Outline for presentation of the basics of climate change with videos and graphs.

All information is found in more detail and with citations in Why We Prioritize Addressing Climate Change, www.rc.org/climatepriority. Many people have asked me for the collection of videos and slides that I have used in presenting basic information about climate change. Videos and graphs really help keep people's interest, as do frequent mini-sessions and a light approach. Here is my collection. (I happily accept additions to this information.)

This is way more than you can use in a one or two hour class. I recommend that you look through them all and choose the ones that make sense for your audience.

You may also want to mix in some of the videos on this page, www.rc.org/climatechange, listed under Funny videos or Videos that get your attention out.

Diane Shisk

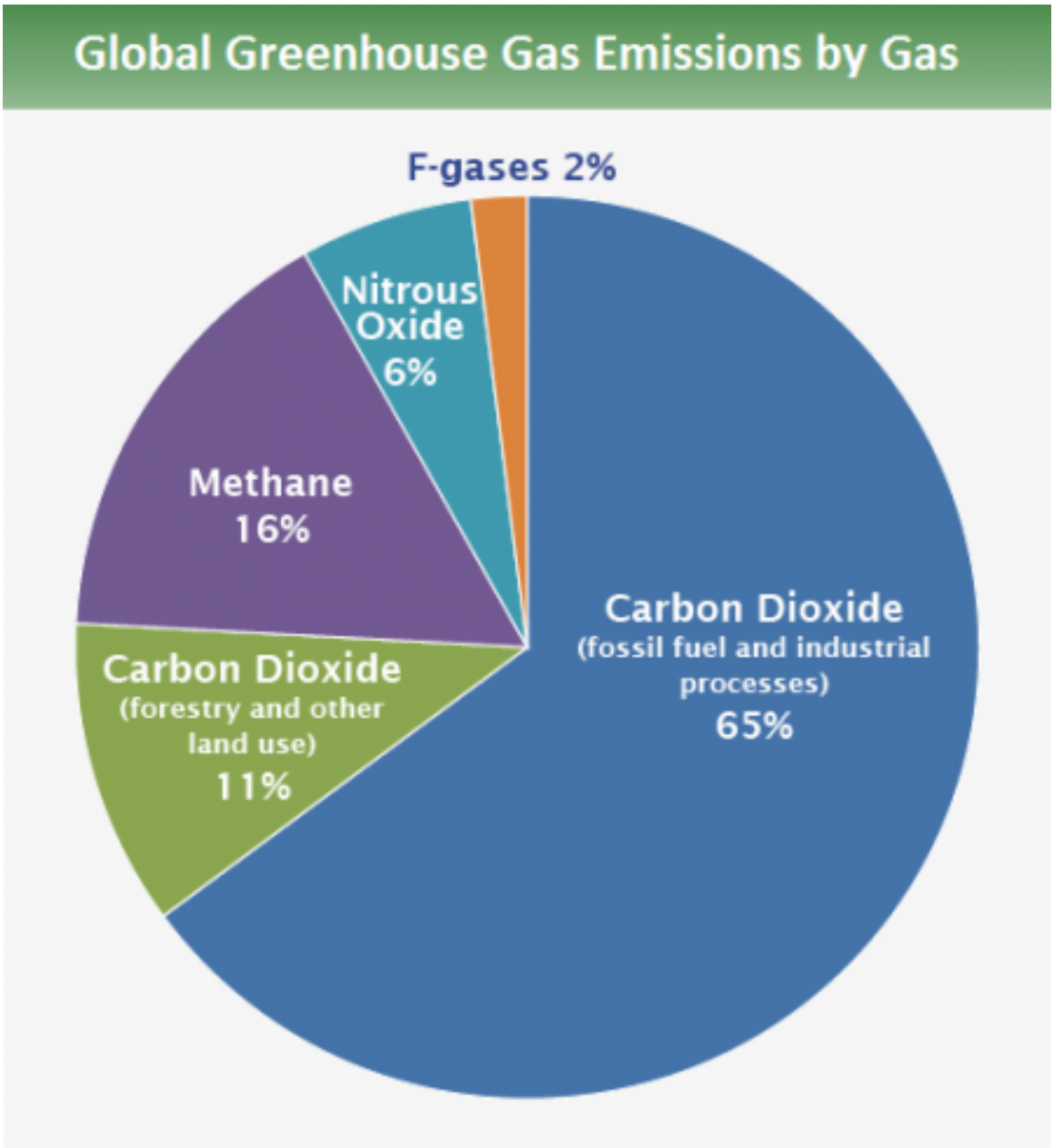
The scientists that are watching climate change closely think there is still time to resolve this crisis if we act now. Millions of people across the world are addressing these issues. I want all RCers to be informed enough to be able to engage in a basic conversation about climate change and take action in the ways that makes sense for them.

Carbon Dioxide and other greenhouse gases are accumulating in the atmosphere. This video shows the natural cycle of carbon dioxide emitted in a year's time, and its absorption by photosynthesis. It also shows very clearly the countries that are emitting the most carbon dioxide into the atmosphere. (It's also a beautiful video to start with.)

https://climate.nasa.gov/climate_resources/142/video-super-hd-view-of-global-carbon-dioxide/

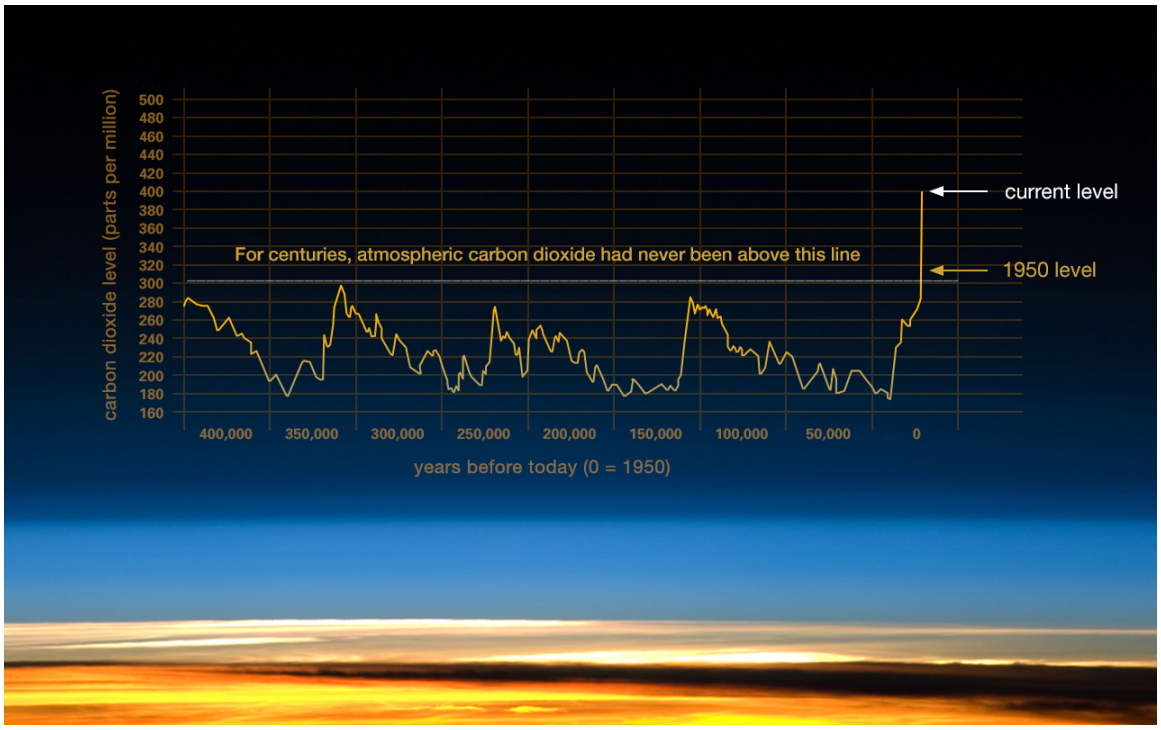
Industrialization, fossil fuel combustion, land-use change (deforestation and industrial agriculture), and overexploitation of resources have created a heat-trapping blanket of carbon dioxide and other greenhouse gases (GHGs) around the Earth.

The most dangerous of these GHG emissions is carbon dioxide (CO_2), although other emissions and substances (methane, nitrous oxide, and black carbon, among others) are also dangerous and together contribute about 50% of the warming of CO_2. This chart from the IPCC is based on global emissions from 2010 to 2014, and shows the percentages of the different greenhouse gases emitted.



https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

The following graph shows that the current accumulation of CO_2 is unique in the history of the Earth, resulting from emissions since the start of the industrial revolution. It charts the levels of CO_2 found in the atmosphere over the last 400K years (information gathered from Antarctic ice cores), and the natural cycles of the CO_2 levels rising and falling as the Earth moves in a slightly elliptical pattern around the sun.



Before 1750, CO_2 levels fluctuated between 180 and 210 parts per million (ppm) during ice ages and increased to 280–300 ppm during warmer inter-glacials. Only after the start of the industrial revolution (and the quick transition to fossil fuels as an energy source in western nations first, and then globally) has the level of CO_2 in the atmosphere exceeded 300 ppm. That level has risen pretty steadily since 1750, reaching 412 ppm today. This is reflected in the spike at the right hand side of the graph.

This video shows the accumulation of CO_2 in the atmosphere from 2002 to 2016 (scroll down to Time Series video). White represents 365 ppm of CO_2 and Red represents 425 ppm.

https://climate.nasa.gov/vital-signs/carbon-dioxide/

This video (How Global Warming Stacks Up) is designed to graphically illustrate how the common theories for global warming put forward by climate skeptics don't match the reality of historical facts.

https://climate.nasa.gov/climate_resources/144/video-how-global-warming-stacks-up/

This video shows the comparative rise in CO_2 emissions from the largest emitters by country since 1850.

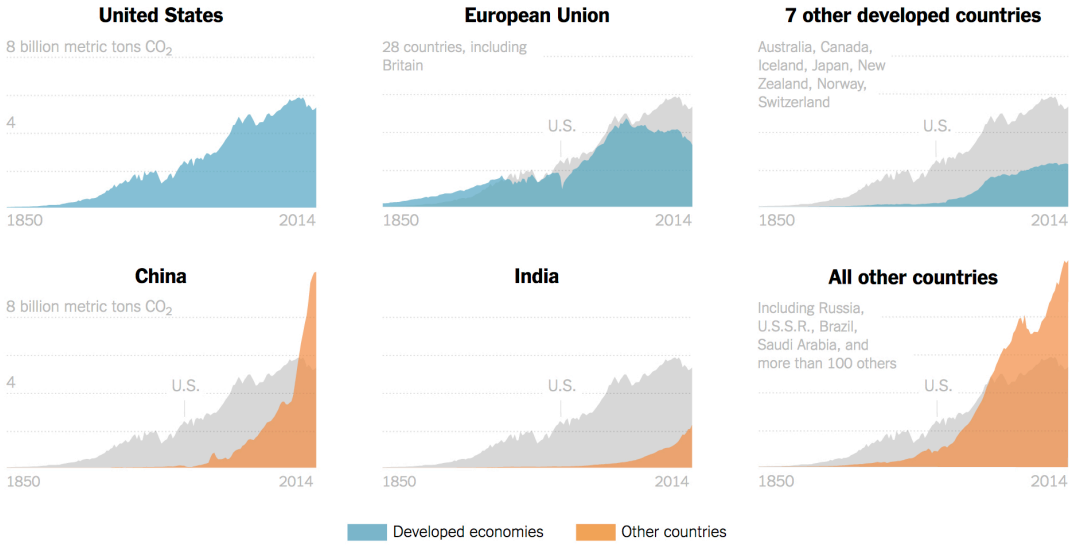
https://www.youtube.com/watch?v=Nowwd-67r7Y

While China surpassed the U.S. in annual emissions a few years ago, the U.S. continues to be the country that has emitted the most CO_2 into the Earth's atmosphere. The average CO_2 emissions per person of someone living in the U.S. are about twice those of someone in China.

60% of CO_2 emissions come from the largest economies: China, the U.S., Russia, India, the European Union, and Japan. The U.S. (with 5% of the global population) contributes 16% of emissions.

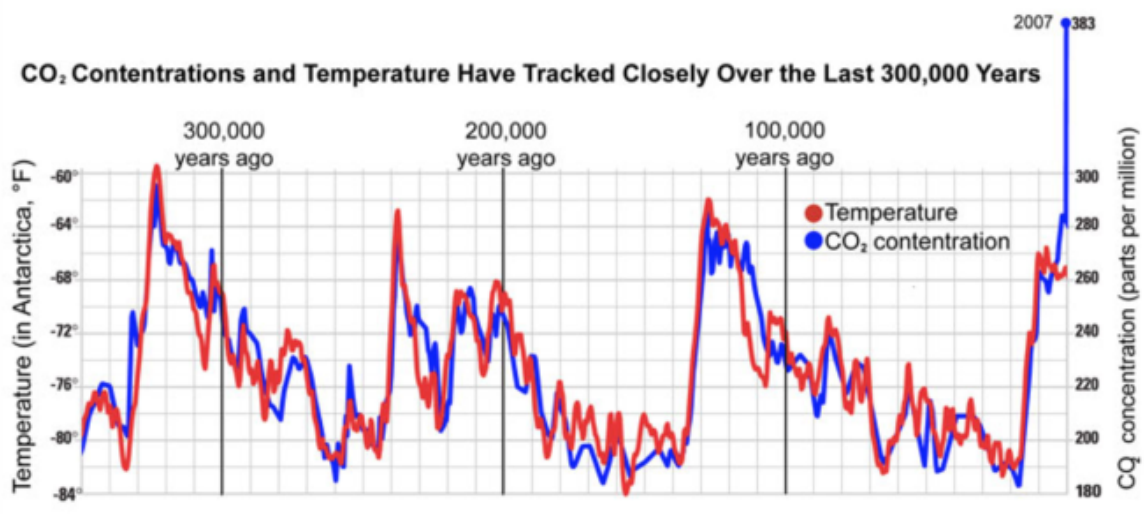
While some countries have “peaked” (reached their highest point of emissions and emissions are now decreasing), CO_2 emissions globally are continuing to rise at the rate of 1.7% annually.

This graph shows “historical emissions” of the largest CO2 emitters.



The rise in global temperature tracks the rise in greenhouse gas emissions

CO_2 emissions and temperature have tracked closely and as a result, the past three decades have been successively warmer than all previous decades on record, with the last 20 years logging the hottest temperatures yet.



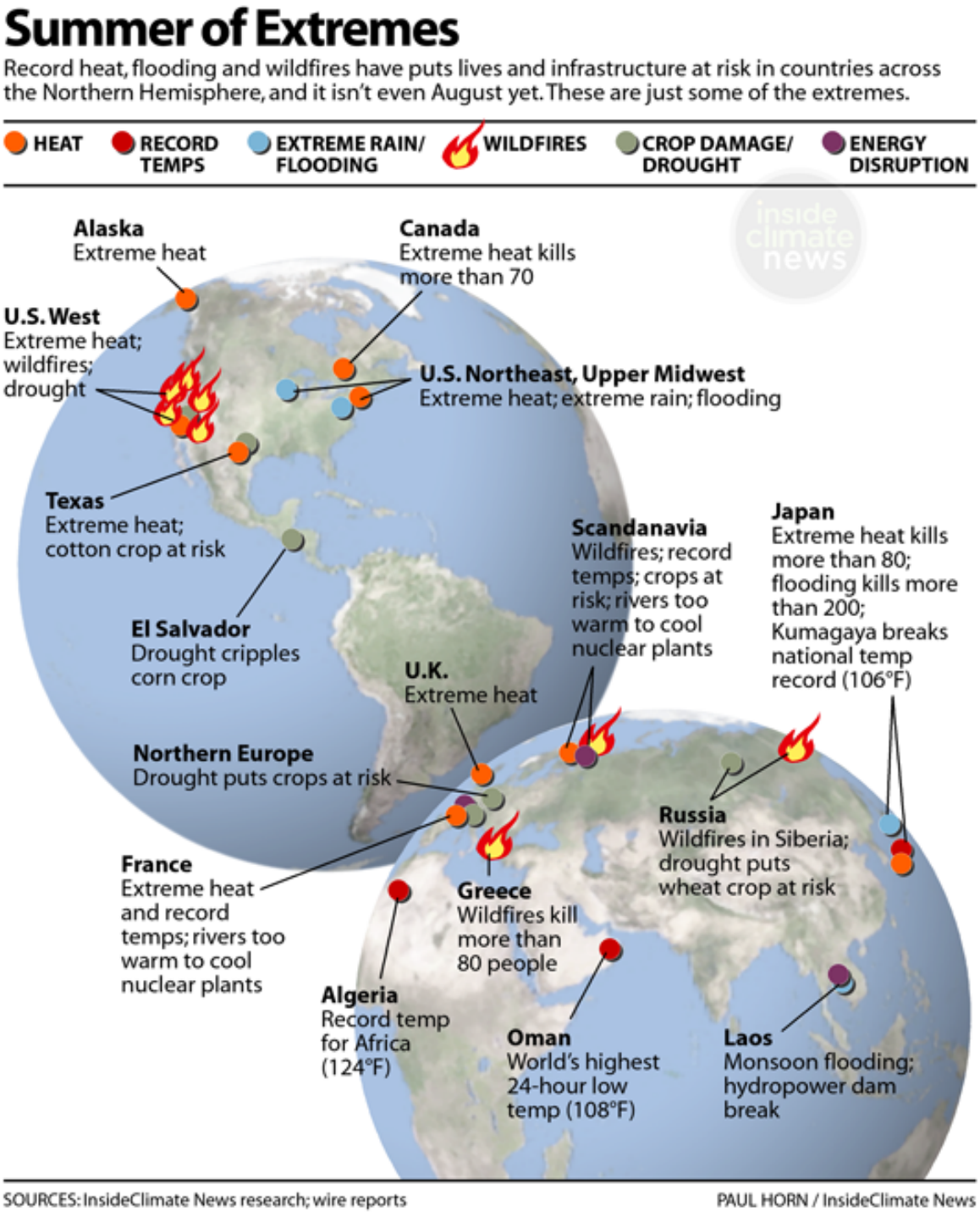
This video shows the gradual warming of the Earth from 1884 to 2017, showing how warming begins to accelerate rapidly in the 1980s to the present. (Scroll down to Time Series)

https://climate.nasa.gov/vital-signs/global-temperature/

New records are being set every month. The rate of warming now is twice as fast as in the 1950s and 1960s. 17 of the 18 hottest years on record have been since 2001; with 2014, 2015, 2016, and 2018 the four hottest years on record.

The hottest temperature in 2018 was recorded in Pakistan: 53.5C (128.3F).

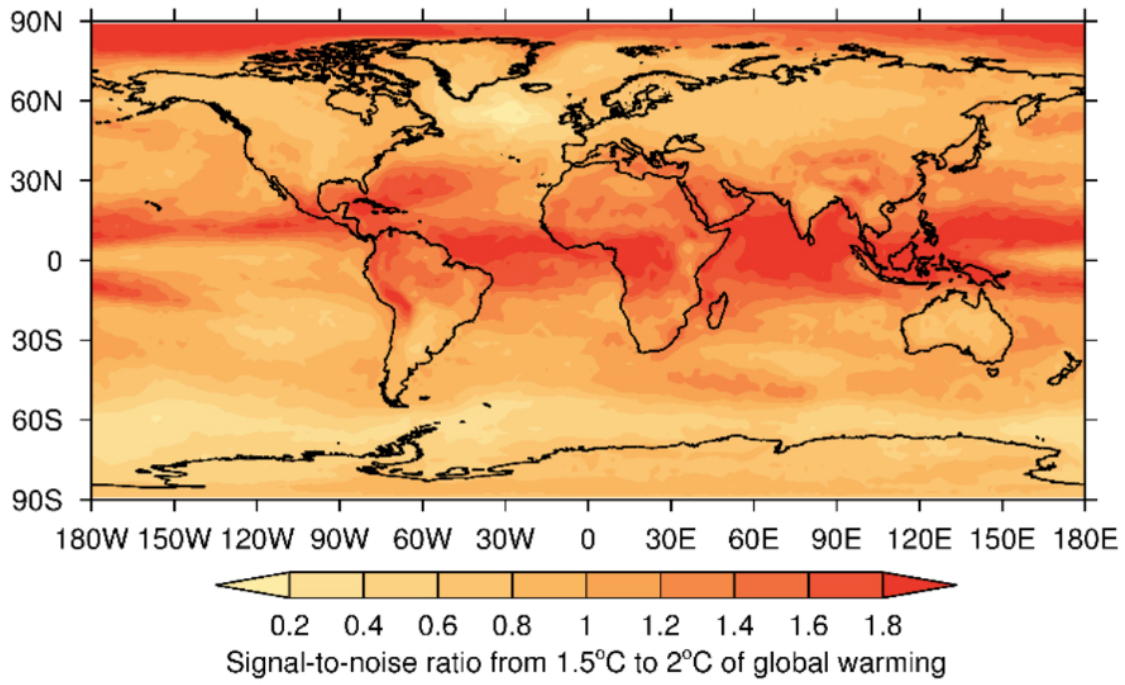
Heat Waves impacted all parts of the world in 2018, causing death, droughts, and wildfires. Global warming is starting to overtake natural variability as the main driver of extreme heat waves.



At our current levels of 412 ppm of CO_2 with the resulting 1° C temperature rise we are already experiencing many damaging effects of climate change including rising sea levels, loss of formerly arable lands, population displacement by extreme weather such as violent storms and floods, prolonged droughts and famine, biodiversity loss, mass extinctions, watershed destabilization, and life-threatening food scarcity.

As the global temperature rises, these problems are multiplying in frequency and intensity. These damaging results of climate change are already a reality in all parts of the globe, but worse closer to the equator (already the warmest places on earth), the Arctic (because of the special vulnerabilities of an ice cap), and where people live on very limited resources.

The graph below shows where an additional .5° of temperature rise, from 1.5° to 2° C, will have the most immediate effect.



The current 1° C temperature rise is a global average. A quarter of the planet's population lives in places where temperature rise is already 1.5° C.

Sea Level Rise

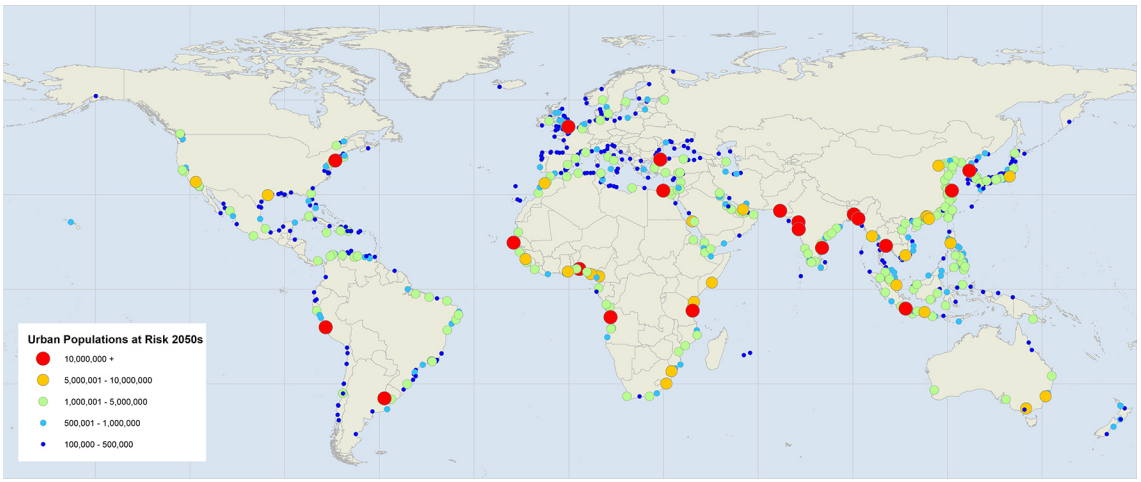
Ice loss from Greenland and Antarctica is a major cause of sea level rise. The oceans are currently rising by approximately 1.5" per decade. That is predicted to increase to 1 foot per decade by 2050 and 2 feet per decade by 2070. Greenland doubled its rate of ice loss between 2009 and 2014. This beautiful film gives more details.

https://www.youtube.com/watch?v=kteMXaUNvlc

This video explaining sea level rise, though recent, doesn't include the latest information that the rate of melting from the Antarctic ice sheet had accelerated threefold in the last five years. There is a lot of concern that thresholds for irreversible, multi-millennial loss of the Greenland and West Antarctic ice sheets may occur at 1.5 or 2°C global warming.

https://climate.nasa.gov/climate_resources/163/video-new-study-finds-sea-level-rise-accelerating/

Even small rises in sea levels (3-6”/5-10cm) will double the risk of flooding to coastal cities.



The Arctic

Warming temperatures have caused a 40% reduction in Arctic sea ice since 1978. The Arctic region is warming at a rate twice that of the global average, with 2017 setting a record low for maximum ice extent. Temperatures hit 100° F in Prudhoe Bay in the summer of 2018 and the ice (which once froze over in September) didn’t freeze until January. This video shows the shrinking Arctic ice cover.

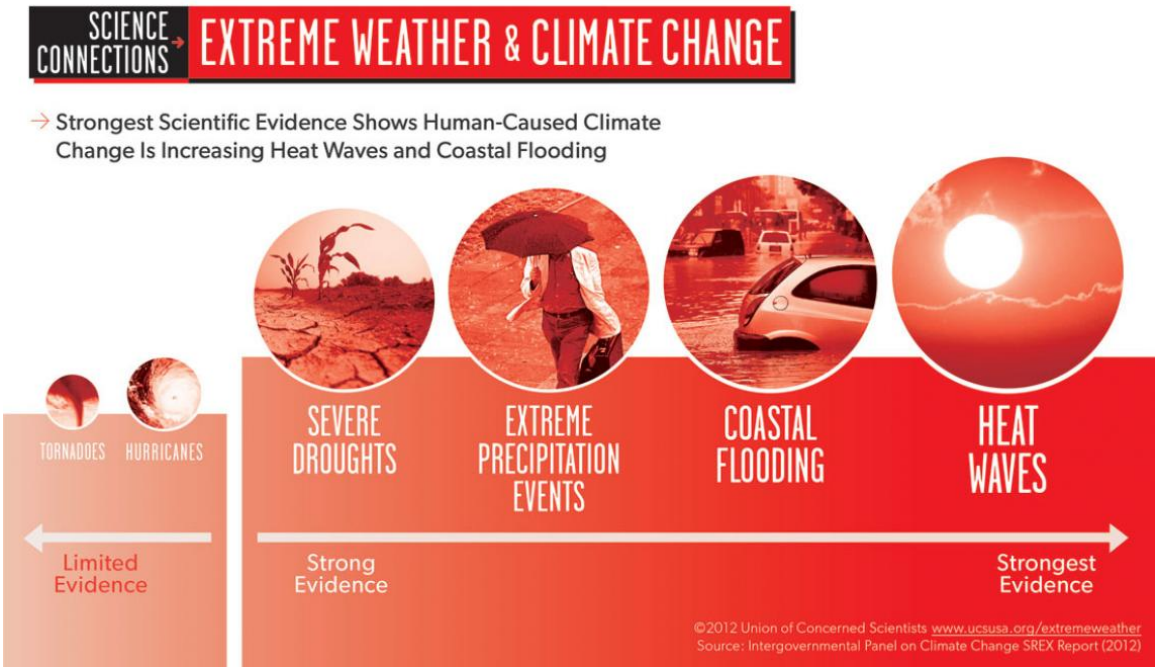
https://climate.nasa.gov/climate_resources/143/video-record-breaking-climate-trends-in-2016/

This has a direct impact on Indigenous populations, who are losing their coastal villages and experiencing declines in the species they depend on for survival—endangering their ways of life and ability to live on their land. All these effects are multiplied by toxins released from fossil fuel exploration and mining in the Arctic Circle.

Extreme weather events

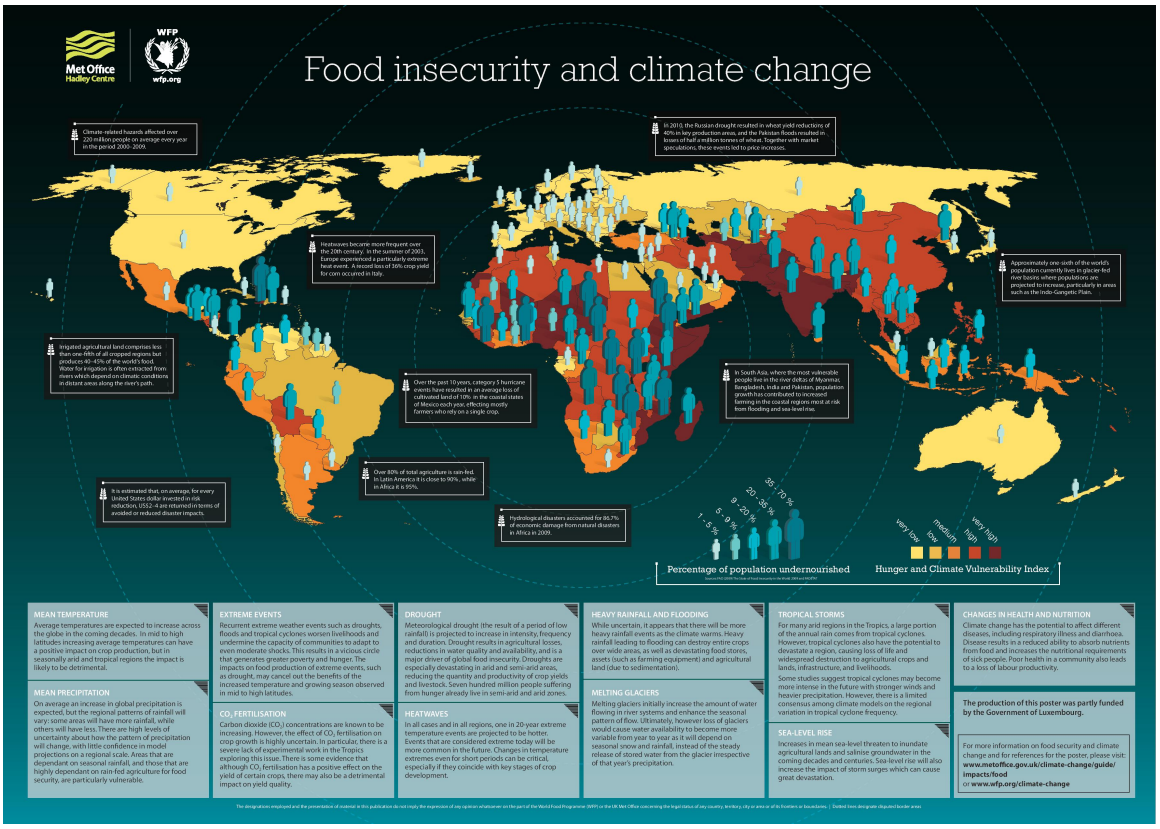
With every 1° C of temperature rise, hurricanes/typhoons are predicted to occur 3-4 times more frequently. With 2° C, they could occur every other year, and be 10x more powerful. Disasters of equivalent strength kill between 12 and 45 times more people in poorer countries than in wealthy ones.

Scientists are studying the relationship between extreme weather events and climate change, and are increasingly confident about many connections, shown in the graph below from the Union of Concerned Scientists in 2012.



Under-nutrition is identified as the largest health impact of climate change in the 21st century. A 6 percent decline in global wheat yields and 10 percent decline in rice yields is expected for each additional 1°C rise in global temperature, with substantial impacts on under-nutrition and stunting in food insecure or poor regions. An additional 7.5 million children are expected to be stunted by 2030, 4 million of whom are expected to be affected by severe stunting, increasing to 10 million children by 2050. Recent studies also show that some crops have less nutritional value when grown in hotter conditions.

An excellent interactive graphic on climate change, and food Insecurity is found here. https://awfw.org/food-insecurity-climate-change/ Below is the basic infographic: the larger the human figure, the higher the percentage of undernourished people in the region; the darker the color of terrain, the higher the hunger and climate change vulnerability.



Species extinction

Currently, with 1° C of warming, 30% of species are at increasing risk of extinction. Hotter temperatures, decreased access to water, scarcer food supply--all will take a toll. Most corals will be bleached if we sustain a 1° C temperature rise. Coral reefs host 25% of the world's biodiversity and provide important coastal protection from storms. Scientists have found no evidence of these disasters before the late 20th century.

Vulnerable Communities

The effects of climate change are harshest on people living in poverty, those in the poorest countries—countries and communities historically targeted by colonialism, genocide, imperialism. Climate change is called a “threat multiplier,” meaning if you were already under threats such as food insecurity, inadequate housing, health, poverty—the threat will be

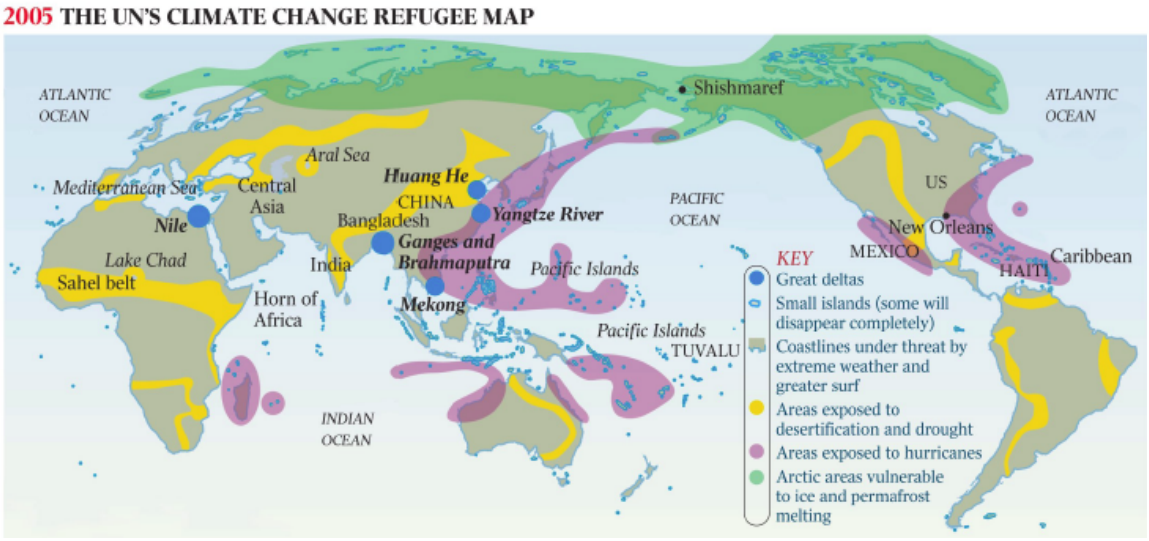
multiplied by climate change. Poor people are disproportionately affected not only because they are often more exposed and more vulnerable to climate-related shocks, they also have fewer resources and receive less support from family, community, the financial system, and social safety nets to prevent, cope, and adapt.

The maps in the website below show the countries most at risk from climate change, based on government stability, food and water supply, and healthcare.

https://blog.theecoexperts.co.uk/countries-survive-climate-change-2018

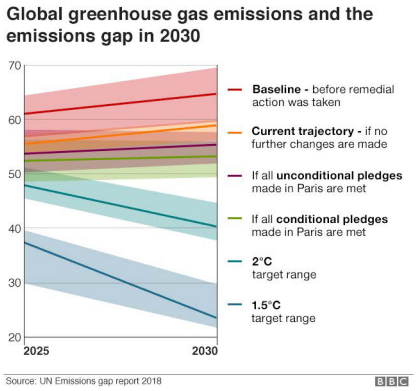
Climate Refugees

In the last 10 years, 22.5 million people have been displaced by climate-related or extreme weather events globally. By 2060, about 1.4 billion people could become climate change refugees because of heat waves, rising sea level, and extreme weather. This map shows the regions of the world most climate refugees came from in 2005 and why they were forced to leave their land.



The Paris Agreement (2015 United Nations climate talks) commits nation-signers to keep global temperature rise to well below 2°C (making all efforts to limit it to 1.5°C in order to avoid devastating sea level rise) to avoid the most drastic, life-threatening global climate change. (There was almost unanimous agreement among the scientific and international community on this point in 2015, although with the passage of time an increasing number of scientists say a 2°C increase is too much.) So far, the Earth has warmed approximately 1°Celsius.

This graph shows the projected levels of greenhouse gas emissions for 2025 and 2030 under various scenarios.



This website shows what is called the global carbon budget, meaning the amount of carbon dioxide we can still emit before warming to 1.5°C and 2°C. The far right circle represents temperature increase between 1850 and the present, the middle circle represents the rising amount of CO_2 in the atmosphere, and the left circle shows the amount of CO_2 humans can still emit and stay below 1.5°C and 2°C.

http://openclimatedata.net/climate-spirals/from-emissions-to-global-warming-line-chart/

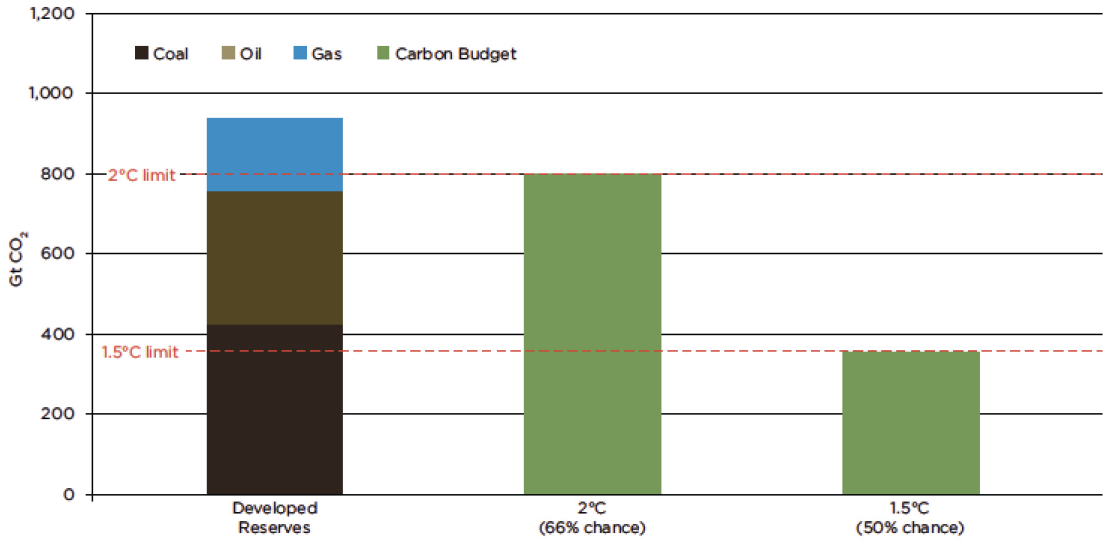
The current national commitments agreed to in Paris would allow a temperature rise of 3.7 - 5° C. While that is acknowledged and the United Nations is pushing countries to do more, most countries are struggling to meet their current commitments. This website shows the progress each country is making toward meeting their commitment under the Paris Accord.

https://climateactiontracker.org/countries/

Rapid Phase Out of Fossil Fuels

To have a 66% chance of staying below a 2°C increase in global temperature, we can only release 800 more gigatons of CO_2 into the atmosphere. (This is from a 2016 article.) To have a 50% chance of staying below 1.5°C we could only release 353 gigatons. (Most scientists now think this is no longer achievable.) But coal mines and oil and gas wells in operation in 2016 contained fossil fuels that would release 942 gigatons of CO_2. That means we cannot use all that is currently in production and stay below 2°C. And it means we should halt all new exploration and production.

Figure 1: Emissions from Developed Fossil Fuel Reserves, Compared to Global Carbon Budgets



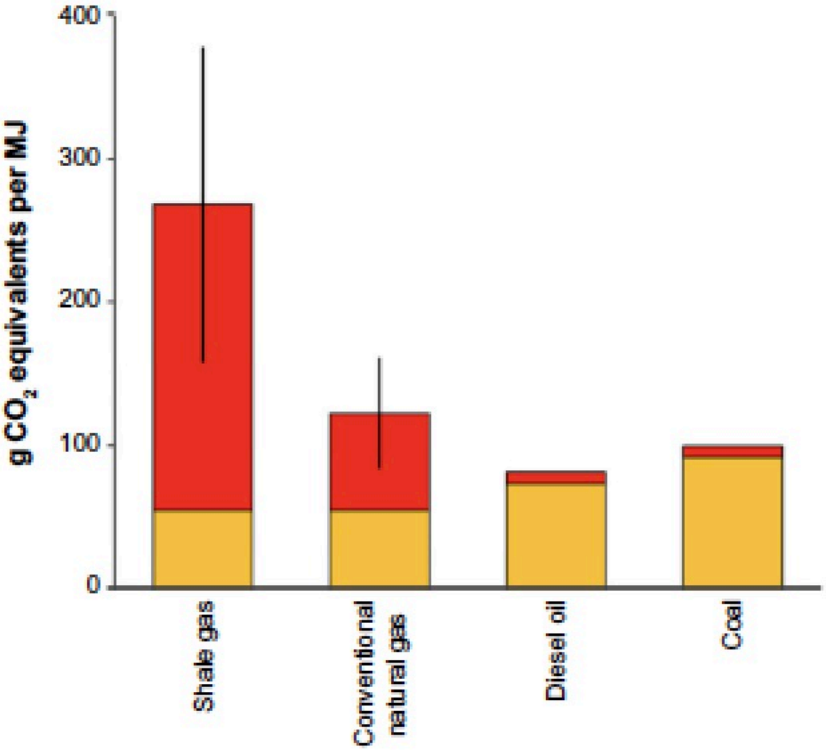
Sources: Rystad Energy, International Energy Agency (IEA), World Energy Council, Intergovernmental Panel on Climate Change (IPCC)[7]

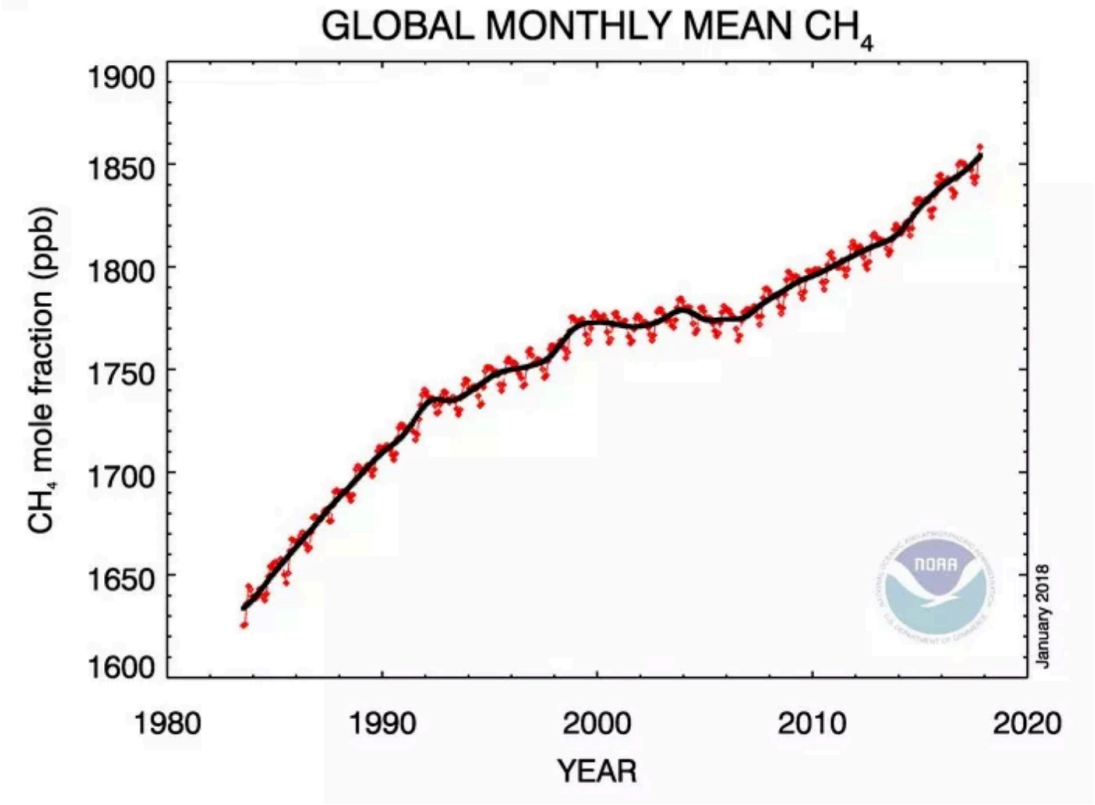
Fossil fuel companies have another 2,795 gigatons of CO_2 in their reserves that will be released if current priorities, policies, and practices do not change.

If the world had begun in 2012 to reduce CO_2 emissions, this would have required a 6% carbon pollution reduction annually. If we wait until 2020 to reduce emissions, it will require a15% annual reduction.

Emissions climbed 1.7% in 2017, as the world's energy consumption increased 2.2%, while percentage of renewable energy remained at 4%. "Keep it in the Ground" (meaning develop and use no more fossil fuels) is a basic climate justice strategy to lower CO_2 emissions, accompanied by a rapid and just transition to renewable resources ("just" in that it not be at the expense of workers, poor people, indigenous people, and people of the global majority).

If we stop fracking, we immediately slow global warming. Recent studies show that dangerous quantities of methane are released into the atmosphere during the fracking process. Because methane is more than 30 times more warming than CO_2, immediately reducing methane emissions will curtail warming significantly and immediately. However, the G20 countries are investing $1.6 trillion in gas production and methane emissions are rising.

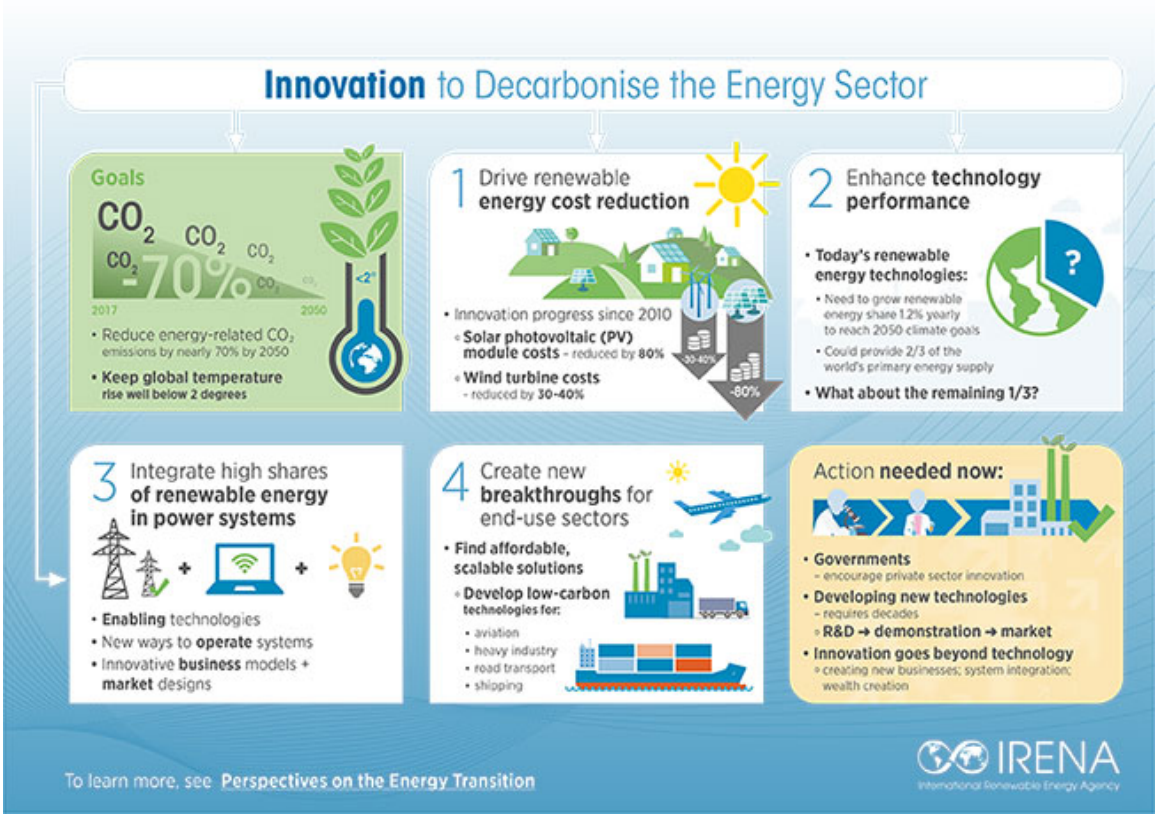




Renewable energy growth

Decarbonising the energy sector requires urgent action on a global scale. The cost of renewable energy is now comparable to that of fossil fuel, and massive development of renewable energy should be supported. Globally 80% of energy now comes from burning fossil fuels. However, each year the use of new and renewable sources of energy (solar, wind, and hydropower) increases.

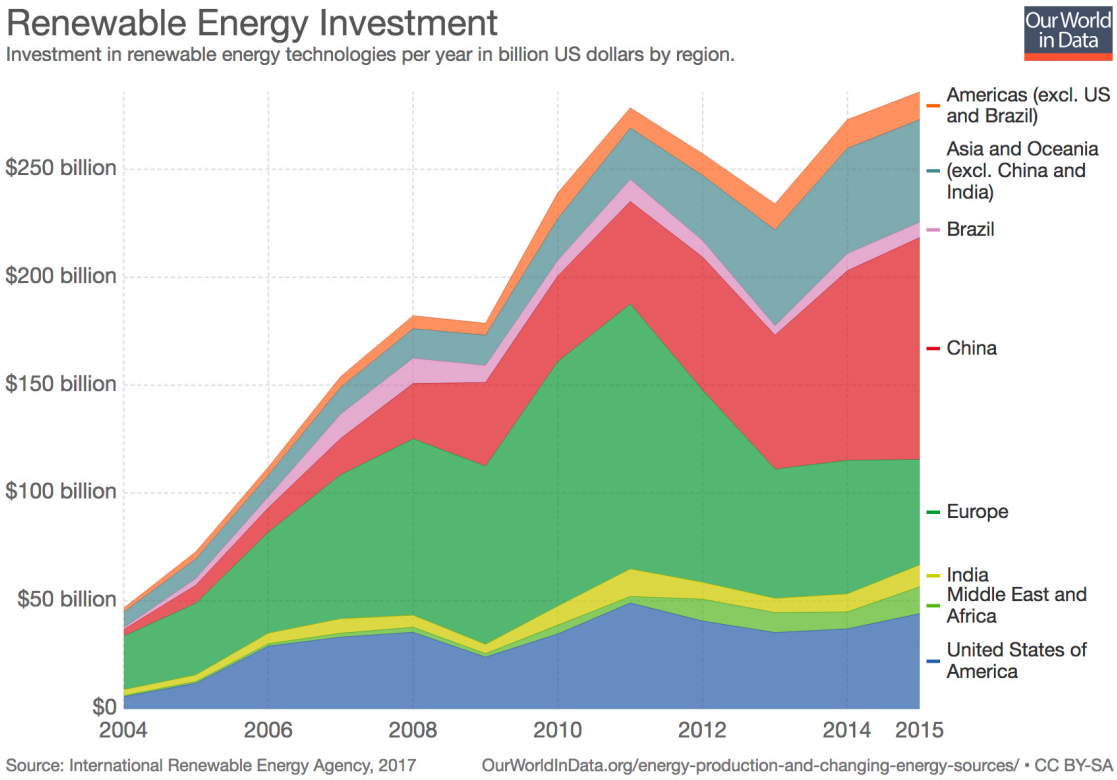
Renewable energy contributed 40% of the total increase of world energy power generation in 2016. But current predictions for continued growth in the renewable sector are inadequate, and fossil fuels are not being replaced quickly enough. While energy production and consumption patterns are changing fast, the shift to renewable sources needs to happen faster to reduce emissions and mitigate the effects of climate change.



Renewable energy investment

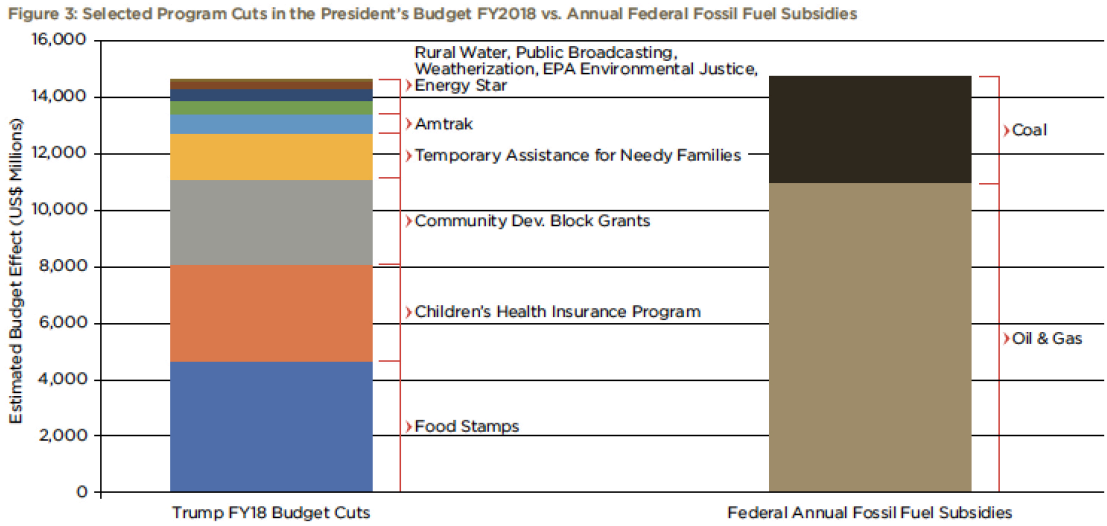
Ninety-six percent (96%) of electricity will need to be low carbon by 2050. This would require $3.5 trillion in energy-sector investments on average each year until 2050.

The chart below shows the growth in renewable energy investment by country/region.



Stop fossil fuel subsidies

Ending fossil fuel subsidies is another important part of the solution. Globally the world subsidizes the fossil fuel industry $1.4 trillion per year. U.S. subsidies are $20 billion per year. (U.S. subsidies for renewables have varied widely, but average $4 billion per year.) This graph shows proposed cuts in the U.S. President's proposed 2018 budget next to the amounts subsidizing coal, oil, and gas.



Preserving Carbon Sinks

Carbon and methane sinks—natural ecosystems on land and in the ocean that absorb or hold GHG emissions, specifically plants, forests, soil, and the ocean itself—are crucially important. Today more than half of human-caused carbon emissions are captured by these natural ecosystems, keeping the emissions out of the atmosphere. We must preserve these ecosystems and create additional ones—by stopping deforestation, planting millions of trees, and adopting regenerative agricultural practices that trap rather than release carbon from the soil.

Most models for keeping temperature increase below 2°C predict we will "overshoot" 2°C, and then have to rapidly reduce emissions by drawing them out of the atmosphere. Natural sinks are inadequate for this; we will need to develop a new sink with the GHG storage capacity of the ocean.

The oceans are the world's largest carbon sinks, They have absorbed about 1/3 of the CO_2 produced from human activities since 1800 and about 1/2 of the CO_2 produced by burning fossil fuels. There is concern that saturation is occurring, so more CO_2 emissions will remain in the atmosphere.

Ocean absorption of CO2 also leads to ocean acidification that endangers marine ecosystems. The oceans are 30% more acidic now than in 1750. Good short video on oceans as carbon sinks.

https://www.youtube.com/watch?v=vgzCY6LccRQ

The majority of deforestation happens to clear land for industrial agriculture and grazing. Between 2000 and 2016 the world lost nearly 10% of its intact forests, and deforestation is increasing. Undisturbed forest landscapes absorb more than 25% of the CO_2 in the atmosphere. A good short video on the importance of maintaining rainforests:

https://www.youtube.com/watch?v=_wVY1kDIIB0

Financing the transition

Wealthy nations are most able to help Frontline Nations adapt to climate change and gain access to renewable energy. Much of the wealth of the wealthy nations comes from exploitation of the resources of Frontline Nations. The Green Climate Fund was established by the United Nations in 2011 to raise $100 billion from the wealthy nations per year by 2020, but to date only $10.3 billion has been pledged. Lack of adequate support for measures of finance and adaptation for Frontline nations continues to be a major stumbling block at the negotiations and will be a major issue at COP24 in Poland.

Green Climate Fund dashboard: https://www.greenclimate.fund/what-we-do/portfolio-dashboard

Recent reports estimate that the global infrastructure investment required from 2016 to 2030 to remain below a 2°C rise is approximately USD 7 trillion per year, and USD 53 trillion in cumulative investments is needed to transition to a low-carbon energy system from 2016 to 2035.

What to do?

There are many proposals for stopping climate change and staying below 2°C. Several are summarized at the end of this article, www.rc.org/sciencesummary. The diagram below contains many elements common to these plans.