teams to choose which ones they will communicate more deeply about, and to tailor them to their audience(s).

Advice for the HACKS teams

The topics are mentioned and exemplified when possible but given the variety of the 15 partners managing a HACKS / Topten website in terms of climate, legal and regulatory framework, it is up to each national team to adapt and illustrate their messages with graphics, numbers in kWh, CO_2 emissions or Euros, appropriate framework information, etc.

When presenting these key HAC topics to their audience, the HACKS partners are advised to:

- Keep the messages simple, even when going into the detail.
- Use country comparisons and point out differences in practices, technologies, etc.
- Provide numbers – most numbers presented in this document come from the French context but should be tailored to each country, customised to the age of the building stock, the climate, technology preferences, etc.
- Use graphics and images (not presented in this document since they will best fit national contexts).

Section 1 – Comfort and air quality

An important part of the HACKS activities is dedicated to promoting low cost and no cost solutions that improve indoor comfort and air quality. But citizens may need to first better understand these two concepts and to be made aware of problems and solutions.

1.1. What is comfort?

Thermal comfort can be defined as "the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation"[1].

The energy consumption of a building strongly depends on the criteria set for the indoor comfort condition**. Feeling comfortable** in a home depends mainly on 3 factors:

- **Temperature** is felt differently by inhabitants according to the walls' temperature. A 20°C temperature can be felt as 17°C if the walls are cold (14°C) or as 19.5°C if walls are at 19°C.
- **Air infiltrations** create sensation of discomfort when they are numerous and uncontrolled.
- **Humidity** should be of good level, between 35 and 60%. Below this rate, the air is too dry which creates discomfort (dryness of the respiratory system), above this rate it will feel cold.

Hot air in winter is dry and irritates mucous membranes.
Air that is too cold in summer creates thermal stress and muscular tiredness.

1.2. Air quality

- **We spend about 80% of our time in closed spaces**. The air we breathe indoors may be of poorer quality than the air outside, sometimes quite clearly because the outdoor air (often polluted) entering the dwelling is compounded by specific pollutants in the indoor air.
- **Several types of pollutants** may be present in closed spaces, with different origins and more or less important consequences on health. Knowing them and adopting the right behaviour on a daily basis is essential to limit this pollution.

1.2.1 Air quality – Glossary

- **Mites** are microscopic animals of the spider family. They proliferate in hot (over 20°C) and humid environments in the home. Very present in bedding, armchairs, carpets and rugs, their allergens cause respiratory problems or eye problems to sensitive people.
- **Allergens** are substances causing violent reactions of the immune system (allergies) after contact, ingestion or inhalation.
- **VOCs** (volatile organic compounds) are a family of chemical substances generally present in gaseous form in the atmosphere. VOCs are emitted by building materials, glues, varnishes, paints, floor and wall coatings, particle boards, cleaning products, etc.
- **Particles** are small airborne elements of a very varied nature: pollen, natural dust, spores, allergens, combustion products, etc. They can also be the carrier of pollutants, viruses and bacteria. Their effects (colds, respiratory problems, cancer, etc.) depend on their size and composition.

[1] ASHRAE 55:2017

- **Thermal bridges** are areas of weakness in the building envelope characterised by high heat loss and condensation phenomena (black marks, mould, etc.).

- Moisture, an indirect source of pollution:
    - There are **many sources of moisture** in a home: cooking, washing dishes, drying clothes, washing-up, auxiliary mobile heaters (gas or oil) but also human breathing. As an example, an adult produces about 55 g of water vapour per hour, and a washing machine about 1 kg over its drying time. Water vapour is not a pollutant, but **if a dwelling is damp, mould and mites proliferate** and pollute the dwelling.
        - Moulds develop mainly in poorly ventilated damp rooms (bathrooms...), on poorly insulated walls or at the level of thermal bridges. Their spores can invade the whole dwelling.
        - Mites live in the dust of the house. They are present in bedding, sofas and fabric armchairs, carpets, curtains, rugs...

- There are **various sources of pollution**, from people, equipment, materials etc. and many relating to **HAC equipment, e.g.**:
    - Stove or fireplace poorly maintained or old
    - Poorly maintained ventilation and air conditioning
    - Poorly maintained boiler
- An old or poorly maintained combustion appliance (heating, water heater) can be a source of pollution, sometimes extremely dangerous. For example, **carbon monoxide (CO) can be fatal** if inhaled in large doses.
- Similarly, poorly installed or poorly maintained ventilation can encourage the presence of pollutants in the home.

1.2.2. Why air quality is critical

- Some pollutants **diffuse** regularly, in low **concentrations** (furniture emissions, for example) while others have **high but occasional concentrations**, depending on activities (tobacco smoke, cleaning products, etc.).

- **High dose exposure: immediate effects**
    - Exposure or inhalation of fairly high doses of pollutants can result in **discomfort** and annoyance: reaction to bad smells, irritation of the eyes, nose and throat...
    - Certain problems (headaches, skin, eye and respiratory irritations, concentration difficulties, etc.) can be attributed in part to nuisances from buildings and in particular to a deterioration in the quality of indoor air (presence of VOCs, bio-contaminants, defective ventilation, etc.). This is known as the "**unhealthy building syndrome**".
    - The effects of indoor air pollution can also be more serious, even in the short term: nausea, coughing, respiratory problems, asthma attacks, and in extreme cases (carbon monoxide [CO] poisoning), asphyxiation and death.
    - **Carbon monoxide** is an odourless, colourless and undetectable gas. Knowing how to spot the symptoms of intoxication and knowing the right reaction can save lives. It is estimated that 4,000 people are intoxicated each year in France, and 100 die.
        - Symptoms: headaches, dizziness, blurred vision, fatigue, nausea, weakness in the legs, inability to walk, drowsiness.
        - The right reactions: open windows, leave the room, call for help.

- **Repeated exposure: long-term effects**
    - Repeated and long-lasting exposure, even for sometimes very low doses of pollutants, can aggravate or cause **chronic or serious illnesses**.
    - Difficult to study, these effects appear long after exposure and determining the pollutant(s) responsible is often complex.
        - A proven responsibility in **respiratory diseases** and **allergies** and other breathing disorders (bronchial hypersensitivity, reduced respiratory capacity).
        - A plausible responsibility in the development of cancers. Although it is difficult to make a definite link between the appearance of cancer and past exposure to atmospheric pollutants, several pollutants are definitely involved: tobacco smoke, formaldehyde, radon, particles and benzene.

1.2.3. Solutions to keep good indoor air quality

- **Promote natural air circulation**
    - If your dwelling is not equipped with mechanical ventilation, sufficient air circulation must be created or maintained to renew the indoor air.
    - Make sure that there is always a space of about 2 cm under the interior doors to allow air to circulate.
    - Never block an air inlet or exhaust vent and clean them regularly to prevent harmful products from being released into the indoor air.
    - Air for 10 minutes every day in the morning and evening. If possible, and if it is not too cold, leave the windows of the rooms ajar at night to evacuate the water vapour produced by the occupants.
    - Open windows according to activities (vacuuming, use of cleaning products, DIY, shower, bath, meal preparation, laundry...).
- **In case of pollution peaks or a high air pollution index, it is important to continue to ventilate the dwelling**. However, ventilation should be avoided:
    - in the early morning and in the evening, in case of particle pollution
    - in the middle and late afternoon, in case of ozone pollution
    - during this events, avoid additional exposure to irritating products (tobacco, DIY and cleaning products).
- In case you want a more precise control on Indoor Air Quality levels, install a CO_2 sensor (pay attention to the fact that it should be re-calibrated from time to time according to specifications by the manufacturer)
- Evaluate the **opportunity to install mechanical ventilation**.

1.2.3.1. How to use mechanical ventilation

- If there is a controlled mechanical ventilation, **it should not be switched off** as it is designed to operate continuously. Its speed is adjustable: turn on the maximum flow when cooking or taking a shower, for example.
- It is essential to **regularly check the correct operation of mechanical ventilation**.
    - Once every three months, **clean the extract and blower vents**: unclip the removable and washable part and reposition it after cleaning. Caution: do not wet the fixed parts of the humidity sensitive air inlets, this would impair their correct operation.
    - Have the maintenance of your mechanical ventilation carried out every three years by a specialist.
    - For heat recovery ventilation, change the insufflation and extraction filters: once or twice a year according to the zones, including at least once after the pollen season.

- In order to check if the mechanical ventilation works properly, (while holding it to avoid it is sucked-in) place a sheet of toilet paper in front of the air extraction mouth in the kitchen, bathroom, toilet: it should be drawn towards the mouth.

1.2.3.2. How to evacuate excessive moisture

- **Maintain a humidity level between 35 and 60% and a temperature between 18 and 22°C**. If necessary, use a hygrometer (humidity tester) to measure the humidity level of a wall or room.
- **Ventilate** during and after activities that produce a lot of humidity (bathing, showering, laundry, cooking, etc.).
- Put a **lid on pots** and pans when cooking and activate the extractor hood.
- **Dry clothes outside** or in a well-ventilated room.
  If these actions are already implemented but the home remains damp, the ventilation system should be reviewed and the cause should be investigated: the indoor air is certainly not being renewed enough.
- **If mould appears** on walls or ceilings, the home is too damp. Do not allow mould to grow, it is harmful to the health. **Clean them** as soon as they appear and look for the cause (e.g. water leaks, capillarity, infiltration, etc.).

1.2.3.3. Additional tips for good indoor quality

- Pay attention to **labels** indicating the level of VOCs from **construction products** or covering.
- Favour **environmental logos** for paints, household detergents, mattresses, etc., buy products with the European Ecolabel, the Nordic Ecolabel, the Blue Angel. They indicate products that limit their impact on the environment.
- Take the time to **read product's composition**. It is not always easy for consumers to decipher. Be aware that formaldehyde (or formalin), solvents (organic solvents or glycol ethers), etc. are used in the composition of many products and their toxicity is recognised.
- **Follow the instructions for use**. They indicate the doses to be respected and the precautions to be taken.
- **Household products are far from harmless**: Some contain substances that are allergenic, irritating, corrosive and dangerous to the environment and health. During their use, they can emit VOCs that will pollute the indoor air. In any case, after using these products, it is necessary to ventilate.
- **Never mix the products**. For example, mixing bleach and paint strippers or descalers containing acid or amonia emits a toxic gas.
- **Avoid the use of disinfectants**. In France, 7 out of 10 households use bleach because the belief that the home should be free of microbes is widespread. However, in households that use bleach, children are more likely to develop respiratory infections.
- Wherever possible, **use cleaning methods that do not emit toxic substances**, such as steam cleaning, damp cloths or microfibre cloths.
- **Do not overspray products** in sprays that easily enter the lungs. Scented or perfumed products (home perfumes, deodorants, products based on essential oils...) all give off VOCs (some of which can be toxic).
- **Avoid overdosing products** and adapt their use to real needs, respecting the recommendations given by the manufacturer.
- In the case of "home-made" products, **limit the number of ingredients** and the quantities of essential oils.
- As far as possible, store products in a ventilated room.
- **Do not abuse candles or incense**: Their combustion releases numerous pollutants (VOCs, formaldehyde, polycyclic aromatic hydrocarbons). There are also high

concentrations of particulate matter. Nevertheless, the levels of volatile pollutants emitted by candles are lower than those found in incense. In any case, it is essential to ventilate after use.

Section 2 - Reducing the use of heating and cooling equipment: solutions to improve comfort and indoor air quality

This section lists a number of topics that can be brought to citizens in different situations:

- *Those looking for solutions because their home is too cold, too hot, too damp*
- *Those moving in a new home and/or planning for a renovation*
- *Those having little or no money to invest in new heating or cooling systems but in need of improving their comfort and air quality*
- *Those aiming at reducing their energy consumption to save energy and/or to reduce their environmental footprint*
- *Etc.*

They could all use solutions more or less simple and costly to implement to reduce their use of heating, hot water and cooling, but they need to be made aware about opportunities, environmental stakes and informed about these solutions.

2.1. Contextual information: climate change, energy & money savings, multiple benefits of the proposed solutions

Below are presented examples of arguments to convince citizens that, whenever it can be, heating, hot water and cooling, should be reduced.

2.1.1. Climate change: the need to reduce the use of fossil fuels

- The **role of energy consumption in climate change** (e.g. 75 to 80% of greenhouse gases come from the extraction and use of energy in all of the activity sectors).
- The few IPCC scenarios that allow maintaining the temperature increase below 1.5 to 2°C include a **massive reduction of energy use**.

2.1.2. Economic arguments

Heating and cooling represent a significant share of households' energy expenditure (see section 2.2, 2.3 and 2.4). However, there are **low cost and no cost solutions** to reduce the use of heating and cooling and improve comfort at the same time.

2.1.3. The Multiple benefits of improving homes

- **Saving energy and money**.
- Improving **comfort**, feeling cosier at home.
- **Health benefit** of housing thermal retrofitting is identified as one of most important non-energy benefits of housing energy efficiency improvement[2]. Thermal discomfort is not only a question of comfort… it is also a question of health. The border between thermal comfort and good sanitary conditions have been established by numerous medical studies: there is a potential threat to health when the temperature falls below 18°C or rises above 24°C for a period of time.
  A French study[3] shows that renovating all French dwelling stock currently under a certain level of performance to the efficiency of the current French dwelling stock, i.e. a medium ambition of renovation, would generate an economy of 634 million €/year

[2] IEA (International Energy Agency). 2014. "Capturing the Multiple Benefits of Energy Efficiency"

[3] Energy renovation of poorly efficient French dwellings: does it help to reduce costs for the French health system?, Marie Hélène Laurent, EDF R&D, Moret sur Loing, France Véronique Ezratty, Service des Etudes Médicales d'EDF (SEM), Levallois Perret, France David Ormandy, Warwick Medical School, University of Warwick, Coventry, United Kingdom Fabienne Boutière, EDF R&D, Moret sur Loing, France Anne Duburcq Cemka-Eval, Bourg la Reine, France

on the French Health system. This is 31% of the annual necessary cost for the retrofitting.

- A lot of people suffer from **discomfort related to air conditioning** (allergies, eye and nose dryness, headaches, etc.).
- **From a community point of view, for investors and policy makers, avoiding heating and cooling expenses**, whether via building's improvement or new more efficient equipment has many co-benefits. More and more studies[4] propose methodologies to be able to quantify those:
    - **Micro multiple benefits (at the private level),** e.g.: Ease of use and control by user, Aesthetics and architectural integration, Safety (intrusion and accidents), Reduced exposure to energy price fluctuations, Thermal comfort, Natural lighting and contact with the outside, Indoor air quality, Internal and external noise, Pride, prestige, reputation, Ease of installation and reduced annoyance.
    - **Macro multiple benefits (at societal level),** e.g.: Reduction of air pollution, GHG impacts, Energy savings, Resource Management - circularity/life-cycle, Lower energy prices, Innovation and Competitiveness, Employment effects, Energy security, Health & wellbeing: reduced mortality, Health & wellbeing: morbidity, Fuel Poverty Impacts, Improved productivity.

2.2 - Reducing the use of heating equipment

2.2.1. Heating and building renovation - Context information

2.2.1.1. Context information on heating

- Awareness of **the weight of heating in the household's energy expenditure** → E.g. "Heating accounts for 66% of a household's energy consumption and domestic hot water production for 11%." The choice of heating and hot water system is therefore very important in order not to penalise households' budget but also to offer optimum comfort.
- **Availability of new products** (since there are chances that last time a consumer heard about a heating system in the detail was more than 20 years ago): The efficiency of appliances has greatly improved. Gas, fuel oil and electricity are no longer the only energies available to heat and produce hot water. Systems using renewable energies are efficient, often more economical and always more ecological.

2.2.1.2. Context information on housing and the need for citizens to look for professional advice on heating

- **Why are we cold?** Because of the heat losses of a house, and their sources: → E.g. for a non-insulated house built before 1974 in France and the publication of the first building code: through the roof (20 to 25%), through the walls (20 to 25%), air renewal and leakage (20 to 25%), windows (10 to 15%), low-level floor (7 to 10%), thermal bridges (5 to 10%).
- **What should we aim for?** Before reducing the amount of energy put in heating thanks to a new equipment, it is **key to reduce the energy losses**, reduce air infiltrations etc. thanks to a good building envelop. **Full house retrofitting is the best step to take when possible**: contact professionals for customised advice.
- A lot of advice is available for free from national, regional and local agencies, as well as a lot of financial support.
- **Starting by renovating a heating system in a poorly insulated dwelling implies the need for a powerful (and therefore more expensive) equipment to heat sufficiently.** Another disadvantage is that it will be oversized once the dwelling is

[4] JRC. Untapping multiple benefits: hidden values in environmental and building policies. Shnapp, S. Paci, D. Bertoldi, P. 2020.

insulated. Yet, running at underload state accelerates wear and tear of the equipment, degrades its efficiency, increases energy consumption and pollutant emissions. Today, there are however so-called “adjustable boilers” which speed can be adapted to the changing energy needs of the dwelling. They can therefore be installed before insulation work, for example when replacing a boiler in emergency.

2.2.2. Heating - Solutions relating to the equipment itself

2.2.2.1. Limiting the consumption of existing heating equipment

- **Insulating pipes** → An essential first step is to isolate the heating and hot water distribution circuits in unheated premises (garage, cellar, etc.) or false ceilings. This will limit heat loss and improve the circuit's protection against frost.
- **Bleeding radiators**: The boiler produces heat which is radiated into the house by the radiators via the heating pipes which are filled with water. During operation, the heating circuit gradually introduces air into the pipes and prevents proper operation. This is because the air takes the place of the water in the top of the radiator and the radiator then heats much less efficiently. Bleeding the radiators will allow 1) avoiding over-consumption of energy. It is a "waste" of energy to try to heat a house with a radiator filled with air; 2) More efficient heating: the heat is better diffused; 3) An increased boiler life time as it will be used less to heat the house.

2.2.2.2. Upgrading the current heating equipment

In an electric heating system or with independent wood heating (stove or insert), the heat emitters and hot water production are independent. There are solutions to make heating more efficient. Replacement can often be carried out gradually, room after room.

- **Change electric radiators** if they are old, not very functional and/or not very efficient, and replacing them with:
    - An insert, a closed fireplace or a wood-burning stove. They offer high efficiency but cannot cover all heating needs, which means having electric radiators to supplement them.
    - Radiant panels or latest-generation electric convectors: thanks to their control and programming functions, they offer substantial savings and greater comfort.
- **Install a thermodynamic or solar water heater**
    - A thermodynamic water heater covers almost all requirements. It is equipped with an integrated booster, usually electric.
    - An individual solar water heater can cover 50 to 70% of a family's annual hot water needs, depending on the region where it is installed. The rest of the needs are covered by an external system (gas or electric boiler) or an integrated system (electric pin or exchanger immersed in the tank connected to a boiler). It is possible to keep the old boiler as a backup.

2.2.2.3. Using thermostats

- **Install thermostatic valves on each radiator**: free heat input (sunlight, cooking) can be taken into account and hot water supply to the radiators to maintain the chosen comfort temperature can be reduced. Savings can range from 5 to 10%.
- **Use smart controls**, integrating weather forecasts.
- **Use multizone programmers**: they allow to control each sector of the home according to activities, hours of presence, etc. Several zones can be defined (bedrooms, living rooms, kitchen) and each assigned a specific programme. Savings can range from 10 to 25%.
    - The location of the room thermostat should be chosen with care.
    - Complex thermostat should be installed by professionals.
- Focus: **Heat the bathroom at the right time**. For this, install:

    - a "per zone" programming that specifically supports the bathroom
    - an electric towel dryer to heat only the bathroom when it is used
    - a "bi-energy" radiator that runs on electricity and the central heating system. It keeps the bathroom at a "base" temperature when the boiler is running. Thanks to the electricity, it will quickly warm up the room just before the shower or if the boiler is switched off, for example out of the cold season.
- Also in multifamily houses, installing balancing valves guarantees a better even heating across the building. Installing heat cost allocators on each radiator (and pairing **"thermostatic valve + heat cost allocator"**) provides incentives for adjusting heating to individual needs and results in around 15-20% energy saving.

2.2.3. Heating - Solutions relating to users' behaviour

2.2.3.1. Heating - Adopting good habits with windows

- When improving the airtightness of windows, or when replacing them, it is important to **check whether there is a functioning mechanical ventilation system**. It is essential for healthy air in the home.
- **Maintain and caulk windows**: To limit air infiltration, check the condition of the doors and windows and, if necessary, reseal them (sealant, gaskets, etc.).
- **Use shutters and curtains**: Doors and windows, even of good quality, are weak points in the insulation of a house. Using shutters and curtains reduces the feeling of cold walls.
- Generic advice to **use windows depending on their orientation** in the winter:
    - Windows turning North: drop down or close the blinds (or other shadow system) in the afternoon to avoid thermal losses.
    - Windows turning East: rise up the blinds (or other shadow system) during the morning, it is possible to open the windows for air ventilation.
    - Windows turning South: keep the blinds (or other shadow system) open as long as there is sun and closed after.
    - Windows turning West: open the blinds (or other shadow system) during the afternoon, it is possible to open the windows for air ventilation.

2.2.3.2. Adopting good habits with temperature setting

- **Lower the temperature** and adapt clothing: e.g. in France setting the thermostat one-degree lower leads to 5% to 7% savings on the energy bill.
- Set the thermostat according to **national / local prescription** e.g. in France 19°C in winter.
- Adopt **different temperatures according to uses and times of the day**:
    - Different temperatures in the living room, the bedroom, use of possible buffer zones.
    - Different temperatures in 24h: when sleeping 16 to 17°C, in the morning 19°C, during working /school time 16°C, end afternoon and evening 19°C, extended leave (anti-frost) 8°C

2.3. Reducing the use of hot water

2.3.1. Hot water - Context information

- Awareness on the **cost of hot water** → E.g. in France, it accounts for 12% of the energy consumption of dwellings. It is important to know one's hot water consumption in order to adapt the equipment (choice of type of equipment, sizing, etc.).
- Awareness on **water savings and of the energy involved in hot water savings**

- Provide information on leaks.
- Provide comparison with neighbouring countries.
- Provide comparison with various appliances using water.
- Illustrate the savings in Euros.

2.3.2. Hot water - Solutions relating to the equipment itself

- **Insulate the water heater and its pipes**: The hot water tank and the distribution pipes must be well insulated. Otherwise there will be significant energy losses.
- **Act against limescale** which reduces the flow of water and can lead to the risk of leaks or even pipe ruptures. Limescale deposits cause a drop in the water heater's performance and a reduction of its lifetime. They also lead to over-consumption. It is advisable to descale the water heater (every 5 years).
- **Act on flow rates**:
  - Adding an **aerator** to taps: it lowers the flow rate from 12 to 6 litres per minute and allows water savings of up to 50% without altering comfort. It is a mixture of air and water that is not felt when in use.
  - Using **water efficient shower heads** can save 30% to 70% water without altering comfort.
  - Using a **stop-shower**: while soaping the body, a button can be pressed to stop the water.
- **Install a thermostatic mixer**: on the shower or bathtub, it allows to have water at the desired temperature. The gain on hot water is close to 30%.
- Refer to **national or European labels** (though most of the time they are voluntary).

2.3.3. Hot water - Solutions relating to users' behaviour

- Set a **good temperature** of the hot water: a low temperature is less consuming and generates less limescale, but legionella must be avoided: 55°C is usually considered as a good compromise.
- **Do not use hot tap water for food preparation** (coffee, tea, cooking vegetables and pasta) as high temperatures favour the migration of metals into the water.
- **Switch off the water heater** when leaving the home.
- **Prefer showers to baths**: A shower uses 2 to 4 times less water than a bath (a 5-minute shower is more economical than a bath - 60 litres instead of 200 litres).
- **Use an hourglass for showering**: The average time spent in the shower is 7 to 10 minutes, the hourglass will reduce the time spent to 5 minutes and make a saving of 30 to 50%.
- **Wash hands with cold water** and leave the mixer tap in the cold position to avoid asking for hot water.
- **Close the tap** while brushing teeth, shaving, soaping hands.
- **Reduce the capacity of the toilet flush** and install energy-saving plates in the old toilet with a 9 or 12-litre water tank. This saves 3 to 4 litres of water with each flush.
- When the dwelling is equipped with a garden, it is possible to install dry toilets. In this way, 18% of the water consumption can be saved.
- **Leaks represent a waste that can represent up to 20% of the water bill**: A dripping tap can flow from 5 to 90 m3 /year, i.e. in France15 to 270 €; A leaky toilet flush wastes between 30 and 250 m3 /year, i.e. in France 90 to 750 €.
- **Water gardens and plants** early in the morning or late in the evening, and use straw to avoid evaporation.

2.4. Reducing the use of cooling equipment

2.4.1. Cooling and building renovation - Context information

2.4.1.1. Context information on cooling

- Awareness on the **cost of air conditioners**: according to the different options chosen – purchase, installation and running costs are not negligible. Despite the costs associated to the installation of air conditioners, space cooling is the **fastest-growing use of energy in buildings**, both in hot and humid emerging economies where incomes are rising, and in the advanced industrialised economies where consumer's expectations of thermal comfort are still growing.
- Awareness on the **impact of cooling on climate change**.
    - **Air conditioners consume a lot of electricity**, most often made out from fossil fuels. Final energy use for space cooling in residential and commercial buildings worldwide more than tripled between 1990 and 2016 to 2020 TWh of electricity. The share of cooling in total energy use in buildings rose from about 2.5% to 6% over the same period. For commercial buildings, the share reached 11.5% in 2016, up from 6% in 1990. Cooling accounted for 18.5% of total electricity use in buildings (up from 13% in 1990) and is expected to reach about 37% in 2050.
    - **Air conditioners contain refrigerants**. Their leakage into the atmosphere (breakdown, improper disassembly, etc.) is harmful for the environment because they are greenhouse gases. In addition, the widespread use of air conditioners increases overall energy consumption; their operation takes place in the middle of summer, at a time when the electrical production capacities are reduced.
- Awareness on the **impact of cooling on health**: Air conditioning is a solution for people who are very sensitive to heat (the elderly...) and for dwellings located in noisy areas. But beware: frequent passages from inside to outside can cause thermal shocks harmful to health if the temperature difference is important.
- Awareness of the **impacts on the daily life**: Air conditioning in operation forces to live with all windows and doors closed; Some appliances, especially individual ones, can be noisy for the user and/or neighbours.
- **Cooling glossary**:
    - **Air cooling**: Lowering the temperature of the premises without seeking to strictly maintain a temperature, but rather by achieving a reduction of a few degrees in relation to the outside.
    - **Air conditioning**: Maintaining a controlled temperature in premises (rather used in non-residential buildings).
    - **Refrigerant**: A fluid that, when pressure is changed, can vaporize and condense at temperatures close to those of the environment. It is then used to produce cold during a refrigeration cycle by capturing heat from a room or enclosure and releasing it outside.
- Advice: **Do not buy an air conditioner in a rush** to deal with an exceptional situation, as it may prove to be expensive to use and poorly adapted to specific needs. There are other actions to be implemented first.

2.4.1.2. Context information on housing and the need for citizens to look for professional advice on cooling

- **Why are we hot**? Because of the outside ambient temperature, the growing numbers of heat waves and because of poorly designed and insulated buildings, capturing the heat during the day and releasing it during the night.

- **What should we aim for**? Before reducing the amount of energy put in cooling with an equipment, it is crucial to keep the heat out, reduce heat gains and improve ventilation thanks to a good building envelop.
- **There are many long-term solutions against heat**. **Effective insulation** will allow living in a more comfortable home in summer and winter. Good insulation will also allow saving on heating costs: 1) Insulating the walls from the outside, effective in both summer and winter; 2) Insulating the roof, which is essential, because after the openings, the roof provides the most heat in summer; 3) if restoring the facade, choosing light colours that better reflect the heat.
- **Full house retrofitting is the best step to take when possible**: contact professionals for customised advice. A lot of advice is available, often for free, from national, regional and local agencies, sometimes coupled to financial support.

2.4.2. Cooling – Solutions relating to housing elements

The easiest way to keep homes cool in the summer is to keep the heat out, which is also more comfortable.

- **Plan ventilation** flow, including at the top of walls, taking into account the problems of intrusion, privacy, confidentiality, noise or outdoor air pollution.
- When the outside temperature is lower than that of the home, **bringing in and circulating outside air** cools the walls, ceilings and floors, which will store the coolness and release it during the day. In addition, **moving air promotes the evaporation** of perspiration and provides a pleasant sensation of freshness.
- A **veranda** equipped with sufficiently large openings at the bottom and top will be swept by night air, which will cool it effectively. However, care must be taken to open and close the air inlets and outlets at the right time. The ideal is a veranda that opens very wide, or that can be folded away in the summer.
- Use **external clear painting**: light colours reflect light and heat (white, yellow, orange, light red ...).
- **Consider orientation**: A south-facing opening is fairly easy to protect with an awning or a modestly wide awning. For an opening to the west, a larger awning or screen must be installed: in the afternoon and evening, the sun's rays are lower and hit the western facades hardest during the hottest part of the day.
- **Install shutters**, exterior blinds, or awnings on balconies and terraces; Exterior shading systems are far more efficient than inside ones because they prevent the heat from entering the room.
- **Lower the blinds** and close the shutters as soon as the sun hits the windows.
- **Install reflection foils** (infrared reflective coatings) on window.

2.4.2.1. Cooling - Adopting good habits with windows

- **Opening the windows at night** create air circulation to evacuate the heat stored inside. If the home is on several levels, opening the windows at the top evacuates the warm air ("chimney effect").
- **Close the windows** as soon as the outside temperature exceeds the temperature of the home.
- Generic advice to **use windows depending on their orientation** in the summer:
    - Windows turning North: open windows to promote natural ventilation and good indoor air quality.
    - Windows turning East: drop down the blinds (or other shadow system) during the morning and open windows for air ventilation.
    - Windows turning South: keep the blinds (or other shadow system) down until sunset, then open the windows for air ventilation.

    - Windows turning West: drop down the blinds (or other shadow system) during the afternoon, it is possible to open the windows for air ventilation.
- In multi-family buildings, the co-ownership by-laws will tell what is possible and what is not from an **architectural point of view**. Probably neighbours have the same problem: it will be interesting to solve it globally by calling a specialist to examine a collective solar protection solution for the entire building.

2.4.2.2. Cooling - Using plants to cool down

- Plants like **ivy on walls** help to keep the walls cooler.
- **Green spaces near the house influence its thermal balance**. Chose autochthones species and deciduous trees.
- Create a **pergola**.
- Grow a **climbing vine** over a window or alongside a veranda.
- **Grow a hedge** to shield the sun's rays to the West and provide shade while allowing air to circulate.
- When building or converting a terrace, limit the masonry surface and **prefer a wooden deck that stores less heat**. A concrete or stone terrace will store heat all day long and will bring a few extra degrees into your home.

2.4.3. Cooling – Solutions relating to air circulation and ventilation

2.4.3.1. Use comfort fans

- Circulating the air: During the day, when it is warmer outside than inside and the windows are closed, **a fan is a very useful solution to create air circulation and improve comfort** (it is useless to leave a fan running if there is no one in the room because it does not cool the air, it circulates it).
    - **Portable air blower** can be a useful supplemental solution, but it only blows air in one direction and is only effective for the person pointing it in that direction.
    - **Ceiling fans promote a slow and steady flow of air**. Choose a model equipped with a speed regulator and check the ceiling height before installing the unit. With a wind breeze or air velocity created by a fan, it feels cool even with temperatures higher than 28°C because of air movement.
- **Use a combination of strategies if a ceiling fan is not sufficient** to provide thermal comfort:
    - **A fan in combination with humidity** (by humidifying the body or a piece of fabric like a light curtain),
    - **A fan in combination with the air conditioner set to 28°C** – rather than the air conditioner alone set to 24 or 26°C. The combined use of a ceiling fan with an air conditioner provides comfort at 28°C. A 2°C higher set temperature is equivalent to 15 % less energy consumption for cooling. Comfort with higher temperatures is healthier because it provokes less muscle stress. Also during winter, ceiling fans may be useful to reduce vertical stratification of temperature and make the heating system more effective.

2.4.3.2. Natural ventilation

- The implementation of **passive cooling strategies such as natural ventilation** can lead to considerable energy and costs reductions due to the decrease in the use of air conditioners thus reducing electricity consumption. This strategy can also guarantee adequate comfort conditions and improve the air quality of the room.
- Natural ventilation is strongly affected by outdoor temperature: in particular, focusing on night ventilation, **the higher the temperature difference between indoor and outdoor during the night, the greater will be the potential to cool down the**

structures during those hours, allowing the building to act as a heat sink for the following day. However, the efficiency of natural ventilation is linked also to the correct positioning of openings, which should be placed, where possible, in order to guarantee cross ventilation and in order to make the most of it.

- When the temperature inside the building has reached the temperature of the external environment, allow the **passage of airflow**. The increased movement of air accelerates the rate at which perspiration evaporates from the skin: since evaporation requires heat, more heat is leaving the body. Although it cannot decrease the temperature of the inner space, it can make people feel cooler.
- Strategies for wind ventilation include **operable windows, ventilation louvers, rooftop vents, as well as structures creating funnel breezes**. Windows are the most common tool. Advanced systems can have automated windows or louvers actuated by thermostats.
- The possibility to exploit natural ventilation is linked to the **interaction between the building and the district, the air quality, the acoustic quality and usability issues**: cities often create constraints and buildings' geometries prevent air movement and pollutants from dissipating.
- In support of natural ventilation, ceiling fans can be adopted (see above).

2.4.3.3. Summer night ventilation

- During summer and shoulder seasons (May to October), **leave open all protected windows during night**. For the automatic windows, ensure that the mechanism is set to "on" and that the system works. Take advantage of the cool temperatures at night (in the morning and the evening) and promote air circulation throughout the house.
- If effective solar protections are present and correctly used/controlled and internal loads are not too high, summer night cooling may avoid completely or significantly reduce cooling energy consumption. **Natural cooling is also healthier**.
- **Position the blinds of the shading systems horizontally** or open the lower part in case of tilting shutters. If the openings are placed to allow cross ventilation, open the windows on both the side of the room to allow fresh air enter the building and cool down the structures.

2.4.4. Cooling - Solutions relating to users' behaviour

- Set temperatures according to the national / local prescription. E.g. in France, it is advised **that room temperature should be at a minimum of 26°C and that there should be no more than 5 to 7°C difference between the inside and the outside**.
- **Set different temperatures in different rooms**, use **buffer zones to limit internal heat gains**. E.g. if possible, better not to cool rooms where many equipment heat-up the air – kitchens, laundry rooms, server rooms, etc. – or choose these rooms positioned to the North, away from living-rooms, separating them by buffer volumes (toilets, corridors, etc.).
- **Choose very low-energy equipment** that generate less internal heat gains, and turn them off during heat waves.
- **Adjust daily schedule to temperatures**: Many activities can easily be moved to cooler times of the day, especially in the morning and evening. Inform employers about flexible working - for example, through flexible working hours, annualised working time or offering the possibility of reducing overtime. On particularly hot days, the company may allow several breaks in cooler areas and a longer lunch break ("siesta").
- **Adjust dress code in offices**: With light clothing, the body can cool down better. Linen, silk or cotton fabrics allow air to pass through. On particularly hot days, avoid wearing a tie and wear short sleeved shirts or shorts.

- **Reduce physical efforts**: in the workplace, they can be reduced by using ergonomic principles and technical aids, as well as by dividing demanding activities among several people. This makes work easier, even at higher temperatures.
- Drink **tepid drinks**.
- Prefer **light food** on hot days.
- Take **cold showers**.
- Use **water from spray bottles** to cool down.

Section 3 - Choosing highly efficient HAC equipment

Within the HACKS project, 15 partners present on-line selection of best available products on their market for a series of product categories, which depend on national situations. This catalogue focuses on the product categories available on the European platform www.topten.eu and does not repeat the content of the published Criteria papers[5].

*The value added from the HACKS project for consumers interested in investing in new equipment focus, is to point to specifically selected products for their energy and environmental performances. This HACKS information comes **downstream in their decision process**, i.e. after the technology has been chosen with the support of professionals who can best assess the specific situation of each consumer (climate, house orientation, size, number of inhabitants, preferences, sufficient and necessary dimensioning of the equipment, etc.).*

Hence this section presents upstream generic issues – to trigger thoughts that should be then clarified with specialists – and redirects to the HACKS / Topten lists of best products when it comes to specific product categories

3.1. Investing in a new equipment: climate change, energy and money savings

3.1.1. An opportunity to turn to a more climate friendly energy?

When renovating and changing a heating system, with a long-term perspective, it may be worthwhile to **opt for renewable energy instead of gas, oil or electricity**. In this case, supply is assured by using energy that is generally local, often low-polluting, low in greenhouse gas emissions, and which availability is guaranteed over the long term.

- **Thermal solar panels** can power a heating system.
- **Some equipment can accept different types of fuel or several types of energy**. They make it easier to switch from one energy source to another: boilers equipped with a mixed oil/gas burner, wood boilers running on several fuels (chips, pellets, shavings, logs, etc.), hybrid systems combining a gas boiler and a small heat pump, etc. The latter systems optimise their energy consumption by running either the heat pump or the boiler, depending on the climatic conditions and the heating demand.
- It is sometimes possible to connect individual dwellings to a **district heating network**. A collective boiler room or substation then serves a group of houses, such as a housing estate for example. Local council may be asked about the possibilities and conditions of connection.

3.1.2. Planning the budget

The budget to be planned should include:

- The **purchase** and **installation** of the equipment.
- The **energy bills** (gas, fuel oil, solid fuel, electricity): Investigate the cost of energies and the trend for the coming years.
- The costs of **maintenance** of the equipment: regular maintenance boilers and other types of equipment is often compulsory and must be carried out by a qualified professional. When not mandatory, it is strongly recommended. The cost of maintenance varies according to the systems, their robustness and reliability. It can be the subject of a contract: the professional carries out the maintenance on a regular and automatic basis. Contracts may also contain a commitment to rapid breakdown service and availability of spare parts in the event of a breakdown.

[5] https://www.topten.eu/private/page/hacks-deliverables

- If heating needs are high (large house, badly oriented building, harsh climate...), **it is often better to install a heating system that uses inexpensive energy, even though the initial investment may be higher**.
- **Financial assistance is often available** to improve the energy efficiency of homes and renovate heating systems. E.g. in France specific tax credit, reduced VAT rate, zero-rate eco-loan, aid from the National Housing Agency, aid from local authorities, aid from energy suppliers as part of the energy saving certificate scheme.
- **Beware of indicative costs**: prices vary according to the characteristics of the building, the state of the existing installation, the geographical location of the home, etc.
- **Look for several quotes** drawn up by competent professionals

3.1.3. Finding qualified professionals

- Most often, **impartial free of charge advice is available** at the national or local level to assess various technologies tailored to each situation, prepare subsidy schemes, find professional workers and installers.
- **Entrust the renovation of heating system or the installation of equipment using renewable energy to professionals** and when possible labelled professionals. Labels certify that companies, in carrying out energy improvement and renovation work, undertake to comply with objective and transparent quality criteria (training, audit, insurance, etc.). Sometimes, financial aid is conditional on the use of qualified labelled professionals.
- **Discuss with the installer the dimensioning of the installation**: whereas undersized equipment often creates discomfort, oversized equipment may be proposed “just to be on the safe side” whereas oversized equipment consume much more energy (and cancel the expected gains from shifting to a more efficient equipment), cannot operate efficiently and risks having a reduced life time.

3.2. – Heating - Choosing highly efficient equipment

3.2.1. New heating equipment - Context information

- Old installations operate with high-temperature water (60 to 70 °C) whereas newest ones with **low-temperature water (35 to 45 °C)**. A new boiler can be adapted to the existing installation by heating at high temperature but will be more efficient at low temperature. For example, **it may be necessary to change the radiators** so that they can heat with low temperature water.
    - For wood or pellet boilers, or high-temperature heat pumps: radiators can be kept if they are in good condition.
    - For high-efficiency boilers, low- or medium-temperature heat pumps, solar panels: existing radiators can work as low-temperature emitters if they are made of cast iron and/or large. The installer should check whether this is a possible option. If not, they will have to be replaced by low-temperature heat emitters, such as "soft heat" radiators or underfloor heating.
    - The installation of underfloor heating can only be considered as part of a major renovation because it implies making a new slab, raising the floor, etc.
- **Additional heating sources** can be a good idea provided it is well planned. It is possible to complement a central heating system:
    - **With an auxiliary wood heating**: fireplace insert, closed fireplace or wood stove can be used to maintain a good level of comfort when the boiler is switched off, for example in the off-season, on a cool evening or a rainy day.
    - **With a solar or thermodynamic water heater** which can supplement the central heating system by producing a large part, if not all, of the domestic hot water throughout the year.

    - **With a heat pump combined with a boiler**: an air-to-water heat pump can be integrated into a central heating system in good condition. The heat pump provides heating above an outdoor temperature set by the installer. The boiler takes over when it gets colder and produces domestic hot water. This solution allows fuel savings to be made. Necessarily implemented by an experienced professional, the installation can comprise two independent pieces of equipment, possibly keeping the old boiler, or take the form of a hybrid system.
- In general**, small electric radiators, oil or gas stoves greatly increase consumption**. Some of them are not safe: they can emit carbon monoxide, a deadly gas if inhaled in large quantities, and encourage the growth of moulds due to the release of humidity.

3.2.2. Choosing transmitters with efficiency and comfort in mind

- Installing emitters that give off heat by both radiation and convection provides optimum comfort.
    - **Convection heats the air in the room**. It can be natural or forced, using a pump, turbine or fan. The closer the temperature of the radiator is to that of the air, the greater the comfort obtained.
    - **Radiation heats bodies, walls, objects** and provides a pleasant and quick feeling of comfort.
- **Various type of transmitters (convection, radiation, forced radiation, a mix of these) provide different level of comfort**:
    - Water radiator → quite good comfort
    - Low-temperature water radiator → pleasant warmth, good comfort, possible re-use of radiators from an old installation
    - Water or electric underfloor heating → pleasant warmth, good comfort, no visible appliances, requires major work
    - Electric convector → low-cost transmitter, poor comfort, dries out the room air, poor performance and high operating costs
    - Electric storage, inertia or heat transfer fluid radiator → quite good comfort, allows you to benefit from an electric night rate, large volume of emitters, does not heat up quickly
    - Radiant panel (electric) → more efficient than convectors, easy to install, medium comfort, dries out the room air, relatively inexpensive
    - Radiant ceiling (electric) → maintenance-free, no visible appliances, economical in use, good comfort, requires ceiling renovation, expensive equipment, reduces ceiling height
    - Fan convector → heats up the air quickly, no radiation, medium comfort
    - Hot air outlet → heats up the air quickly, no radiation, medium comfort
    - Wood stove → easy installation, quite good comfort, pleasant wood fire
    - Insert, closed fireplace → quite good comfort, pleasant wood fire, chimney required for an insert

3.2.3. The different types of heating systems

3.2.3.1. Electric heating

- Its **general inefficiency (because a lot of primary energy is lost in the process of producing electricity** that is transformed again into heat) makes it so that electric heating is banned in some countries, whereas it is promoted in others (e.g. in France where there is a lot of nuclear electricity base-production).
- Its efficiency depends a lot on the heat emitters: convectors, underfloor heating, radiant panels, inertia or storage radiators have different performances.

- Its installation is inexpensive, but it is expensive to use. For this reason, it can only be considered in a perfectly insulated dwelling, with transmitters equipped with programming clocks.
- Its maintenance is not very demanding.
- It is well suited to small spaces.

3.2.3.2. Gas or oil heating

Gas and oil heating are not advisable because of their greenhouse gases emission. Several countries are even banning or discouraging oil heating. If gas heating is considered, the best choice is a condensing boiler:

- It is robust, reliable and efficient, especially with low-temperature emitters (underfloor heating, "soft heat" radiator) and regulation according to the outside temperature.
- It can be coupled with a system using renewable energy, such as solar thermal.
- Installed against an outside wall, a boiler can be equipped with a suction cup to evacuate the fumes directly outside. This device makes it possible to install a boiler in a small unventilated space.

3.2.3.3. The micro-cogeneration boiler

- It is efficient and produces in addition electricity. This electricity is usually consumed on site or fed into the electricity grid.
- Expensive to buy, its electricity production is all the more important as heating needs are high.

3.2.3.4. Heat pump

- **It is economical in use and efficient, with a seasonal energy efficiency of over 100% in heating mode.**
- The geothermal heat pump is the most efficient: it recovers approximately constant heat from the ground and does not need any additional heating to meet all heating needs.
- The aerothermal heat pump makes good use of the heat drawn from the air but is more sensitive to variations in outside temperatures. Consequently, its efficiency is variable, which requires a back-up system, usually electric and integrated into the system.
- It is expensive to buy and pays for itself more quickly in a home with high heating needs.
- It requires regular maintenance, in particular to check the condition of the circuit containing the refrigerant fluid, a powerful greenhouse gas if it is released into the air.
- Some models can complement an existing system.
- Heat pumps can further improve their performance by finding other sources of heat, such as air extracted by ventilation or waste water.

3.2.3.5. Wood furnaces and stoves

- Boilers and pellet stoves are the most efficient. **The performance of wood-burning appliances is constantly improving.**
- Stoves are moderately expensive, the most expensive are not necessarily the most efficient. Aesthetics have a significant influence on the price.
- The automatic feed boiler represents a significant investment, but it is possible to reuse the distribution and emitters of an existing central heating system.
- A storage area for wood is required.
- Non-automatic systems and stand-alone appliances involve handling.
- Care must be taken to ensure good smoke extraction.

- The installation of a buffer tank extends the service life of the wood boiler. It stores the surplus heat produced and releases it later.

3.2.3.6. Solar heating

- **It is very economical in use.**
- It can be combined with a conventional central heating system.
- It covers between 20 and 50% of heating and domestic hot water needs depending on the sunshine conditions, the technology used and the characteristics of the installation.
- A supplement is essential, it will have an impact on the performance of the system.
- This system is expensive to purchase.
- There are so-called "packaged" systems: they provide the entire system, including its back-up. Wood/solar or heat pump/solar couplings offer good coverage by renewable energy.

3.2.3.7. Circulation pumps

- Circulation pumps are a **component of various heating systems**: they transport the hot water from the heat generator (boiler, heat pump) or from the heat storage tank (solar etc.) to the heat consumption, i.e. underfloor heating or radiators. In most cases, a hot water storage tank is also supplied via the heat generator.
- **Their energy consumption is considerable**: e.g. in Switzerland, they account for around 3% of total electricity consumption, i.e. about as much as washing machines and dryers combined. But these pumps can account for up to 10% or more of a household's electricity consumption, especially because they are oversized.
- **The latest generation of pumps consumes up to ¾ less energy than older models**: when purchasing a new pump, a correctly dimensioned Class A model should be required, otherwise the opportunity will be missed for many years to come. The generated electricity savings over their lifetime compensates for their higher purchase price.
- **Correct sizing and correct regulation (and relation to the thermostat) are the two key points to watch and on which installers should commit**[6].

3.2.4. Comparing different types of heating systems

3.2.4.1. Technical terms to understand

- The **nominal power** (Pn), expressed in kilowatt (kW), is the maximum power that the equipment (oil, gas boiler, wood heating appliance) can supply continuously.
- The **efficiency** expressed in % reflects the efficiency of the appliance or system (boiler, solar panel and its back-up...), i.e. the energy it can provide in relation to the energy consumed. The higher the efficiency, the more efficient the equipment is.
- The **emission factor** of a wood-burning appliance reflects the amount of pollutant or greenhouse gas emitted per unit of fuel burned.
- The **coefficient of performance** (COP) of a heat pump is the ratio between the amount of heat it produces and the energy it consumes, under given conditions. It therefore reflects its efficiency.
- **Seasonal energy efficiency** (η) reflects the overall efficiency over the entire heating season, not just when a boiler burner is running. Expressed in % and as primary energy, it can be higher than 100% in the case of systems using renewable energy.

  The actual COP and seasonal energy efficiency are different from those indicated by the manufacturer, which are calculated in a laboratory under defined conditions.

[6] See the “per-mil-rule” in the corresponding Topten / HACKS criteria paper.

Likewise, the actual performance of a solar domestic hot water or heating system depends on the technology used, its use and the solar radiation it receives (variable according to orientation, shadows, cloud cover, etc.).

3.2.4.2. What should be compared?

- The **efficiency** of the most common heat production equipment is a function of its output and the possible share of renewable energy in this production.
- **Heating systems using renewable energy sources are generally very efficient and produce more energy than they consume**.
- The comparison between systems, presented below, is possible using **primary energy efficiency**.
  Electricity does not exist in nature in a form that we can use directly. It comes from the transformation of a primary energy (nuclear, fuel oil, wind, solar, hydraulic, biomass): it is therefore a secondary energy. This transformation is accompanied by upstream losses: it is considered that in order to benefit from 1 kWh of final electrical energy, 2.58 kWh of primary energy must be used (this French coefficient may be different in other countries for policy reasons and depending on their energy mix).

- **Primary energy efficiency for heating** (measured in laboratory):
  - Electric radiators have an efficiency of 38% maximum and generally use non-renewable energy (though electricity can be from renewable sources).
  - Gas or oil-fired condensing boilers have a 92% for gas and 89% for fuel oil, on average, seasonal energy efficiency on gross calorific value, with recovery of energy contained in the flue gases; they use non-renewable energy (fossil).
  - Aerothermal heat pumps have a 110% seasonal energy efficiency for aerothermal heat pumps at medium and high temperatures, 130% for those at low temperatures; they use renewable energy (heat from the air) and electricity to run the heat pump.
  - Geothermal heat pumps have a 140% seasonal energy efficiency for geothermal heat pumps at high temperatures, 190% for those at low temperatures; they use renewable energy (ground heat) and electricity to run the heat pump.
  - Wood-fired boilers have a 65 to 90% for log boilers 75 to 105% for pellet and wafer boilers efficiency, they use renewable energy.
  - Solar combi-systems have a 90 to 110% efficiency and use renewable (solar) and other auxiliary energy (usually electricity or gas).

3.2.5. Heating, selecting most efficient equipment: Topten / HACKS selection criteria

Once the choice is made – with the support of professional advice - on the source of energy and the heating system, the Topten/ HACKS Criteria Papers[7] present how the various equipment work, and the key points to watch when choosing a specific model, within a specific product category. When possible, the Topten / HACKS selection criteria base on the European energy label and on national quality labels.
The Topten / HACKS product lists present a range of precise models and brands compliant with demanding selection criteria that are tailored to national markets, available on these national markets, and that have the best energy and environmental performances.

[7] https://www.topten.eu/private/page/hacks-deliverables

3.3. Hot water - Choosing highly efficient equipment

This section focuses on hot water production, excluding equipment for combined heat and hot water production.

3.3.1. The different types of hot water production

3.3.1.1. Electric water heater

This system heats the water contained in a tank by means of an **electric resistance**. It can be set to heat the water as soon as the desired temperature drops or only at a fixed time, to take advantage of off-peak rates for example. It is not very efficient, and to avoid heat losses, it is recommended to insulate it.

3.3.1.2. Thermodynamic water heater (TWH)

Heat pump dedicated to the production of domestic hot water that **recovers energy from the ambient air**, extracted or outside (aerothermal) or from the ground (geothermal). It requires a supplement energy, usually electric, to ensure the production of domestic hot water all year round. The different systems are:

- TWH **on outside air**, which is most sensitive to the outside temperature.
- TWH **on ambient air**, which cools down the air in the room where it is installed and leads to overheating and is therefore not recommended.
- TWH **on extract air**: coupled with the ventilation system of the dwelling, it is efficient but often more expensive and requires the presence of a controlled mechanical ventilation system.
- **Geothermal** TWH is very efficient, suitable for harsh climates, but more expensive. It is necessary to have a free surface in the garden to install the geothermal collector (buried pipes) connected to the TWH.

3.3.1.3. Individual solar water heater

- This system requires a boiler, electric pin, etc. to ensure the **production of domestic hot water in all seasons**.
- The **monobloc** type is a simple and robust thermosiphon system, with a water reserve located outdoors, integral with the solar thermal collectors. It is **suitable for hot regions**.
- It can have separate elements with a storage tank placed under cover in the dwelling (garage, storeroom...) which can be kept away from the solar collectors. There are two types of models:
    - the **forced-circulation model**, which forces the circulation of the heat-transfer fluid using a small pump: this is often the most widely installed system in temperate climate.
    - the **thermosiphon model**: the tank is located higher than the collectors, and the fluid circulates naturally (hot water being lighter than cold water), without the need for a pump, which reduces energy consumption.

3.3.2. Comparing different types of hot water systems

Efficient systems using renewable energies are available to produce domestic hot water. As with heating equipment, the efficiency of domestic hot water equipment can be compared **using the primary energy efficiency**. Primary energy is the energy available in nature before any transformation; Final energy is the energy actually delivered to the consumer. It corresponds to the primary energy minus the losses due to its transformation and transport. Systems using renewable energy sources have a very good overall performance and produce more energy than they consume.

Primary energy efficiency for domestic hot water (measured in a laboratory):

- Electric water heater: efficiency less than 30% taking into account the heat losses related to the storage of hot water; Type of energy used: Non-renewable energy (electricity can be from renewable sources).
- Solar water heaters: efficiency depending on the installation: from 60 to 130% (integrated electrical back-up), from 90 to 190% (integrated gas back-up), from 95 to 150% (instantaneous back-up) (solar coverage of energy requirements generally between 50 and 70%); Type of energy used: Renewable and non-renewable energy for back-up (except if wood back-up).
- Thermodynamic water heater: efficiency 90 to 160% depending on the technology; Type of energy used: Renewable (air heat) and non-renewable energy for back-up (except if wood back-up).

3.3.3. Hot water, selecting most efficient equipment: Topten / HACKS selection criteria

Once the choice is made – with the support of professional advice - on the source of energy and the heating system, the Topten/ HACKS Criteria Papers[8] present how the various equipment work, and the key points to watch when choosing a specific model, within a specific product category. When possible, the Topten Hacks selection criteria base on the European energy label and on national quality labels.
The Topten / HACKS product lists present a range of precise models and brands compliant with demanding selection criteria that are tailored to national market, available on these national markets, and that have the best energy and environmental performances.

3.4. Cooling - Choosing highly efficient equipment

3.4.1. New cooling equipment - Context information

- For low power air conditioners, electricity consumption can range from 300 to 500 kWh/year for 500 hours of operation in a closed room. **Even the most efficient air conditioners consume more energy than refrigerators and freezers**, which are plugged in all year round.
- **Air conditioners contribute to raising global temperatures**: beyond the fact that they consume energy, they reject considerable amount of heat; especially in cities, they contribute to the formation of urban heat islands.
- Most often, **poor quality air conditioners are bought in emergency**, because of a heat wave, whereas their installation should be anticipated to best meet the user's needs:
    - Most of the time, it will be enough to equip one room.
    - The **energy label** is available to find the most energy-efficient equipment. It shows the energy class of the appliance, the annual energy consumption, the power, the EER (cooling efficiency ratio) and the noise level. Choose an air conditioner with the best possible energy class (**A+++**). Class A is the lowest energy class currently allowed on the market. Watch out: an A-class monobloc appliances has a worse efficiency than a D class split model.
    - It is better **not to rush into a low-end equipment during a heat wave: the risk is to buy unreliable, inefficient, energy-intensive products that will cost a lot of money**.
    - Call on qualified professionals for the purchase and installation of air conditioning. Most often companies must be authorized to work on refrigerating circuits and trained.

[8] https://www.topten.eu/private/page/hacks-deliverables

- Make sure the air conditioning system matches the size of the room (based on square metres). **Oversizing is not desirable because the unit cools the air faster than it can dehumidify it**. The resulting air in the room is cold and humid. On top of this, the purchase price and electricity costs of a larger appliance are higher.

3.4.2. The different types of air conditioning systems

3.4.2.1. Single-unit room systems

These relatively small units can be used to air-condition a single room.

- **Mobile air conditioners** are easy to install and can be transported from one room to another. They are inexpensive, low-powered and noisy. They should be installed near an opening for the exhaust hose (usually a window with a gap in it) that allows warm air to enter. This system is therefore not very effective and should be avoided.
- **Split mobile air conditioners** are composed of two blocks connected by tubes: an outdoor condenser evacuating the hot air, and an indoor unit delivering the fresh air. These units are less noisy than monoblocs for the user: the noisiest part is outside. This advantage can become a disadvantage for neighbours, especially in buildings. These two mobile systems are the least expensive and do not require any specific installation, they are also the least reliable, the least efficient and the most energy consuming. Often purchased in an emergency during a heat wave, they do not respond satisfactorily to the particular conditions of the home.
- **Split stationary air conditioners** are composed of two units connected by a duct. The indoor unit can be floor or wall-mounted, spandrel or ceiling-mounted, and the other unit can be mounted outside the dwelling. A specific installation is required: a hole in the wall must be made to allow the hot air duct to pass through.
  Split units are more convenient and efficient than compact units. Compact units have higher energy consumption and often do not cool enough.
  - The **Inverter technology** allows the air conditioner to adapt its speed according to the ambient temperature, which avoids the succession of starts and stops of the compressor of a conventional air conditioner. Energy savings can reach 30% (for a class A Inverter air conditioner). In addition, the fluctuation around the set temperature can reach +/- 2 °C for a conventional air conditioner, while it is only about +/- 0.5 °C for an Inverter air conditioner. All air conditioning systems on the market today are equipped with it.
  - A **reversible air-conditioning system can also perform a heating function**: it takes heat from outside and releases it inside. This is the principle of the heat pump. However, be careful: These individual air conditioners which provide a "heating" function, because they are reversible or equipped with heating resistors, are **generally not necessarily adapted to all heating needs in winter** and are very energy consuming.

Also **air conditioners have to be cooled**: In an air-cooled air conditioner, the condenser must be placed outside, because it is the outside air that removes the heat taken from the unit. If this is not possible, a water-cooled air conditioner can be installed with a waste-water cooling system: city water removes the heat, and the condenser can be installed indoors. This system **wastes a lot of drinking water and loads the room with moisture**. Monobloc air conditioners are usually air-cooled. Split and multi-split air conditioners use either air or waste water.

3.4.2.2. "Centralized" systems for a home

These systems can be used to air-condition several rooms, an entire dwelling or an entire building. Often reversible, they also represent an important investment and require the intervention of competent specialists.

- The **multi-split** is a device to which several indoor air conditioning units are connected. The equipment can be done progressively room by room and can be installed in an already built dwelling.
- **Reversible heat pumps** can power fan coil units, a cooling (and heating) floor or a ductwork (also called centralized air conditioning). The latter is expensive but efficient, it also ensures the ventilation and air renewal of the dwelling. A cooling floor or ductwork can only be installed during construction or during a major renovation.

3.4.2.3. Choosing a comfort fan

- There are different types of fans:
    - **Table fans** are suitable for individuals but cannot ventilate large rooms. They are usually not height-adjustable, so the user needs to improvise to set the right height.
    - **Floor fans** - sometimes also called air circulators - provide a pleasant circulation of air in a room. They should not be directed against a person because of their strong airflow.
    - **Standing fans** are ideal for larger rooms, as they are often height-adjustable and rotatable and can therefore reach the whole space.
    - **Tower fans** produce a lower airflow and are less energy efficient than floor fans, but the airflow produced is evenly distributed and can feel more pleasant to the user. The rotor blades are not visible from the outside, which can give a feeling of higher safety to certain people (the air is sucked at the bottom of the fan through small holes and expelled above; the oval or circular shape of the fan entrains the air that is around and inside the oval shape to multiply the amount of air being displaced).
    - **Ceiling fans**, due to their large rotor blades, are very efficient and quiet. Some models have integrated lamps. They must be installed fixedly. Larger diameter but slower fans are generally preferable respect to smaller but faster ones.
- Attention should also be paid to the **noise** of the unit when buying it. The declared sound power level corresponds to operation at the highest speed level. At the highest speed level, certain fans can be very loud and therefore difficult to use in settings such as a bedroom or an office. It is best to test the volume of the unit in the shop before buying, although it is often underestimated due to the ambient noise.

3.4.3. Cooling, selecting most efficient equipment: Topten / HACKS selection criteria

Once the choice is made – with the support of professional advice - on the source of energy and the heating system, the Topten/ HACKS Criteria Papers[9] present how the various equipment work, and the key points to watch when choosing a specific model, within a specific product category. When possible, the Topten/ HACKS selection criteria base on the European energy label and on national quality labels.
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[9] https://www.topten.eu/private/page/hacks-deliverables

Section 4 - Using HAC equipment in an efficient way

This section presents topics in relation to the correct use of equipment producing heat, cool air or hot water. Key topics for reducing the demand of heat and cooling services can be found in Section 2.

This catalogue covers products that are the most efficient technologies and that are displayed on the Topten / HACKS platforms, i.e. solar heating and solar water heating, even though efficient and largely using non-fossil fuel, are not presented here: they are not covered by HACKS because of the too many national differences concerning this type of products.

4.1. Using heating and hot water equipment in an efficient way

4.1.1. Good operation: Heat pumps and heat-pump water heaters

The environment (the ground beneath, the water from the groundwater, the air) stores the energy provided by the sun every day. Recovering this free and inexhaustible energy and using it for heating or for domestic hot water production is possible thanks to heat pumps. This electrical equipment reduces consumption of fossil fuels and related greenhouse gas emissions. There are several types of heat pumps, which draw heat either from the air (aerothermal pumps) or from the ground or groundwater (geothermal pumps). **Whatever the technology, the choice of an efficient model and the quality of implementation of the complete system (collector, heat pump, heat emitter) are particularly important.**

4.1.1.1. Heat pump installation: check all issues with the installer

- Get **impartial advice on the various HP systems** before making a choice.
- Heat pumps are sophisticated machines: their design, development, dimensioning and installation require specific know-how. They are complex to install, with choices to be made with the installer, sometimes with **administrative consequences** (e.g. get an authorisation before drilling), or **internal architectural checks to make** (e.g the air must able to circulate from one room to another: to allow this circulation, the doors must be recessed – with a space of about 2 cm at the bottom of the doors).
- HPs can be "**reversible**" and ensure a **moderate drop in temperature**, of the order of 3 to 4°C less than outside. It is therefore a cooling function and not an air-conditioning function.
- Once installed, beyond maintenance (see below) there is not much to do to use heat pumps in an efficient way.

4.1.1.2. Thermodynamic water heaters installation and operation

The performance of thermodynamic water heaters (TWH) depends on:

- The **temperature of the ambient air**: the performance decreases on average by 2% per degree.
- The **set temperature for the water in the storage tank**: TWHs work optimally at a set temperature of 55° C.
- The **water consumption**: the more the tank is emptied, the better the performance. It is therefore **essential not to oversize the tank** in relation to requirements, otherwise the performance of the appliance will be significantly reduced.
- The **location of the tank** which must not be installed in a room subject to outside temperatures (for example, avoid shelters).

4.1.1.3. Regular maintenance

- Keep in mind that in case an additional energy support is necessary, or if the HP does not produce hot water, there will be a **double maintenance** needed (one for each system).
- The **user can maintain directly** some of the HP parts/aspects:
    - For aerothermal pumps: 1) **the air must circulate freely** around the outdoor unit of an air-source pump. It is therefore necessary to regularly check that there are no obstacles (tree leaves, various objects, etc.) hindering this circulation; 2) **the air inlets and direct expansion units must be dusted and cleaned** periodically (with soapy water).
    - For geothermal pumps, the user does not have to carry out any particular maintenance himself.
- In order for the installation to maintain its performance and last a long time, it must be **monitored and maintained by a specialist every year**. In particular, the specialist will **check the tightness of the refrigeration circuit**. This check is mandatory for machines containing more than 2 kg of refrigerant (in France) and can only be carried out by a qualified company complying with existing regulations.
- Signing a **maintenance contract** means ensuring an annual visit (possibly twice a year for a reversible HP) during which a technician will carry out the list of operations defined by the contract.
- **TWH must also be regularly maintained** by a qualified professional.
- At the **end of life, HPs and TWHs must be dismantled by a specialist** who will recover the refrigerant fluid for recycling or destruction. In particular, old heat pumps contain refrigerants that are now banned. They must be recovered by a company authorised to handle fluids to be treated or destroyed.

4.1.1.4. Beware of the noise

Some aerothermal heat pumps are noisy. If the heat pump is installed outside the dwelling, it must not disturb its inhabitants or neighbours. **It may be necessary to install devices to limit the nuisance** (anti-noise screen, installation on anti-vibration mounts, etc.). In co-ownership, before installing an aerothermal heat pump, it is necessary to check that this type of device is authorised.

4.1.2. Good operation: Local space heaters and solid fuel boilers

4.1.2.1. Choose well what is being burnt

- **Favour dense hardwood logs** (beech, hornbeam, chestnut, oak, ash, robinia): they provide a lot of energy and give equipment greater autonomy. Other species (softwoods, resinous trees) are more suitable for ignition.
- Buy logs, chips or pellets bearing **quality labels or marks**. Wood fuels bearing PEFC and FSC labels also come from sustainably managed forests.
- Do not use any wood that is dirty, painted, varnished, etc., which releases toxic substances (dioxin, etc.) or corrosive substances when burning and contaminate your appliance. **Do not burn any waste of any kind**.
- **Use only one wood briquette (also called a heat log) at a time** because the heat it gives off is very important. These are small "logs", 20 to 35 cm long, made by compressing shredded wood, sawdust and shavings. They can be used in log stoves. **Night briquettes emit more pollutants** and are not advisable.
- Use logs with a **low proportion of bark**.
- **Do not put logs or shredded wood in a pellet stove**, otherwise it will damage the appliance.

4.1.2.2. Do not use damp wood. Choose dry logs that:

- Have **no fungus or mould**.
- Show **no green tint** under the bark, which should come off easily.
- Have **small cracks** that radiate from the centre.
- Are **light and resonate** when banged together.
- Give off **blue flames** when burned.

4.1.2.3. Watch moisture content

- Moisture content **should not exceed 20% for wood, 30% for chips and 10% for pellets and briquettes** because damp wood is more polluting and less efficient. Burning moist wood:
    - Provides less energy than dry wood.
    - Releases significantly more polluting substances that are dangerous to health.
    - Prevents efficient appliances from reaching their full power.
    - Harms the equipment which clogs-up more quickly and is likely to deteriorate.

4.1.2.4. Good Storage

- Good storage allows the wood to dry well and the pellets to retain all their qualities.
    - **Outdoors, suitable for logs**: Cut the wood and split the logs before storing them for faster drying and more efficient combustion. Dry logs that are too damp for 18 months on pallets or slats under a covered, well-ventilated shelter or breathable tarpaulin.
    - **In a room, suitable for dry logs, chips, granules in bags**. Store the fuel preferably slightly elevated, in a dry and well-ventilated room (garage, ventilated cellar). Store 10 to 15 logs next to your fireplace, 24 to 48 hours before using them to complete the drying process.
    - **In a silo, suitable for pellets and granules in bulk**. Silos are sensitive to moisture and can deteriorate quickly if not stored in a suitable place. Whether "turnkey" or custom-built, silos must be watertight and airtight to prevent the dispersion of dust when pellets are delivered. **It must also be easily accessible and close to the boiler**.

4.1.2.5. For an optimum performance

A **wood-burning appliance must run at full capacity to be efficient**. Its performance deteriorates as soon as it idles: it consumes more, becomes clogged and pollution increases.

- **Ask the installer for assistance the first time of use**. He or she will give useful advice and point out good practices to make the most of the appliance on a daily basis.
- **Follow the instructions in the manual** carefully: Not all appliances work in the same way. The instructions will tell how many logs to put in your appliance and how to set the right amount of fire.
- **Reverse ignition for less pollution**: In reverse ignition, instead of being transformed into polluting gases, the gases generated by combustion are smothered in the flames and in turn end-up as fuel. This type of ignition is therefore less polluting than the traditional method, but is also more energy efficient and therefore more economical.
    1. Open all the air inlets of the appliance.
    2. Stack the logs, the smaller diameter logs at the top. Do not overload the firebox and space the logs to allow air to circulate.
    3. Place small pieces of dry softwood and an ignition cube (without petroleum product) on top.
    4. Light the cube and close the door.

5. Turn down the air supply after 30-40 minutes if your fireplace was cold when lit and after 10 minutes if it was already warm.

- **Check the chimney draught**: The draught is the suction created in the chimney flue. A well-adjusted draft is essential for the proper functioning of the installation.
    - The **draught is too weak**: If the wood burns poorly and thick smoke is produced, or if the glass gets dirty quickly, there is insufficient draft. Combustion is of poor quality, hence the installation pollutes more and its efficiency decreases.
        - Open the air inlets immediately.
        - Check the draught setting, referring to the recommendations in the manual or the advice of your installer. For pellet stoves, the draught control is probably automatic.
        - Make sure that the operation of any cooker hood or the opening of windows does not interfere with the draught.
        - Check that the flue is tight and not clogged or dirty.
    - The **draught is too strong**: This is the case if the wood is burning too fast and the temperature of the appliance is too high. The appliance overconsumes and wastes energy. It also emits more fine particles. If the flames are sucked into the flue, depending on the type of appliance, reduce the pull key according to the instructions or have the speed of the extractor checked.
- **Make sure that the combustion goes well**: Complete combustion ensures low pollutant emissions and produces a lot of energy. This is the case when the ember bed burns quietly. It emits very little smoke and the smoke is white because it is very rich in water vapour. The glass of the appliance is not very dirty.
    - Close the fireplace.
    - Make sure there is a sufficient air supply. When lighting a stove, open all the air supply dampers and only reduce the air supply when the fire has well established (after about 30 minutes). In a log boiler, split the load.
    - Check that the operating speed is sufficient. Caution, slower combustion is incomplete combustion, which emits more pollutants.
    - When recharging your appliance, open the door in two stages to prevent ashes from flying out.
- **If the glass gets dirty**: Open the pull keys. If this often happens with a recent appliance, it is not normal. Ask the installer for advice: he will tell how to properly adjust the appliance to avoid this malfunction. Caution! This can also be caused by a dimensioning error: the appliance is too powerful for the needs.

4.1.2.6. Regular maintenance

This is a guarantee to keep the appliance in good condition and for a long time. It is also essential for safety.

- **Cleaning and checking inserts, closed fireplaces or stoves**
    - Empty the ashtray frequently: running your appliance with a full ashtray can damage it over time.
    - Regularly clean the appliance window with a damp cloth and fine ashes, which are just as effective as commercial products that can damage the window sealing film.
    - Also clean the inside of the hood and the hot air grilles.
- **Cleaning and checking boilers**
    - Clean and empty the shop regularly and systematically at the end of the heating season. To vacuum the heating chamber, use an ash hoover and not a domestic appliance.
    - Regularly check the fuel level in the silo of the automatic boiler.
    - Leave the door open during the summer.

- A **poorly maintained appliance is less efficient and pollutes more**. Annual maintenance by a qualified person is compulsory for a boiler, and highly recommended for other types of appliances (pellet stoves, log stoves, inserts) to check the condition of the joints and the burner in particular. A maintenance certificate will be given that should be kept for at least 2 years (for insurance purposes).
- **Mandatory chimney sweeping**: Without regular chimney sweeping, the flue pipe of a wood-burning appliance becomes clogged and can even become blocked, which can lead to poisoning or chimney fires. Soot-removal is therefore essential for safety. This maintenance is also a guarantee for the longevity and proper functioning of the appliance: 1 millimetre of soot deposited in the flue causes 10% more wood consumption.
  Soot removal by a professional is mandatory, generally once a year, twice if the consumption of the appliance is more than a certain amount. A chimney sweeping certificate is delivered, which should be kept and can be required by insurers in the event of a claim.
  Avoid the use of chimney sweeping logs, as they have not proved their effectiveness.

4.2. Using Cooling equipment in an efficient way

4.2.1. Good operation: Air conditioners

4.2.1.1. Air conditioners: Functionality

- For cooling, **set the thermostat at a minimum of 26°C**. Generally, it is sufficient to lower the temperature of the rooms of a maximum of 6 degrees compared to the external one. A greater cooling fatigues the body and increases the risk of colds (see also Section 2).
- **Use the equipment only when it is really hot outside**.
- **With splits, keep doors and windows closed** when the air conditioner is on.
- With compact appliances, verify that the opening, from which the **air enters, faces north.**
- **Turn off** the air conditioners if there is no one in the rooms. Switch off the air conditioning as early as starting from an absence of one hour. **Use a timer** not to forget the evening shutdown.
- Some reversible room air conditioners provide a "heating" function. **They are generally not suitable for winter heating requirements** because they are not dimensioned for this.

4.2.1.2. Cooling: during the installation

- Ensure that the **fresh supply air can circulate** freely and that no furniture, walls or curtains block the air flow.
- If possible, install the outdoor part of the split unit **in a location that does not receive sunlight**. Also make sure that there is enough space around the unit for air to circulate. If an air conditioner is mounted near the corner of a room, look for a unit that can **send the airflow in the right direction**.
- **Adjust the capacity** as necessary given the location of the external unit:
  - If the room is heavily shaded, reduce capacity by 10 percent.
  - If the room is very sunny, increase capacity by 10 percent.
- Anyone using a compact air conditioner must make sure that the **exhaust pipe is well sealed** to the outside. Do not leave any windows open nearby and fill any small gaps. Otherwise the hot exhaust air will be drawn in again. As far as possible, fresh air should enter from the north side in a controlled manner.

4.2.1.3. Care and maintenance

- Maintain air conditioners following the indications of producers. Regular **cleaning of the heat exchangers, the condenser and the evaporator** are particularly important. Otherwise the performance of the device can also reduce by about 50 %. Regular maintenance is important also for hygiene reasons.
- **Some parts can be maintained by the owner**: change or clean the filters of individual appliances every six months, dust and clean the air vents often with soapy water.
- **Entrust the maintenance and servicing of systems to professionals with a certificate of competence in handling refrigerant**s.
- If the system has air ducts (e.g. if connected to a ventilation system), have them cleaned every three years: they become dirty and can generate a health risk.
- In many countries, for air-conditioning and reversible heat pump systems with a cooling capacity of more than 12 kW, a **periodic inspection is mandatory** – sometimes even below 12 kW.

4.2.1.4. Dismantling

- Air conditioners contain **refrigerants. Their leakage into the atmosphere (breakdown, improper disassembly, etc.) is harmful to the environment** because they are greenhouse gases. The dismantling of an installation must be carried out by professionals.
- **Private individual should never dismantle the system themselves**, as this may release all the refrigerants in the system into the atmosphere.
- An individual appliance should not be thrown away just anywhere: take it to a **waste disposal site** so that the refrigerant it contains can be recovered and recycled.

4.2.2. Good operation: fans

4.2.2.1. Fans: Functionality

- See **Section 2 for advice on using fans in the summer**.
- **In winter, ceiling fans can also be used as a way to push the warm air downwards especially in rooms with high ceiling**s. In rooms with a height of up to 2.6 meters, ceiling fans can be operated in reverse to distribute heat: the air flow is directed towards the ceiling and flows down the walls downward. In the occupied zone the air speed is very low and hardly noticeable. This mixes the temperature in the room and creates a pleasant feeling. In summer, the fan should be operated in normal direction of rotation, so that the air flow is directed directly downwards. The air speed in the occupied zone becomes higher and provides cooling.

4.2.2.2. Fans: correct installation

A fan should be positioned in a way that is the most comfortable to the user. Some people prefer a direct breeze, while others not.

- The unit should be placed in such a way that the **generated airflow is not obstructed** by any objects and it can flow freely.
- Colder air lies on the floor while warmer air rises to the ceiling. For better cooling, the **fan should be placed close to the floor to move the colder air upwards**. This can be easily done with a floor fan.
- In the evening or early in the morning, **when the air outside is cooler, the fan can be directed outwards to blow the warm air outside**. New fresh air can enter the room through a second open window.

4.2.2.3. Fans: low maintenance requirements

Maintenance requirements are low for comfort fans.

- For people prone to allergies, it is recommended to regularly **dust the appliance** or vacuum it.
- **Tower fans** gather the most dust in their rotors and they **are more difficult to clean** because they need to be taken apart. The efficiency of the product will also suffer if not maintained as the dust will hinder the airflow of the product.