

Net Zero Energy Buildings: Passive Heating, Cooling, and Ventilation

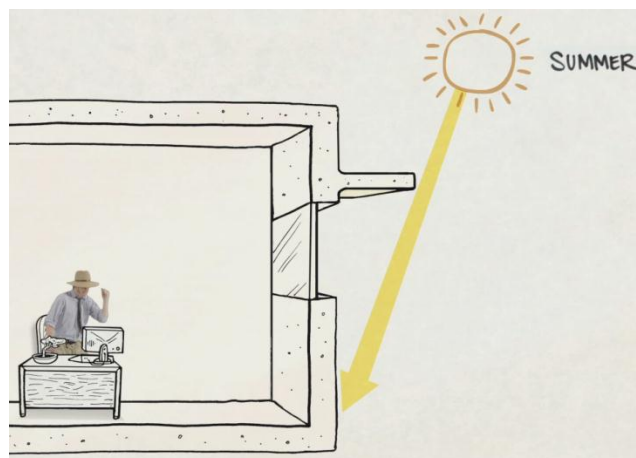
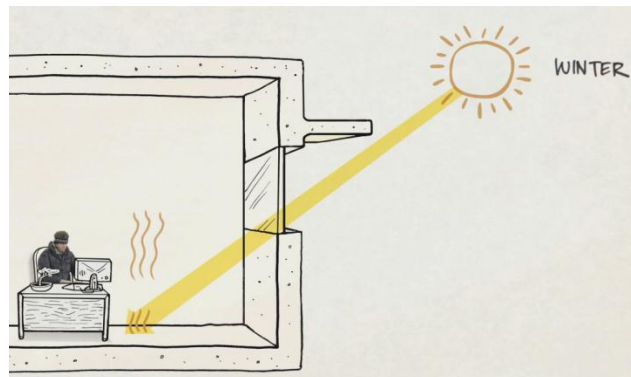
Companion to the video: Script and Illustrations

The first step to affordably producing as much energy as your building consumes is lowering the amount of energy it takes to keep your building comfortable.

Maintaining the right interior temperature, humidity, and air quality often accounts for THIRTY PERCENT or more of a building's energy use. But you can do this passively, without demanding purchased energy at all!

Designing passively means working with external weather conditions, instead of fighting against them.

For example, building orientation, overhangs, and other features can be designed to capture the sun's heat in cold times, and avoid it in hot ones.

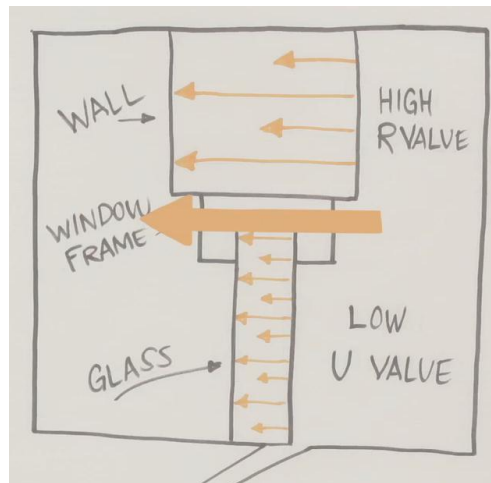


There are no one-size-fits-all passive design strategies; but knowing some fundamentals, and working together as a cross disciplinary design team goes a long way.

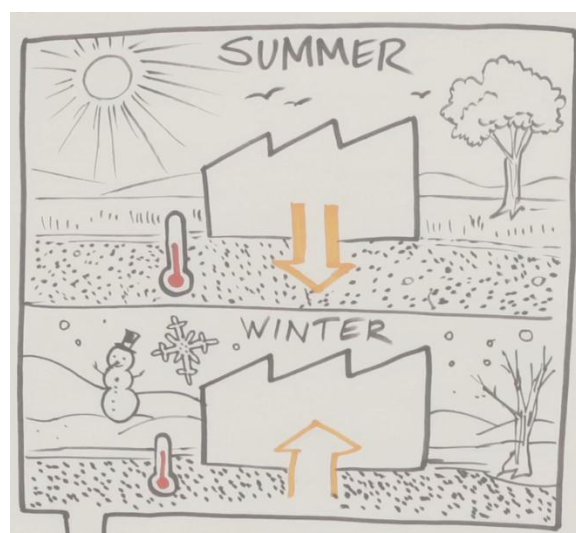
To start, you need to understand your site's climate, and how heat energy is transferred through conduction, radiation, and convection.

When heat passes THROUGH your building materials, that's conduction. You can reduce it by using insulation with high R-values and windows with low U-values.

But watch out! Even a well-insulated building can be undone by steel beams or bad window frames that create a thermal bridge across your insulation to leak heat outside.



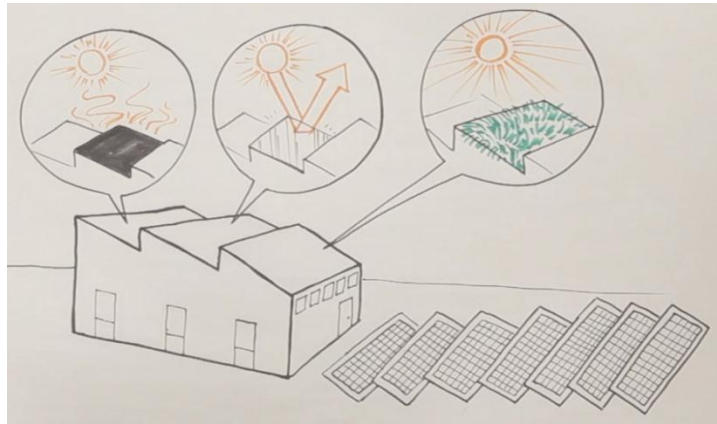
Conduction isn't always a bad thing. You can make it work for you. For instance, the ground stays at a relatively constant temperature, so you can conduct excess heat into it in the summer or pull heat from it in the winter.



Radiation, in the form of sunlight, is another major source of energy gains.

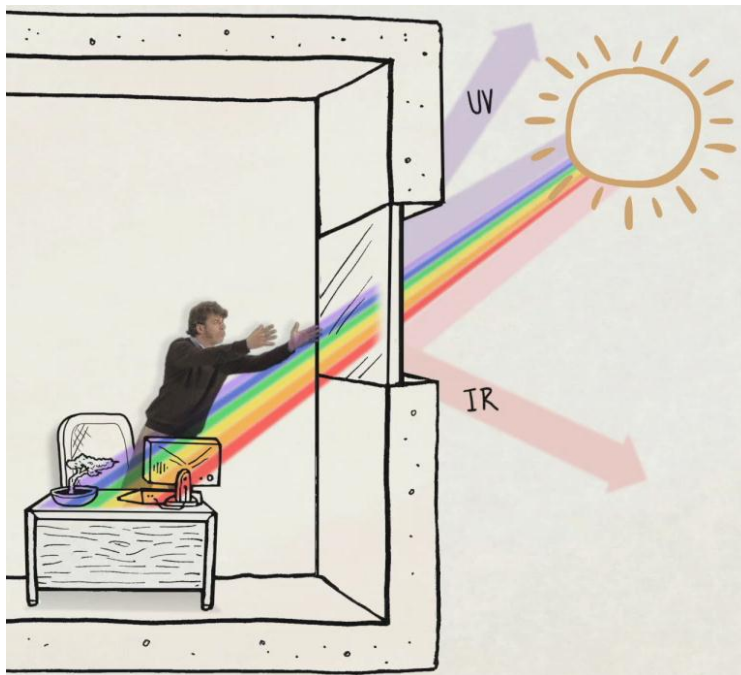
The sun heats buildings, especially on dark roofs and pavement.

You can minimize unwanted heat gains by choosing more reflective surfaces, or vegetation.



Energy also radiates in and out of buildings through windows.

You can make windows work for you by optimizing the window-to-wall ratio on each side of the building, and choosing windows that optimize how much energy passes through as infrared, visible light, and higher-frequency radiation.



Then there's convection, when heat energy is transferred by moving fluids, like air.

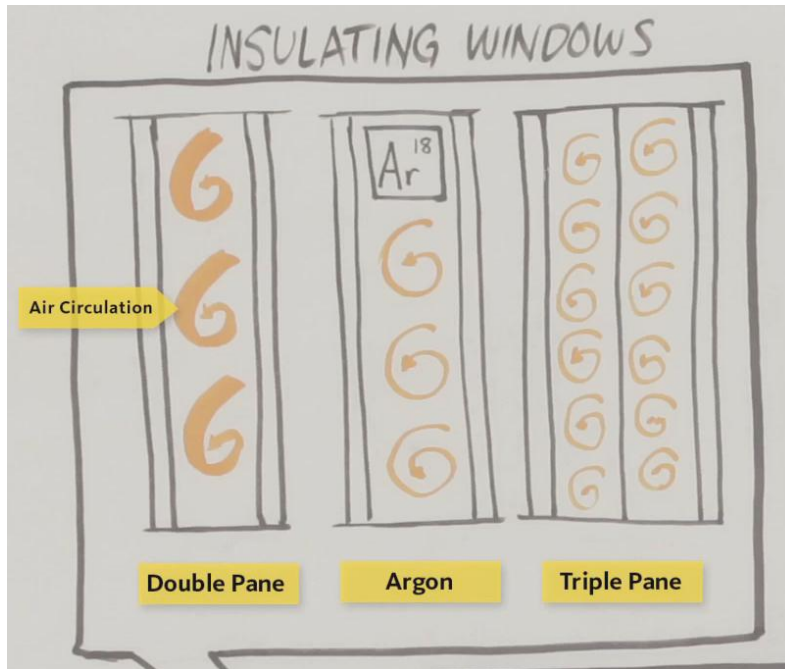
Air is constantly circulating within buildings due to temperature and pressure differences.

Anyone who's been in a drafty building knows how powerful convection can be in moving heat: Air leaks cause up to FORTY PERCENT of building heat loss.

But you can stop this, by sealing the building well.

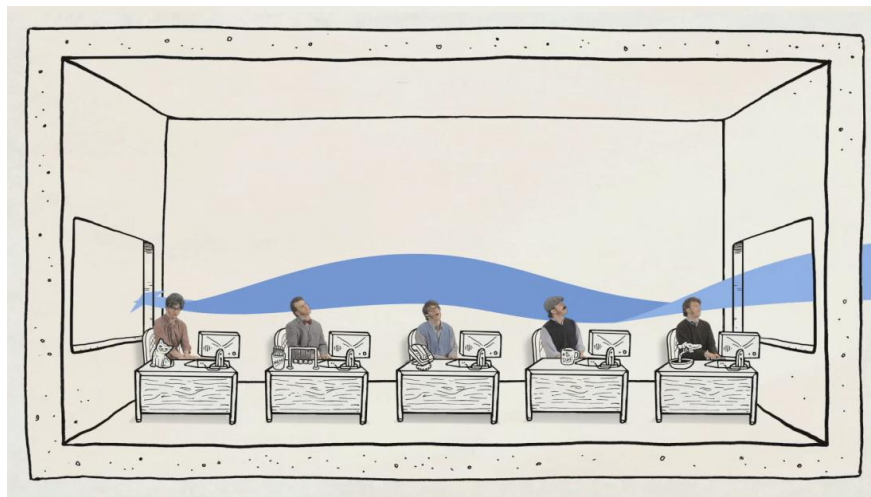
Convection happens inside building elements, too.

Installing Argon-filled windows and triple-pane windows reduces the convection of heat between panes.

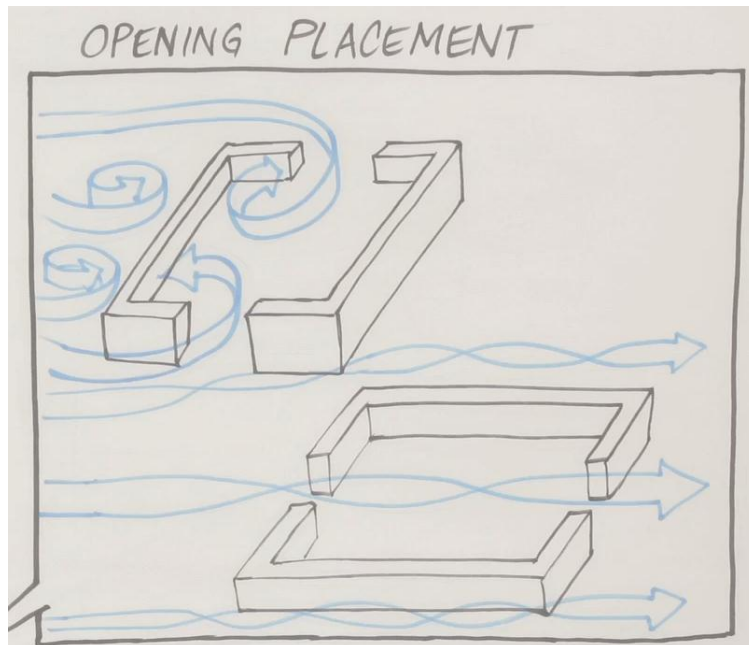


Of course, you can use convection to your advantage by transferring energy where you want it and bringing people fresh air.

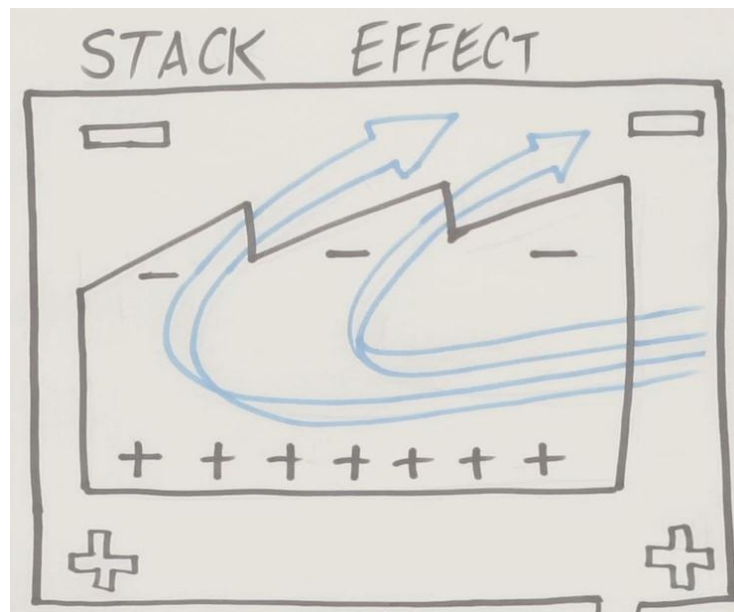
The wind can bring cool fresh air into your building, and reduces the energy you might need for fans.



You can control it with the size of your window openings, and place your openings to take wind direction into account.



Another principle of natural ventilation is called the “stack effect”.

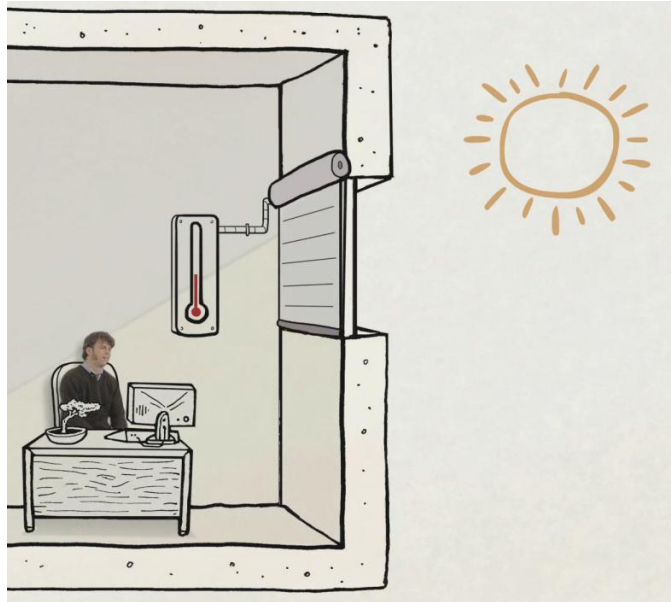


Wind and heat make air pressure lower farther from the ground. Higher pressure air then wants to move there, so if you have windows at the top and the bottom, air will naturally flow upwards with no fans needed!

You can consult a wind rose diagram for your location to find out: how often the wind blows from different directions, at what speeds, and even its temperatures.

Throughout the year, and even throughout the day, environmental conditions change, so your building needs to adapt.

Sensors and electronic controls can be used to turn lights off, open shades, and even change windows from clear to tinted.



As you begin to master how energy and air move, you'll find that working with natural forces can cut your heating and cooling energy demands in HALF, or even drive them to ZERO.

It's a critical step on the path to Net Zero energy buildings.