AIRCO SAVER

Physical / thermodynamic basics

Thomas Brandner, 08.02.2009

What is the Aircosaver?

The Aircosaver is a control unit which adds intelligence to simple aircon units and improves their overall efficiency.

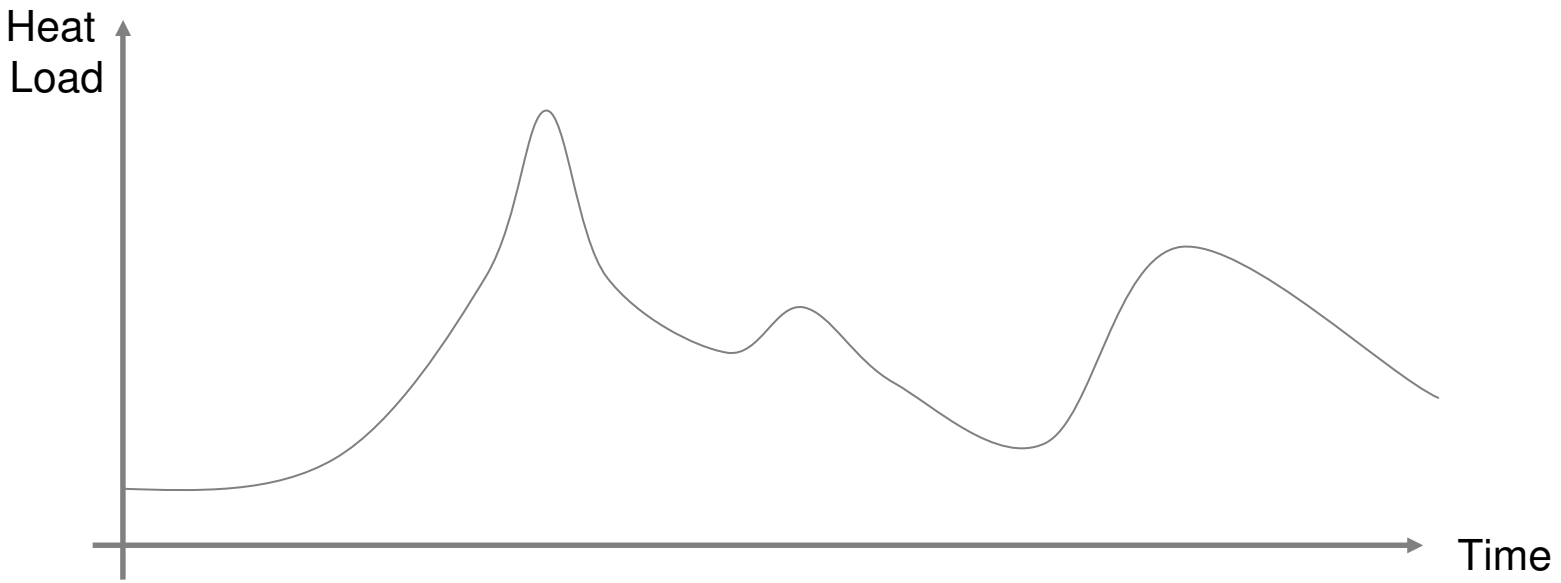
Why are savings possible?

An aircon system together with a room can be modelled as a thermodynamic system. The system efficiency varies!

- During the cooling process with simple On/Off compressors (NOT Inverters) there are stages of higher efficiency and of low efficiency.

Why?

- Below is a picture of a typical heatload curve in a given room. This looks similar both over a day and over a year.



Why is it a dynamic system?

3 components interact dynamically:

1.) Compressor (motor) → **ELECTRICAL**

2.) Refrigerant cycle with evaporator and condensor → **MECHANICAL**

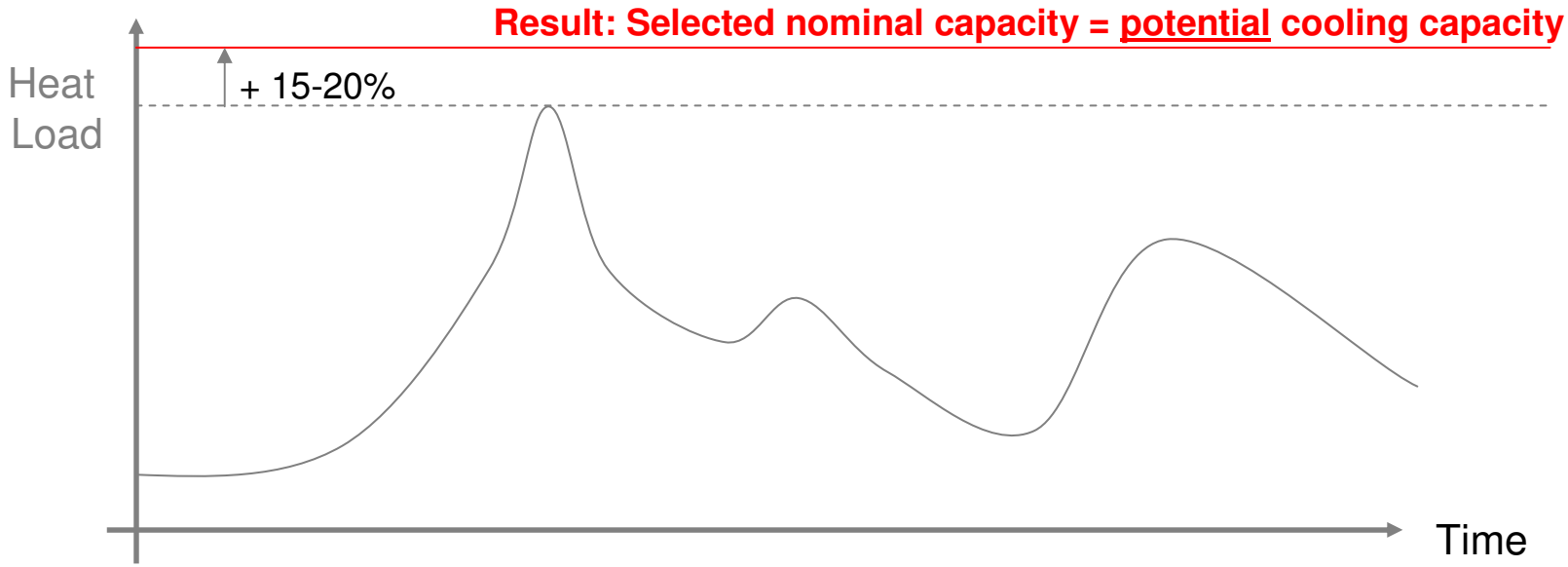
3.) Room to be cooled → **MECHANICAL**

Cooling a room is highly dynamic in thermodynamic terms! Energy transfer and efficiency changes dramatically over time.

Sizing of aircon systems

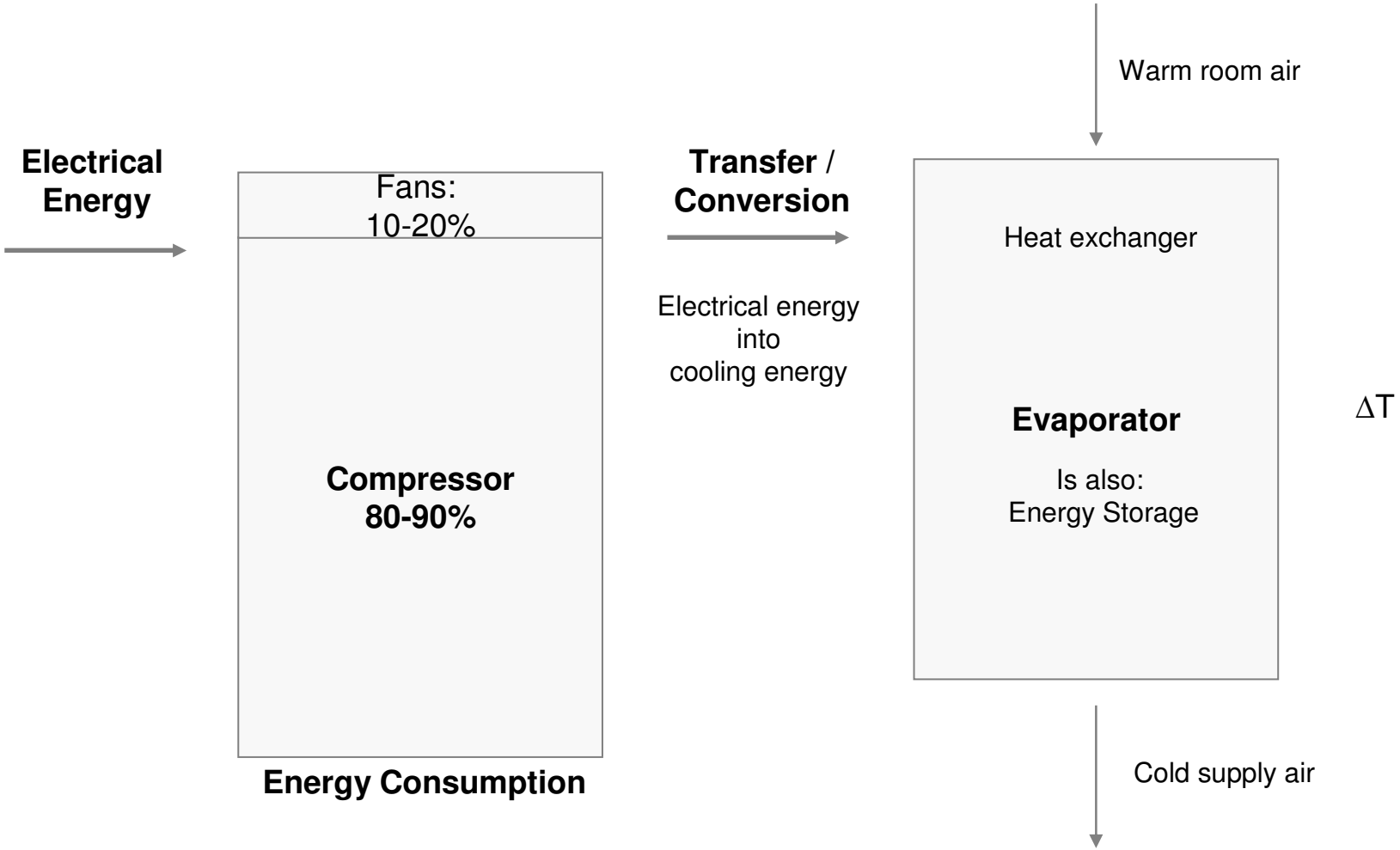
Aircon systems are usually sized to handle peak load conditions.

In most cases the contractor / sales person adds 15-20% in size „to make sure“.



Aircon systems are most efficient when all potential cooling provided by the compressor can actually be transferred into the room air. This is very seldom the case because in most situations the room air can simply not take up all of this cooling energy (partial load).

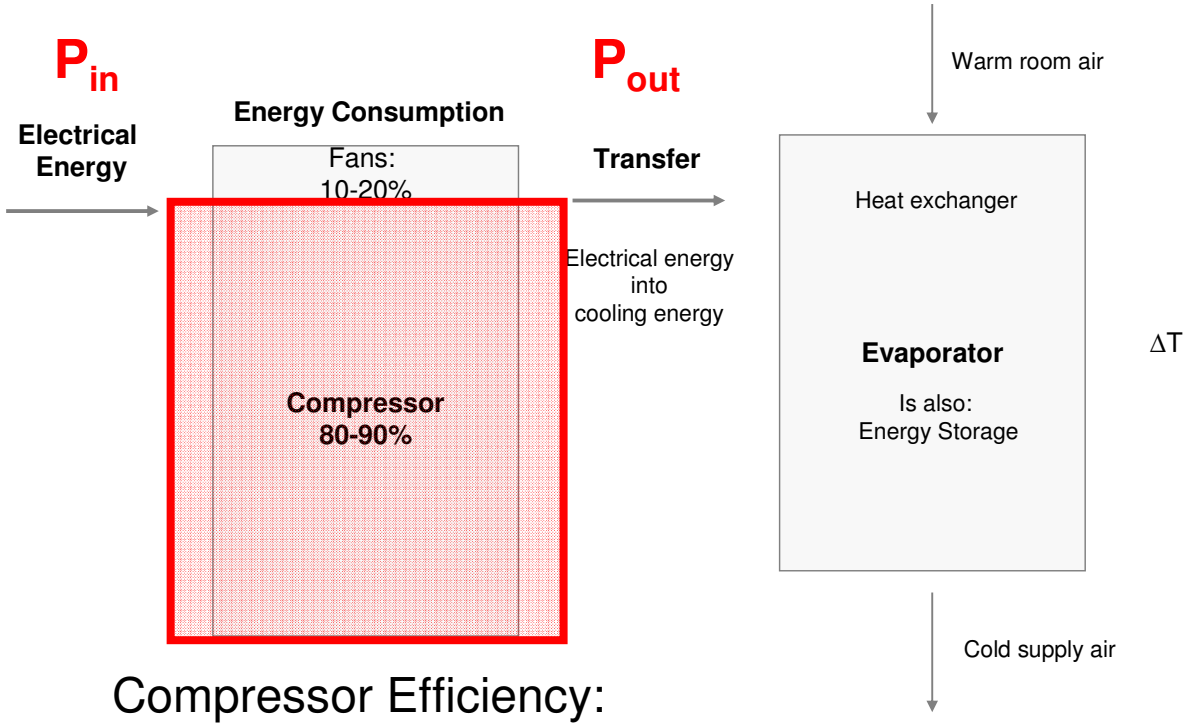
System view of an aircon system



Let‘s look at the use of the electrical energy!

Our aim is to save <u>electrical</u> energy!

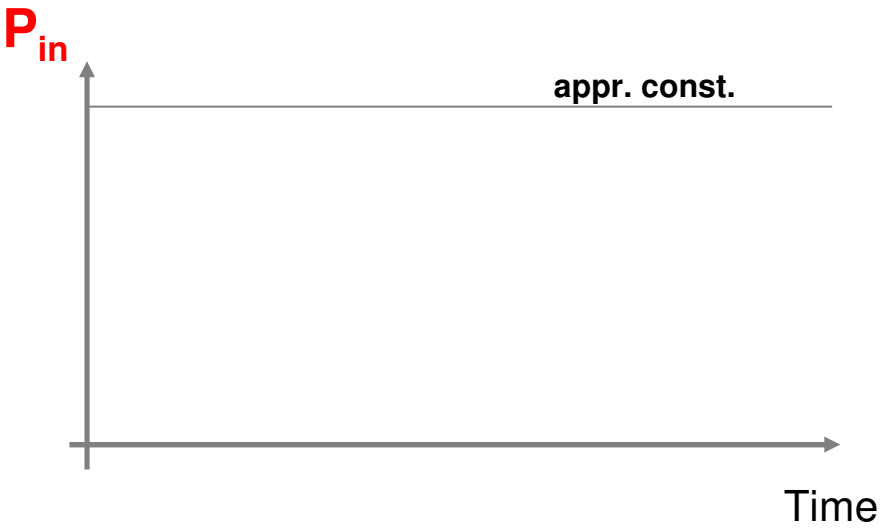
Therefore, we need to look at the efficiency of the largest electrical consumer: the compressor!



Compressor Efficiency:

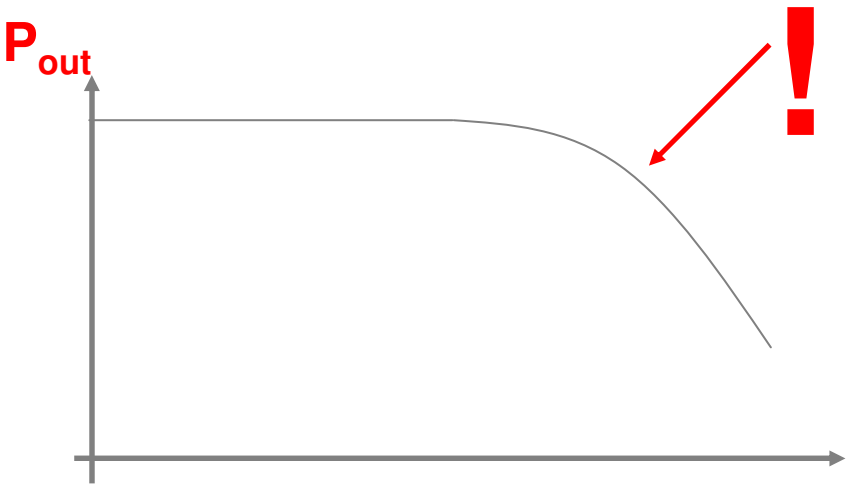
$\eta = P_{out} / P_{in}$

What does P_{in} look like?



- The electrical power consumption of the compressor is almost constant (whenever the compressor is running).
- There are hardly any variations relating to actual heat load.

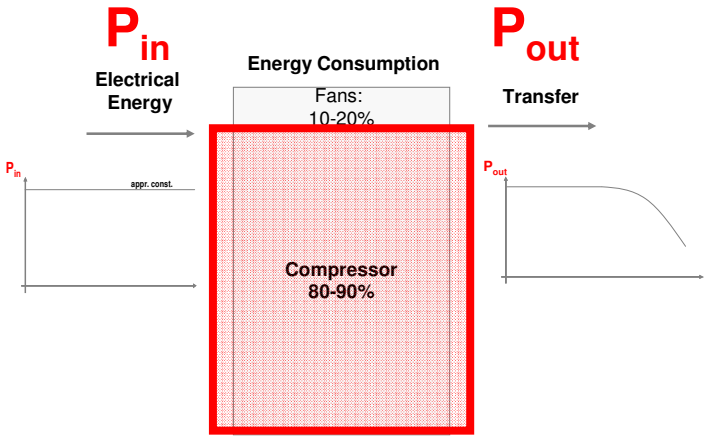
What does P_{out} look like?



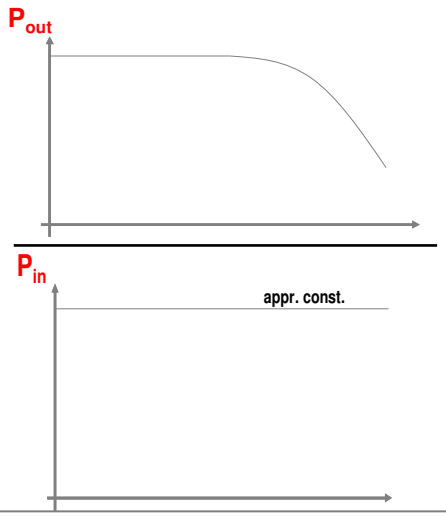
- In the first part of each cooling cycle (thermostat closed) the compressor manages to move a large quantity into the cooling cycle and into the room.
- The refrigerant cycle, including evaporator and condensor acts as an energy storage, too.
- **KEY POINT:**

  In most situations the single-speed compressor can supply more (potential!) cooling energy than the room air can take up.
- The energy storage slowly fills up.
- At one stage thermodynamic saturation is reached. The refrigerant cycle (storage) is fully charged and can only accept a small percentage of the available cooling potential from the compressor.

Now, let‘s come back to the compressor efficiency



Compressor Efficiency: $\eta = \frac{P_{out}}{P_{in}}$ =



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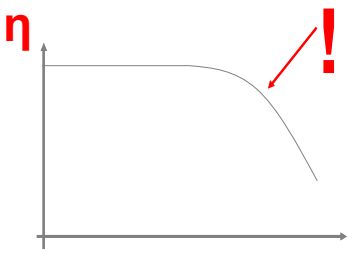


AIRCOSAVER Control Approach

The compressor efficiency worsens significantly at a certain (variable!) stage during each cooling cycle.

This stage can be detected by monitoring and analysing the supply air behaviour and extracting various parameters:

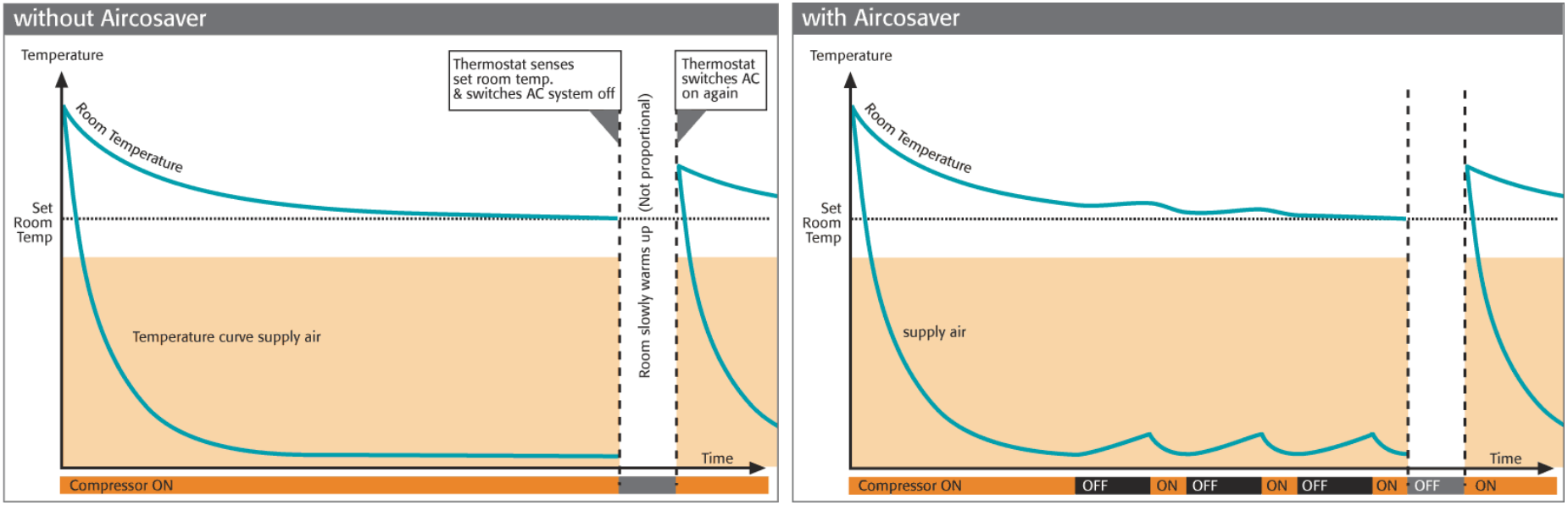
- Absolute & relative temperature levels over consecutive cycles
- Temperature behaviour over time
- and several more.

When thermodynamic saturation is sensed, the compressor is switched off. Stored energy is used up. When the compressor is switched on again later, it will operate at higher efficiency levels again.

In doing so, the most inefficient stages of the cooling cycle are eliminated and overall system efficiency is improved.

<u>Important:</u> Anti short cycling measures are maintained and are implemented in the AIRCOSAVER software.

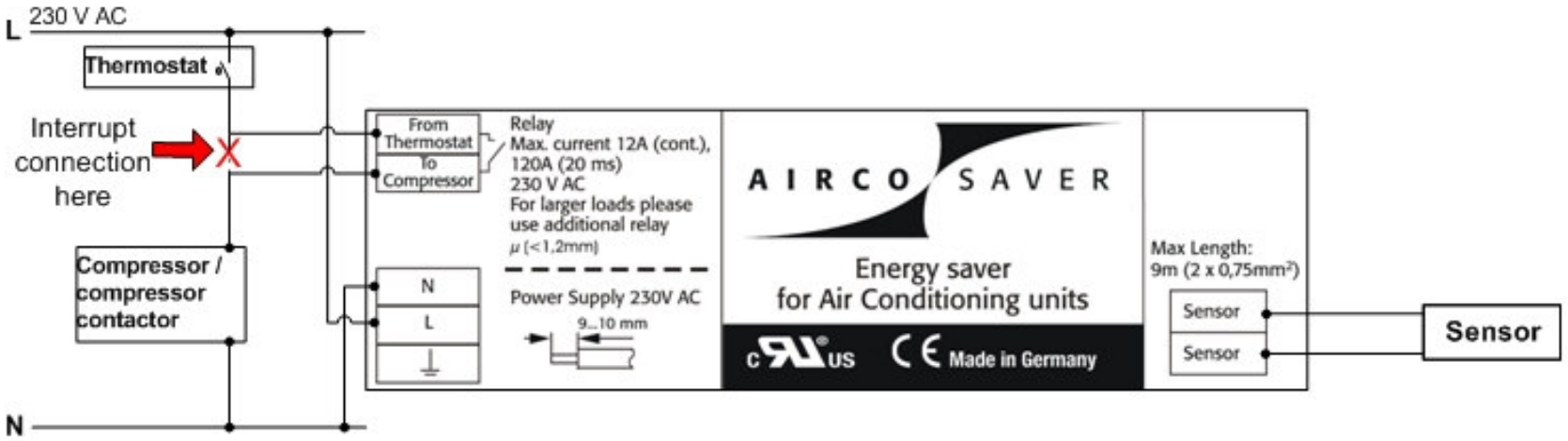
How does the AIRCOSAVER work?



A very simple AIRCOSAVER analogy

- Imagine a sink with a drain and a tap
- The tap can only be turned full on or completely off. Nothing inbetween.
- The tap usually can deliver more water than the drain can take (partial loads).
- So when the tap is turned on, the water in the sink will rise
- The aim is to achieve a constant flow out of the drain without spilling any water.
- The water level rises and rises
- At one stage the water will start to spill over the sink (thermodynamic saturation)
- At this stage the tap can be turned off and the water in the sink will continue to flow out of the drain
- Later, the tap is turned on again before the sink is empty and the sink fills up again.
- So, no spillage – that means best efficiency.
- (In this analogy inverter systems would adjust the flow of the tap accordingly, not just on/off.)

How is the AIRCOSAVER wired?



- The thermostat remains in control.
- The Aircosaver only optimizes how the cooling is achieved.

For which aircon systems is AIRCOSAVER suitable?

DX (direct expansion) aircon systems

- Single speed (On/Off) compressors
- Up to approx. 10 tons
- Single evaporator
- Single compressor (suitable for some dual compressor systems, too).

→ **Single split systems, window units, some packaged systems.**

Not suitable for

- Inverter systems (they already have this kind of intelligence)
- Multisplits
- Chilled water systems
- Evaporative aircon systems