WHAT TO DO ABOUT CLIMATE CHANGE?

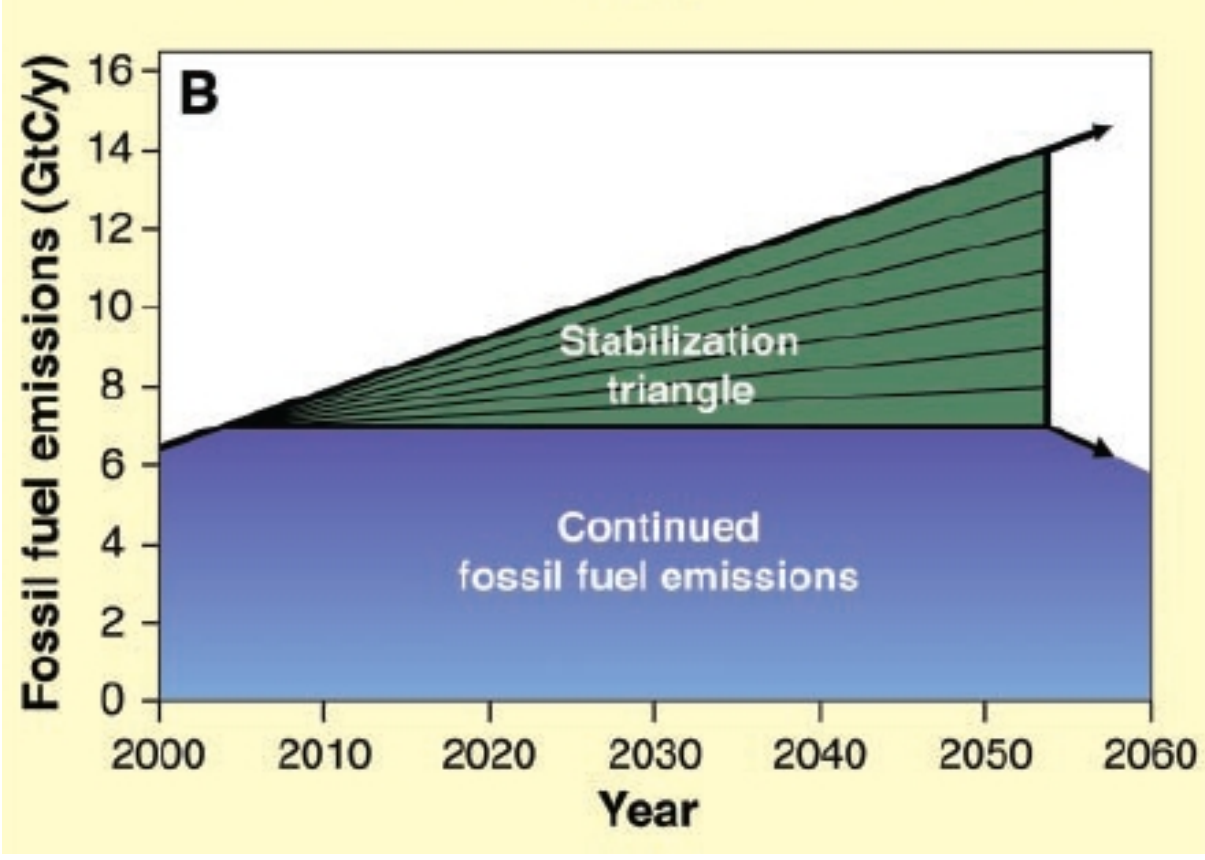
Slowing the rate of carbon burning won't stop global warming: most CO_2 stays in the air *over a century*, though individual molecules come and go. Global warming is like a ratchet.

So, we will:

- 1. leave fossil fuels unburnt,
- 2. sequester carbon,
- 3. actively cool the Earth, and/or
- 4. live with a hotter climate.

1. Leaving Fossil Fuels Unburnt

This is a big challenge. In 2004, Pacala and Socolow said merely holding worldwide carbon emissions constant for 50 years would require 7 'wedges', each cutting carbon emissions by 1 gigatonne per year by 2054:



Here are 7 ways to cut carbon emissions by one gigatonne/year by 2054:

- Replace 700 gigawatts of coal power by solar power. Starting now, *multiply solar power by 20* by 2054.
- Replace 700 gigawatts of coal-fired power plants by wind power. Starting now, *multiply wind power by 7*.
- Replace 700 gigawatts of coal power by nuclear power. Starting now, *double existing nuclear power*.
- Replace 1400 gigawatts of coal-burning power plants with gas-burning plants.

- Double the average efficiency of all coal-fired power plants.
- Make all cars worldwide twice as efficient *without people driving more!*
- Cut carbon emissions by 25% in all buildings and appliances worldwide.

By now, Socolow estimates we need to cut carbon emissions by 9 gigatonnes/year within 50 years, just to hold emissions flat.

McKinsey & Co. have argued that the world could cut carbon emissions by 10 gigatonnes per year at roughly no net cost! We need analyses like this based on publicly available numbers.

2. Sequestering Carbon

In China, the Huaneng Group says it's scrubbing CO_2 from a coal-fired plant at less than $35 per tonne.

Sucking CO_2 from the air or sea could be a safe way to 'ratchet back' global warming, but it's hard to do on a large enough scale.

If you grind up a common mineral called serpentine, it absorbs 2/3 its own weight in CO_2. But to absorb all 37 gigatonnes of CO_2 emitted in 2010 would require 55 gigatonnes of serpentine. The total amount of material handled by US mines is only 6 gigatonnes.

Plants already suck CO_2 from the air! Suppose we could make farmers deposit all crop residues on the deep ocean floor. That's about 5 gigatonnes of stuff, not nearly enough to equal 37 gigatonnes of CO_2, but significant. See Strand and Benford.

Sustenance farmers can already do something similar by making biochar, which also fertilizes the soil.

Iron fertilization of algae growth in the ocean is worth looking at — but so far the results have been poor.

In the future, nanotechnology may make it easier to sequester lots of CO_2. It sounds far-out, but a century ago so did computers. We need to do things *now*, though.

3. Actively Cooling the Earth

This doesn't stop ocean acidification. It will probably change weather patterns in new ways. It means *accepting responsibility for actively managing the climate*, and *getting it right*.

But we need to research it — starting now. If global warming gets bad, public opinion may suddently flip, with people wanting to do geoengineering *yesterday*. To make good decisions, we need more information.

We could experiment with putting aerosols in the stratosphere over the Arctic in summer, starting with small amounts. If this works, cooling the Arctic to the 1950 temperature range could be quite cheap.

See reports by the National Academy of Sciences, Royal Society, Asilomar Conference and Congressional Research Service.

4. Learning to Live with a Hotter Climate

We are doing this now. We will keep doing it! This will be our main 'strategy' for a long time.

US carbon emissions have been dropping since 2009, and are now back to 1992 levels. The EU is committed to reducing emissions to 20% below 1990 levels by 2020, and wants to reduce them by at least 80% by 2050.

But much of this 'progress' is due to *outsourcing of carbon emissions*. Worldwide, growth of coal power now exceeds growth of renewables. In Europe, the biggest source of renewable energy is wood. Germany is replacing nuclear with coal.

So let's get ready for a changing climate.

We may not stop global warming. But we **will** adapt to the Anthropocene: like it or not, this is our future.