



The climate is lost when we fill this cube

How much carbon can we release into our atmosphere before the climate crisis gets even more serious? Human impact has disrupted the Earth's atmospheric equilibrium, which means we are now emitting more carbon into our atmosphere than we are removing. We need to transform five economic sectors if we want to have any hope of preventing a climate catastrophe and ensuring a sustainable future.



0:01

Animation of a cube being filled with carbon emissions.

This is the Earth's atmosphere. Every year natural processes add approximately 200 gigatons of carbon to it, in the form of carbon dioxide, methane, and other compounds. This doesn't just accumulate in the atmosphere, however, as approximately 200 gigatons of carbon are removed every year through natural processes such as acid rain. This means that the earth's atmosphere is broadly in equilibrium, with carbon sources balancing carbon sinks. Or at least it would be, if we humans hadn't entered the scene. We currently add about five percent as much carbon to the atmosphere every year as natural processors do. But while some natural process is removing carbon from the atmosphere have slightly increased, such as the oceans absorbing more carbon and becoming slightly more acidic, carbon is building up in the atmosphere because of human emissions. We have disturbed the natural equilibrium.

0:47

Surface air temperature anomalies map.

Animation of carbon emissions since the Industrial Revolution.

This is a problem, as the total amount of carbon in the atmosphere is proportional to the ability of the atmosphere to trap heat. The more carbon there is in the atmosphere, the hotter the planet gets.

Since the start of the Industrial Revolution, humans have added a lot of carbon to the atmosphere. Initially, we didn't add very much as there weren't that many processes like factories or power plants emitting carbon by burning coal. But as the 19th and then 20th centuries rolled on the amount we added rose significantly. By 2020 we were adding 9 gigatons of carbon to the atmosphere in a single year. Scientists estimate that if we are to avoid the worst effects of climate change, we need to limit the total amount of carbon that we add to the atmosphere to less than 1 trillion tons or 1000 gigatons. This is an approximate threshold and plenty of negative effects will occur before it is reached, but 1 trillion tons is still a useful target to aim for. To date, we have added more than half of this threshold amount already.

1:42

Animation of cube overflowing.

Video clips of a busy city and climate engineers.

Animation of the cube and the five main emissions sources.

At current rates of carbon emissions, this threshold will be reached in just 30 years. To prevent this happening we need to have a plan.

Limiting carbon emissions involves fundamentally restructuring our economy. And we can't expect to hit this target with an ad hoc approach. But, crucially, it can be done. We just need to get on with it.

We can divide our current emissions as coming from five rough categories: How we generate electricity, how we make things, how we grow things, how we get around, and how we generate heat and keep cool.

Video clips of the energy sector.

First of all, how we generate electricity. Currently, electricity generation represents around 27 of global carbon emissions. But, considering that nearly a billion people don't currently have reliable access to electricity, this number will only grow. In theory, we can cut our emissions from electricity generation to near zero through shutting down polluting coal, oil, and gas power plants and replacing them with firm low carbon sources, such as geothermal hydro and nuclear, as well as variable generation like solar and wind. In practice, this will need to take place over several decades. Perhaps accelerated by a carbon tax, making electricity generated through high carbon means more expensive. And will need to be supported by extensive infrastructure spending. If we cut emissions from power generation to zero, representing closing fossil fuel plants and replacing them with renewables, we delay reaching the 1 trillion tonne threshold by 11 years.

3:03

Animation of cube overflowing.

This on its own is, obviously, not enough. We need to consider where the other emissions are coming from. Construction and manufacturing accounts for 31% of all man-made carbon emissions.

Video clips of the cement production.

Decarbonizing electricity generation will certainly lower emissions from how we make stuff, but not entirely. To make cement or steel you must create a chemical reaction that produces carbon dioxide. And as we make billions of tons of cement and steel every year, this is a significant source of emissions. Without just shutting down the construction industry, we can't stop these emissions, but we can certainly improve matters. We can improve efficiencies in the manufacturing process, reducing the emissions.

3:41

Animation of negative emissions.

But mostly, we will need to counter out the remaining intrinsic carbon emissions with what's known as negative emissions, removing carbon from the atmosphere. This could be done by seeding algae in the oceans, a synthetic process, or planting a lot of trees. It's completely impractical to counter out all our emissions, but we don't need to. We can certainly make a big dent in the emissions that we just can't avoid.

Video clips of and data on the agriculture sector.

Another sector that seems at first glance to be non-negotiable is agriculture. Everyone on earth needs to eat and that necessitates growing food and that necessitates releasing carbon. In fact, as the world's population continues to grow and more and more people are lifted out of poverty, we will need to grow more and more food. Currently, agriculture emits around 18% of our total carbon emissions. The majority of which comes from two sources: raising animals, notably cows, and the use of fertilizer. Reducing emissions from the former is in principle easy. Everyone should just stop eating meat and dairy products. Doing so would reduce global carbon emissions by up to 14%. But that's not realistic. Decreasing meat and dairy consumption and eating more meat substitutes made using renewable electricity is a more realistic way to cut emissions from food, perhaps by a third.

4:40

Animation of the cube overflowing and video clip of fertilizer.

Decreasing the emissions from fertilizer is much more difficult, however, and there just isn't a practical alternative to synthetic fertilizer right now. For the moment, increasing negative emissions to counteract the emissions from fertilizer is our best bet.

Video clips of the transportation sector.

Transport is the last big slice of the emissions pie, accounting for some 16% of global carbon emissions. Road traffic, cars, motorbikes, trucks accounts for around three quarters of these emissions, which is a good thing. Electric vehicles have been shown to be more and more feasible and economical. And if we make our electricity generation low carbon over the next few decades, this will coincide with the increasing market share of electric cars and trucks. This will likely happen anyway due to market forces incentivizing people to buy more electric vehicles over oil-powered vehicles. But, as with electricity generation, a carbon tariff would accelerate that process. The remaining quarter of transport emissions coming from planes and container ships will be much more difficult.

5:46

Animation of the cube overflowing.

Between efficiency improvements, use of biofuels, and changing habits, hopefully emissions from the sector could halve in a few decades, but that's a best case scenario.

Video clips of heating and cooling.

Lastly, the remaining 6% or so of emissions comes from how we heat and cool our buildings. In terms of how we use energy as individuals, 50% of it on average actually goes to heating or cooling ourselves. Between improving efficiencies and converting, our electricity grid to zero or low carbon, emissions from cooling air conditioning and fridges could fall to near zero. Heating is more of a challenge, as many households burn fossil fuels to do so, whether that's natural gas or wood or coal. Electric heat pumps are becoming increasingly affordable and with appropriate incentives could completely phase out gas boilers. This is another sector that will see huge growth in the 21st century, as global prosperity rises and highlights just how important it is that we decarbonize our electricity supply. But in principle, we can tie its decreasing emissions to those of electricity generation.

6:45

Animation of the cube and the five main emissions sources.

Each of these five sectors must be fundamentally restructured if we are to avoid emitting the trillionth ton of carbon. It will be difficult, but it can be done, it must be done, and done in the next half century. If we are to avoid the worst consequences of our own actions.



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