



## EMBODIED ENERGY

Perhaps you have already learned about renewable and non-renewable energy and resources in school. Non-renewable resources are those which run out and are not replenished, or are replenished only very slowly over time. The current use of non-renewable resources is unsustainable, as they are used at a faster rate than they are replenished. We know that there is a finite quantity and they will eventually run out if they continue to be used at the rate they are now.

Renewable energy resources are those which do not run out, such as solar, wind, hydro- and tidal power – the use of which does not result in harmful emissions being released into the air, water or earth. The use of renewable energy resources is said to be **sustainable**. This means that it can continue on without running out of anything or causing any ongoing environmental problems.

So you would think that using solar panels, which harness a renewable resource, causes no pollution, right? Well you'd be wrong.

Ask yourself, how were the solar panels made?

### Solar Panel Manufacturing Process



The materials, such as aluminium and silicon were mined out of the ground and refined from the rock ore. This process used heavy machinery which probably runs on diesel or petrol fuel, and electricity from the burning of coal or gas.

Embodied Energy =



These materials were then transported to different factories where they were formed into shapes suitable for making solar panels. Energy is consumed during transportation (trains, planes and boats all run on fossil fuels) and the manufacturing energy is again provided by the burning of fossil fuels.

Embodied Energy =





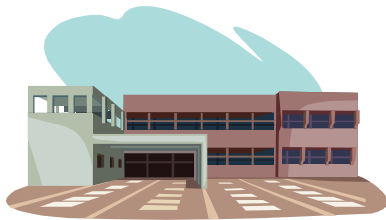
The materials will then be transported again to another factory for final assembly. Other parts may have come from different factories in different countries around the world. Assembly takes place in a factory which runs on electricity, which is again generated from the burning of fossil fuels.



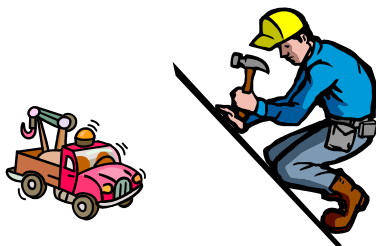
Embodied Energy =



When the solar panel is complete, it will be transported again to the store or warehouse and then to the customers' home for installation. Only after installation (which also uses energy), is the solar panel ready to produce energy of its own.



Embodied Energy =



Total Embodied Energy =



You can consider the energy that is used during the process of manufacturing something as the **EMBODIED ENERGY** – the energy that was used in making the solar panel. This can be seen as an account, into which energy is deposited at each stage of construction, transportation and installation. This is energy that has been generated from non-renewable resources and is therefore responsible for carbon pollution being released into the atmosphere.

When the solar panel starts to produce energy then it starts to pay off this account. It will keep paying off this account as it continues to produce electricity. The time it takes to 'pay back' the embodied energy with renewable energy is called the 'payback time'. For solar panels this is estimated to be around four years, but this can vary based on a number of factors, such as the manufacturing process and where it took place, to where it is finally installed and how much sunlight it receives during its lifetime.



## Paying Back Embodied Energy

After 1 year...

Embodied Energy 'Account' =



After 3 years...

Embodied Energy 'Account' =



After 5 years... (paid off)

Embodied Energy 'Account' =



When the embodied energy account has been 'paid off' by the solar panel, the amount of energy generated by the solar panel is equal to the amount of non-renewable energy it took to produce the solar panel.

At this point, no more energy has been consumed by the production of the solar panel than would have anyway been used to power the home over the same time period.

## After pay back



But from this point onwards, all the energy the solar panel generate will represent a saving in non-renewable energy resources: if the solar panel was never made or installed, the house would STILL be using non-renewable resources in the future, and contributing CO<sub>2</sub> pollution to the atmosphere. Now, however, energy is being generated from sunlight and no more CO<sub>2</sub> emissions are being released. This will continue into the future until the end of the solar panel's usable life is reached. This is estimated to be around 25 or 30 years.



