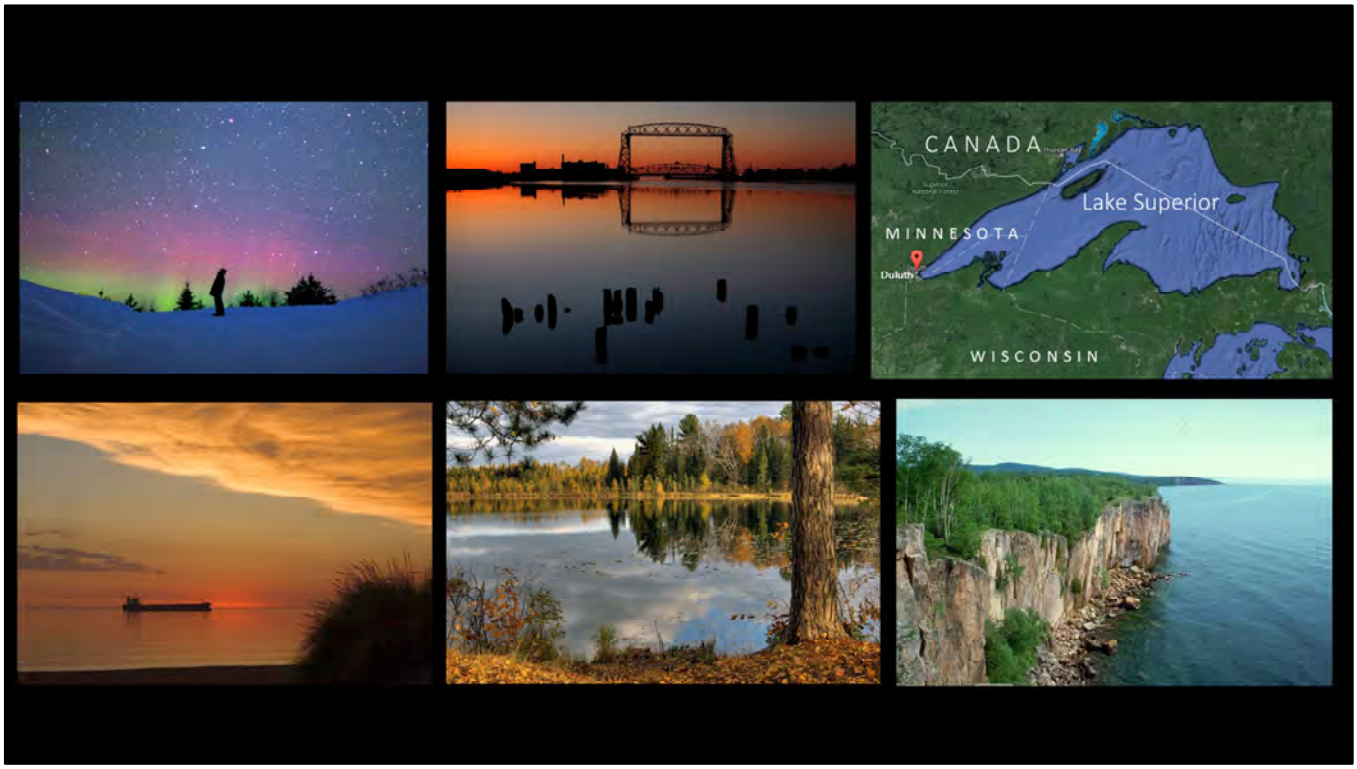
The afternoon sky glows red from bushfires exacerbated by climate change near Nowra in the Australian state of New South Wales on December 31, 2019.
Saeed Khan/AFP via Getty Images



I grew up in the USA, here (at the red star on the map). For comparison, this is Japan, at about the same scale; Japan is almost the size of California (94%) and has a climate similar to the US, stretching from Minnesota to Mexico.

This is Lake Superior...the largest freshwater lake in the world! It is about the same size as all of Hokkaido.

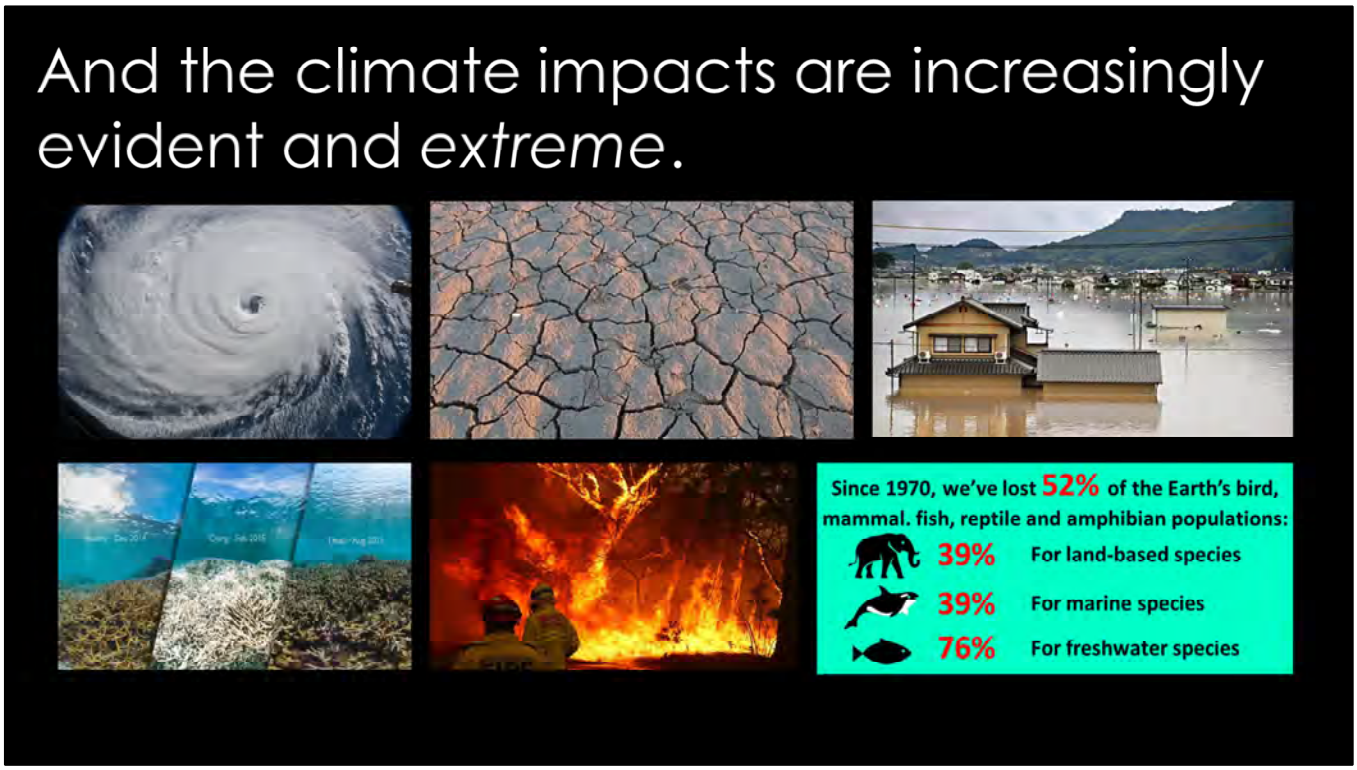
And this part of the USA is mostly NATURE. The forest near my childhood home was the second largest city owned forest in the United States! It was just a few minutes walk to the lake, rivers, the forest, nature from my parents home...This affected me greatly. I spent much of my early years fishing, camping, ice skating, skiing, hiking, star watching, taking pictures, making movies—all outdoors...and now, **I believe that the "*roots of sustainability and integrated design, come from nature*."**

We rely on nature for food, water, air, comfort, beauty, medicine and many natural resources. However, nature has not been able to rely on us to take good care of, and heal it. We instead continue to destroy nature and believe it will all be ok—It will not be ok if we continue this path of destruction for even another 10 years.

However, it is not enough to love nature or be an environmentalist today. We have to do MORE!

Because of where I came from, before I became an architect--I was first an environmentalist. An environmentalist is simply **a person who cares about the environment.** Do you ever think about where you grew up and how it shapes your life, your work, your feelings about nature? [CLICK]

The conditions of Earth's atmosphere today haven't been seen for roughly 3 million years; humans have *never lived* on a planet like this. Changes are coming faster than most scientists have predicted — and **society needs to change even faster**. It's a daunting (and difficult) task for us.



Today, the world is HOTTER, WETTER, with STRONGER STORMS, and there are longer lasting DRAUGHTS. SEA LEVELS are rising, the OCEAN is ACIDIFYING, coral REEFS are DYING, forests are BURNING; there are already widespread CROP FAILURES, along with dramatic losses of mammals, fish, reptiles and amphibians.

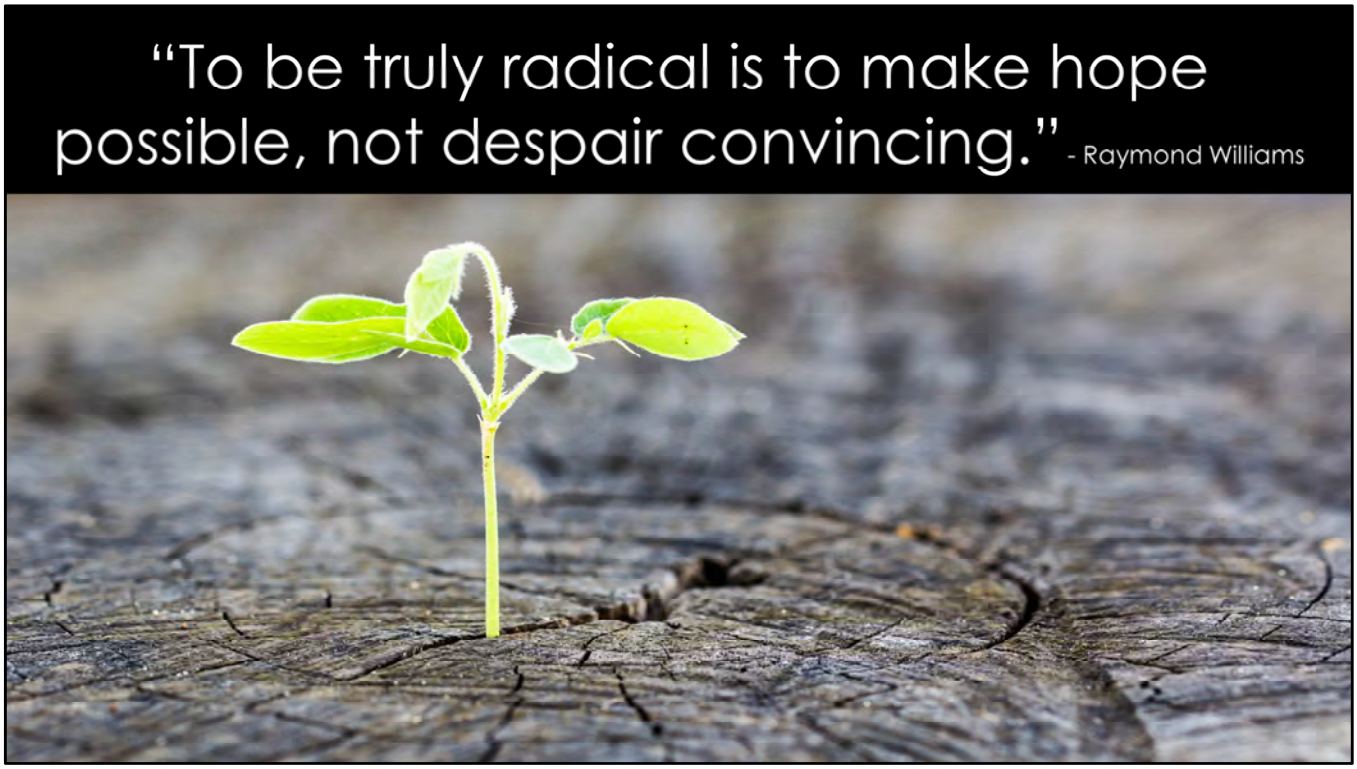
There are also dramatic shifts in marine life, animal & plant ranges and populations due to climate change--not to mention increased viruses spreading.

SOME OF THE MOST ENDANGERED SPECIES ARE: 1. Elephants, 2. Whales, 3. Hippos, 4. Chimpanzees, 5. Koalas, 6. Giraffes, 7. Rhinos, 8. Tigers, 9. Gorillas, 10. Lions, 11. Sharks, 12. Bats, 13. Butterflies, 14. Penguins, 15. Turtles, 16. Bees

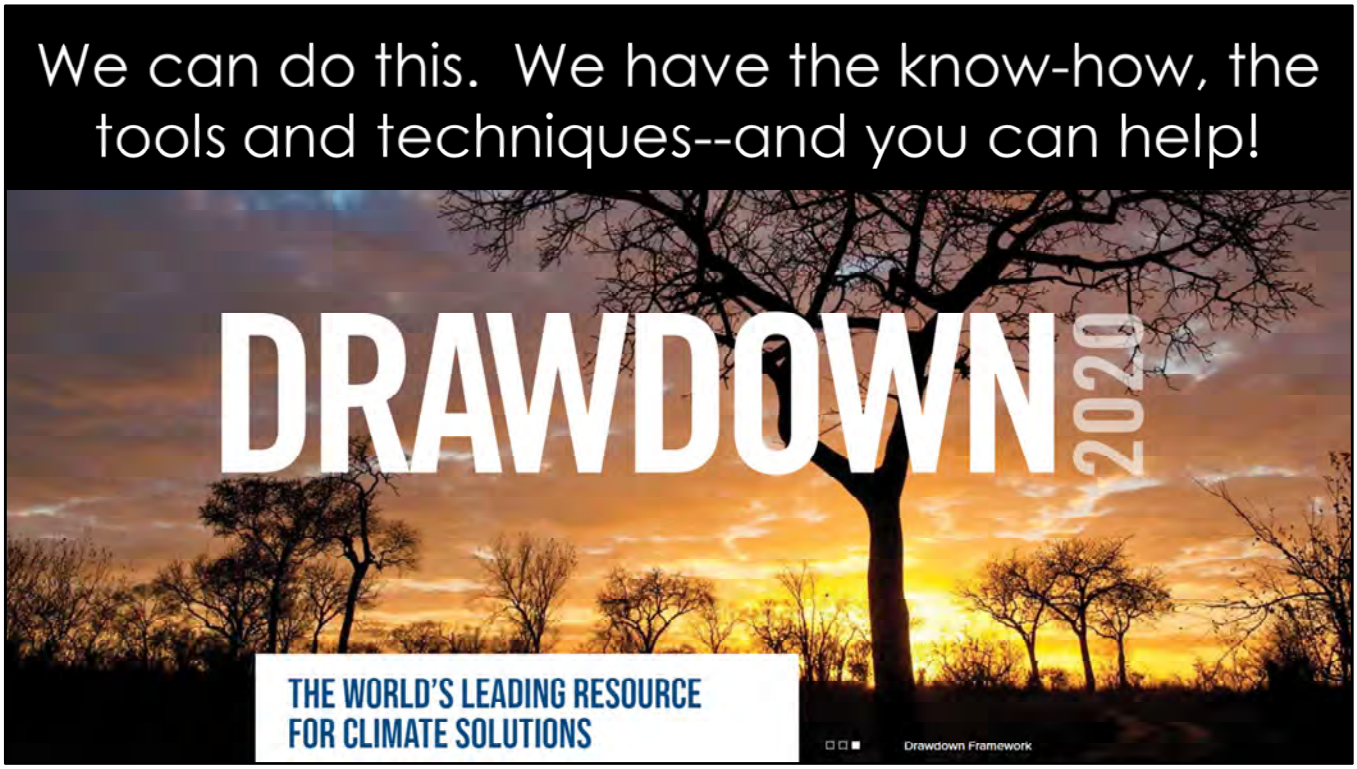
The severity of these climate impacts is directly linked to the amount of carbon dioxide and other heat-trapping gases that are released into the atmosphere. The more carbon, the worse the impacts will be. Scientists have concluded that avoiding the worst impacts of climate change will require limiting global warming to 1.5ºC to 2ºC. I believe we may be too late for limiting warming to 1.5 C.

Many people feel some level of hopelessness regarding climate change; it is normal to feel that way…they feel they cannot do enough.

BUT, PLEASE REMEMBER, *HOPE is a verb*.



My friend Amory Lovins would say this often when I was working with him. It seems this is very true.



There is an incredible mosaic of solutions (palette of options), with benefits that go beyond reducing emissions to improving health, creating jobs, and shoring up resilience. There are also roles for everyone on the planet. Climate leadership comes in many forms: individuals, households, cities, companies, social movements and local, regional and national governments. Every one of your customers can also help. And so can you!

[CLICK] Introducing DRAWDOWN. DRAWDOWN is a comprehensive global assessment of practices and technologies that already exist, to help us transcend this climate crisis. There are nearly 100 solutions that range from buildings and cities to ecosystems and food; from electricity to materials to transport and social equity.

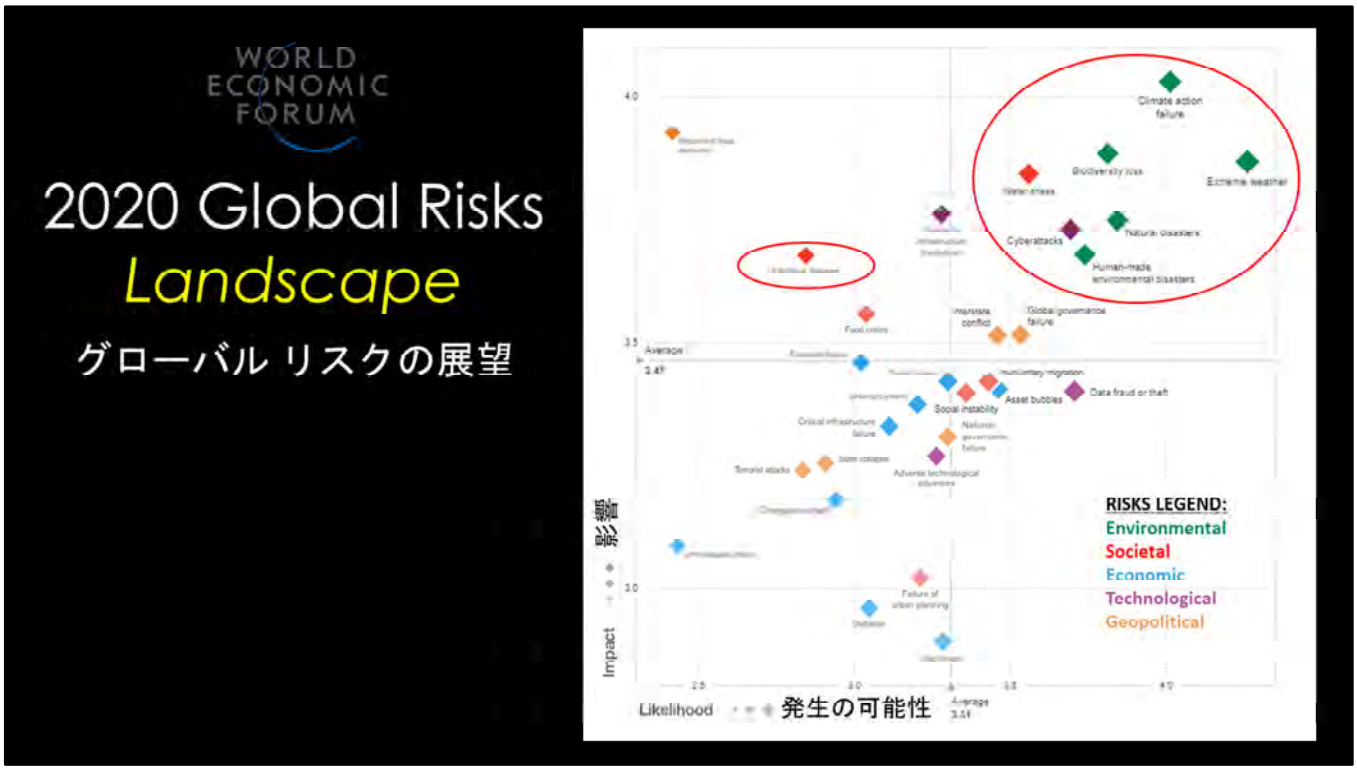
Some strategies stop greenhouse gas emissions from going up, and others bring carbon back home through the power of photosynthesis. All of these are important and some are quite critical. I am asking you to join me in helping to fight climate disruption today.

Imagine a world where carbon emissions have long been steadily declining—at a handsome profit, because saving fuel costs less than buying fuel; where global climate has stabilized and repair has begun;

Imagine a world where the successful industries, rather than wasting over 99% of their materials—they take nothing, waste nothing, and do no harm; where service providers and their customers prosper by doing more and better with less for longer;

Imagine a world where integrative design and biomimicry create abundance; and where elegant frugality turns scarcities and conflicts in energy, water, land, and minerals into enough, for all, forever.

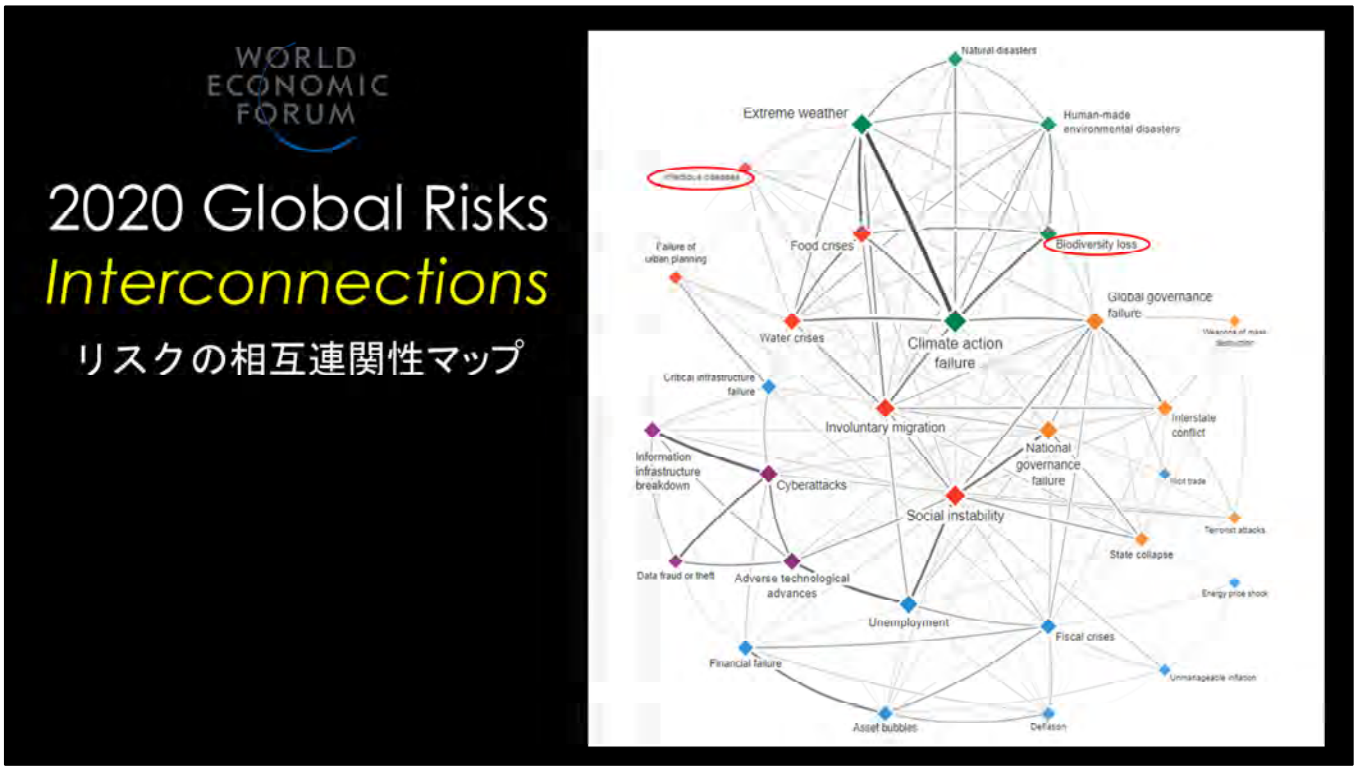
The Problem



The World Economic Forum Global Risks Report 2020 presents the major risks the world will be facing in the coming year. It stresses the need for a multi-stakeholder approach to addressing the world's greatest challenges

The X axis is the likelihood (or chance of occurrence) (hassei no kanōsei) that the risk will become reality. The Y axis is the potential influence or impact (Eikyou) of the risk. The larger the shape, the bigger the risk.

You'll notice [CLICK] the upper right corner shows the most likely risks with the biggest impacts. Most of these are environmental. It is worth noting where [CLICK] infectious diseases and [CLICK] involuntary migration are with both likelihood and impact. These are all related to each other. But what are the connections between these? [NEXT]



This graphic shows the interconnections between the risks (risuku no sōgo renkan-sei). Again, the larger the shape, the bigger the risk. The heavier the line, the stronger the connection. Notice that climate change risk is either directly or indirectly connected to almost every risk we face.

[CLICK] Infectious diseases are connected to [CLICK] biodiversity loss and climate change is strongly connected to biodiversity loss.

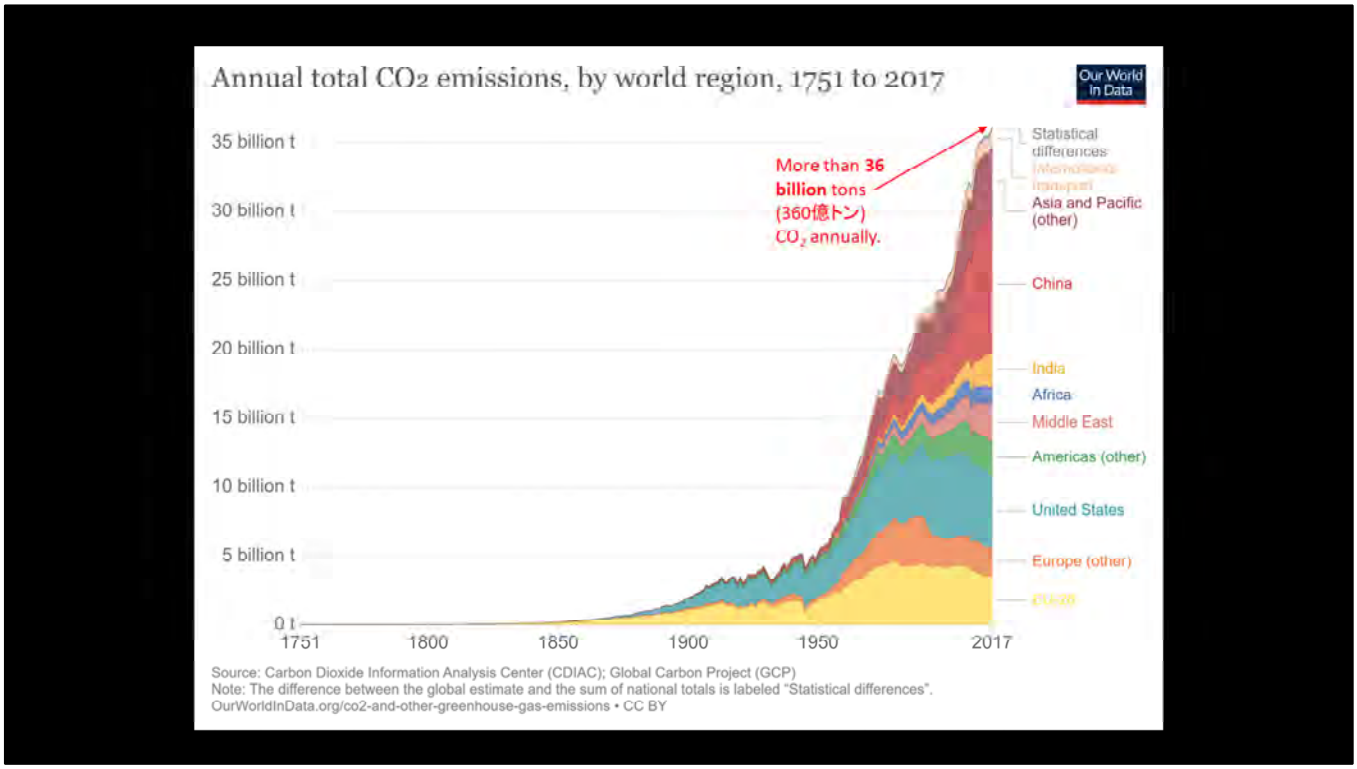
Habitat destruction is a major cause of biodiversity loss is caused by deforestation, overpopulation, pollution, and **global warming**. [NEXT]

These risks aren't just possible**, they are happening now**. There is major disruption and the death of hundreds of thousands of people every year. This is flooding in Jakarta. I think climate change isn't coming for them—it's happening now.

This photo was taken last month, I believe...India and Bangladesh have had massive flooding recently and millions of people have been displaced. Japan is expected to receive record rainfall, with likely flooding again, in the near future...This is climate crisis, happening now.

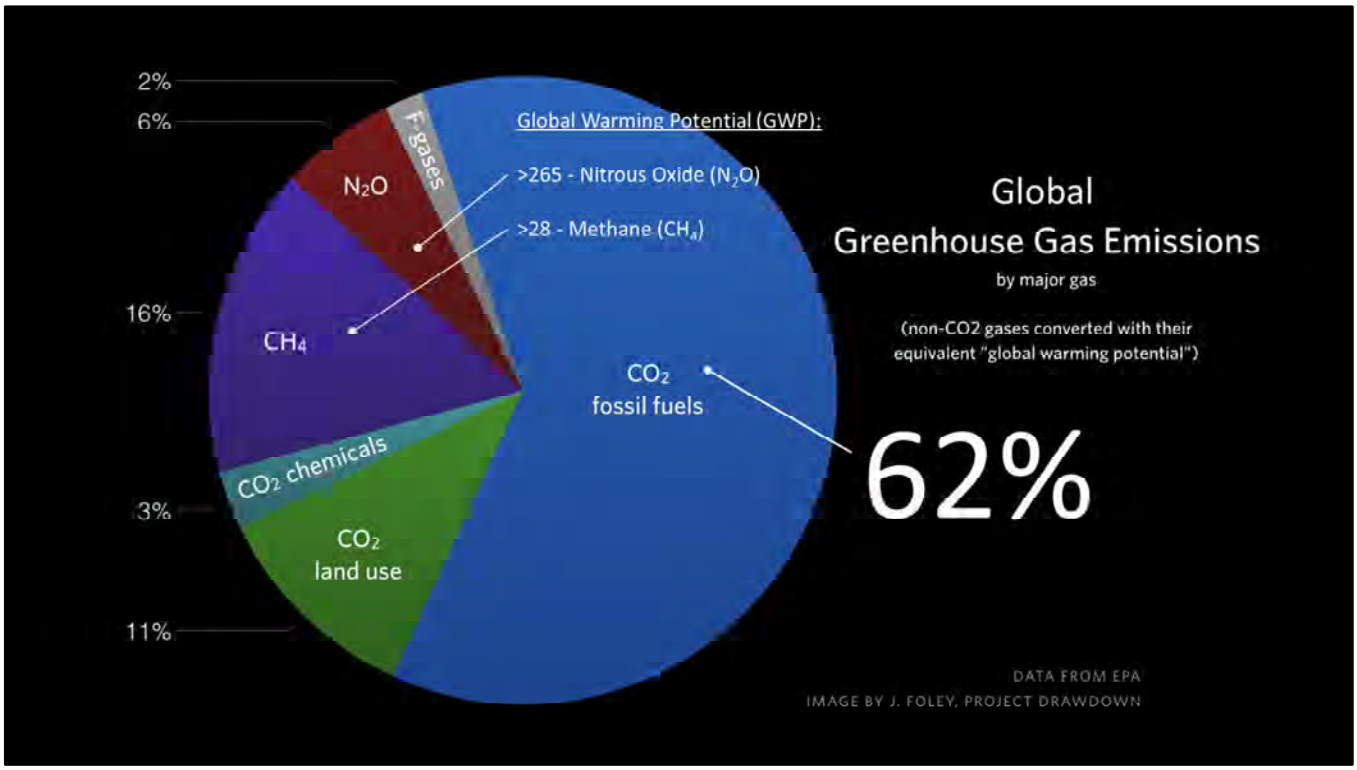
When 80% of corn and bean crops are lost to droughts; 1.4 million people from Central America flee their homes…This is real impact for these people now!

NOTES:
In a stark new finding about the planet's rapidly warming climate, a study finds that for every 1.8 degrees Fahrenheit (1 degree Celsius) of global average warming, 1 billion people will have to adapt or migrate to stay within climate conditions that are best suited for crop production, livestock and a sustainable outdoor work environment. [Washington Post]



CO2 continues to rise in the atmosphere. Concentration in the atmosphere is now well over 400ppm – **the highest level in over 800,000 years.**
Today, we are emitting over **36 BILLION tons of CO2 annually** *(I want to ask you to remember this number*).

Since CO2 knows no boundaries, the emissions by country or region are not really important, except it is interesting to see which countries are <u>decreasing</u> versus <u>increasing</u> (developed versus developing economies) [NEXT]

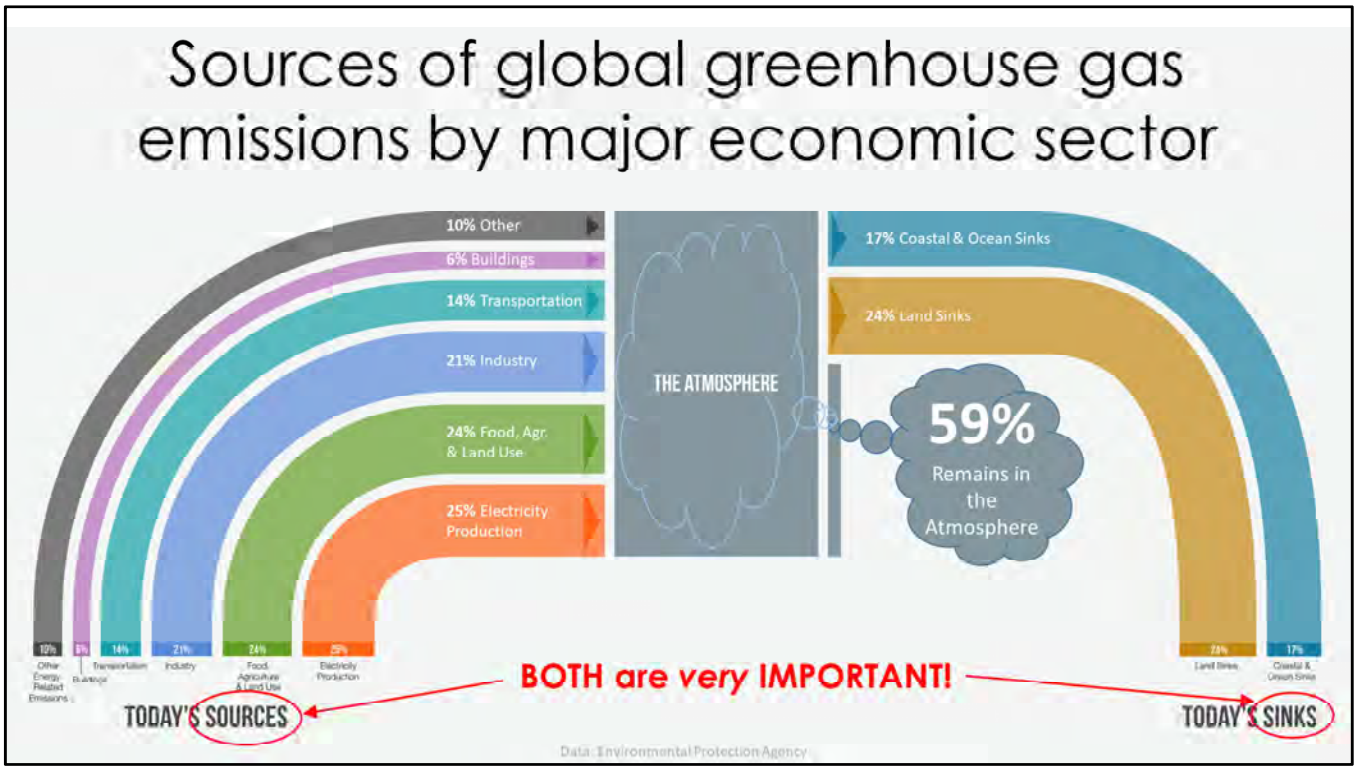


Climate change is *not* just an energy problem; it's about **62% an energy problem** — food & land use are also crucially important — and so are leaking natural gas pipelines, landfills, cement, and refrigerant gasses.

While carbon dioxide (CO2) is the most important greenhouse, stemming from fossil fuel combustion, land use, and industrial processes, **methane (CH4), nitrous oxide (N2O), and fluorinated gases (f-gasses) are also important**. Here each gas is compared on an "apples to apples" basis by averaging their "global warming potential" over a 100 year period.

NOTES:
Methane (CH4) can be released from leaks from fracking and natural gas pipelines, landfills, and biomass burning. Another major source of methane comes from agriculture, especially from rice fields and cattle (belching). **Nitrous oxide (N2O)** is mainly produced from overusing fertilizer in agricultural soils. **Fluorinated gases (f-gases)** such as hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs), and sulfur hexafluoride (SF6) are typically used as refrigerants or in industrial processes.

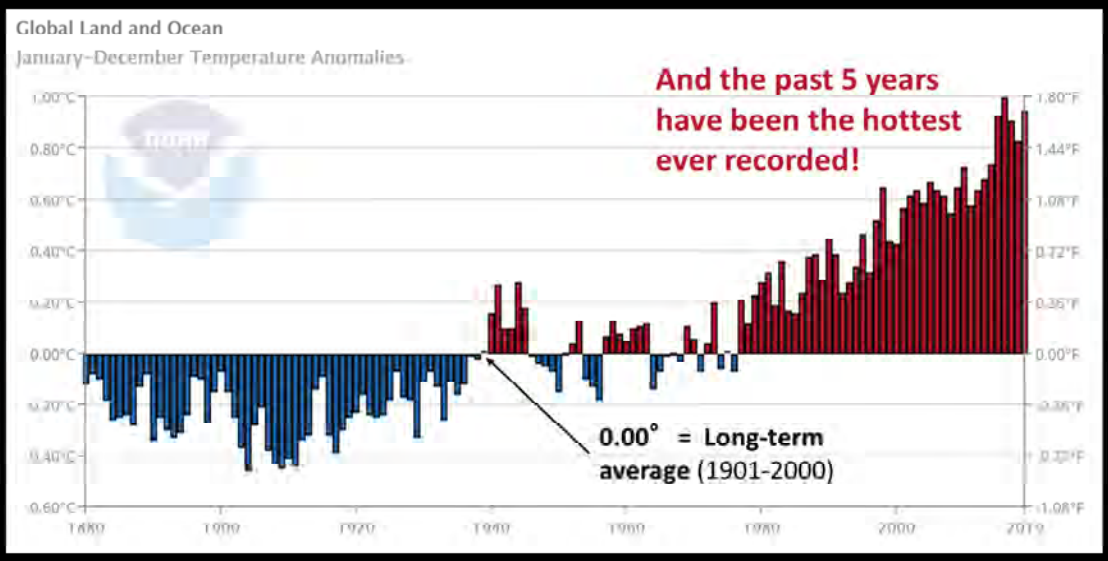
Data from the EPA, with adjustments to separate chemical and cement emissions of CO2 from fossil fuel combustion based on data from the World Resources Institute.
https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data



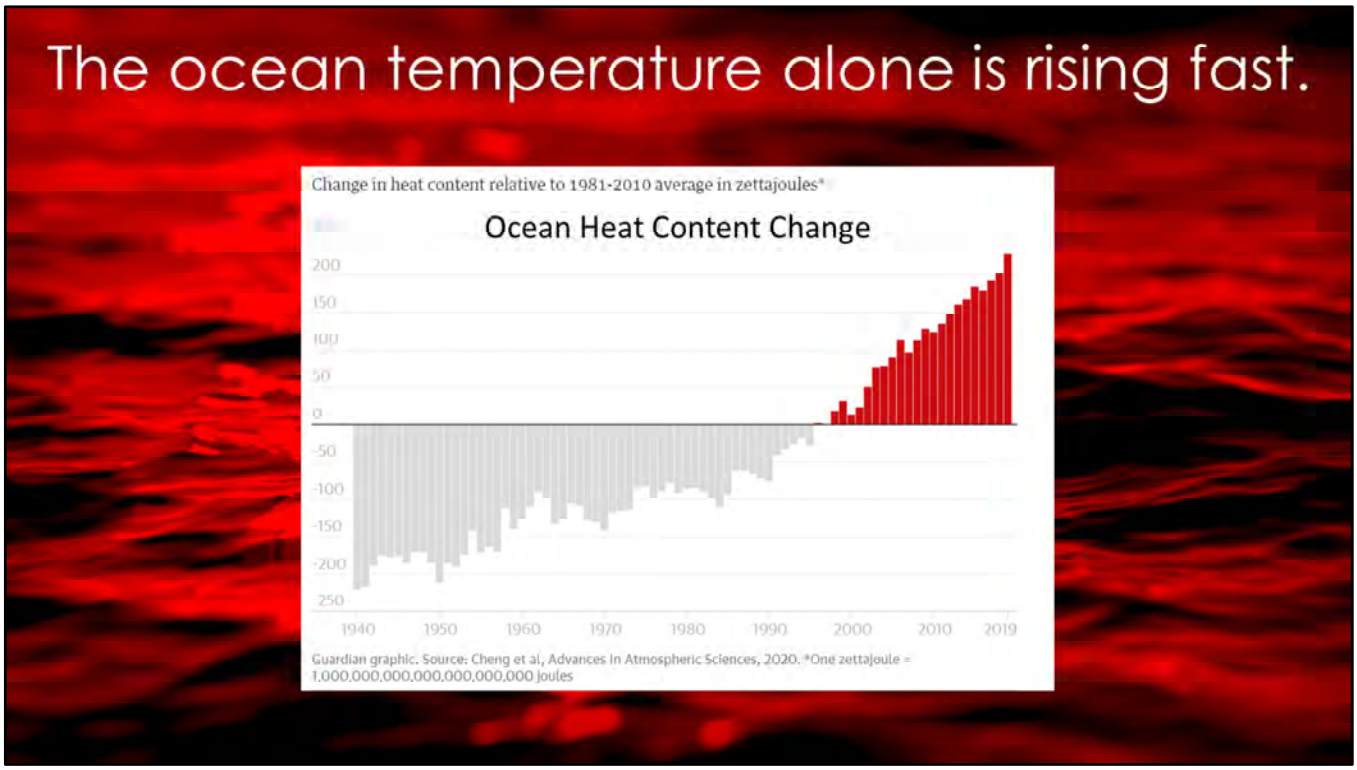
SOURCES of emissions (transportation, electricity, and buildings) is our usual focus. However SINKS (land, forests, and oceans) are also very important. Land use and agriculture also play a big role.

(Note: these data are for the world as a whole, and each country has a different emission profile. In the United States, for example, food & land use are a smaller fraction of emissions, but transportation is higher. Data from the EPA).

The global temperature continues to rise.



The graph shows average annual global temperatures (land and ocean) since 1880 (source data) compared to the long-term average (1901-2000). The zero line represents the long-term average temperature for the whole planet; blue and red bars show the difference above or below average for each year. Global average temperatures have increased by more than 1℃ since the pre-industrial era. And the past 5 years have been the hottest ever recorded.



And this is very problematic (and should concern you) if you care about life on Earth.

NOTES:
A **Joule** is a derived unit of **energy**. It is equal to the **energy** transferred to an object when a force of **one** newton acts on that object in the direction of its motion through a distance of **one** metre. After a billion, of course, is trillion. Then comes quadrillion, quintrillion, **sextillion**, septillion, octillion, nonillion, and decillion.

Crabs (and other coruscations) shells are disintegrating; signaling a possible coming extinction. Bleached (dead) coral reefs--nearly 50% have already been lost. With dead coral, the small fish leave....along with their predators. And entire populations of fish have been completely lost--giant masses of dead fish have been discovered and fisherman (even in Japan) have recently been surprised by this. Late 2019 reports off northern Hokkaido said that fisherman have been going out of business as there are no more fish to catch.

NOTES:
Warmer waters decreases oxygen and increases algae growth. Algae survive through photosynthesis, which means they release oxygen during the day. But at night, they "breathe" the same way we do: taking in oxygen and releasing carbon dioxide. And when algae die, the chemistry of their decomposition removes yet more oxygen from the water. Algae can also form "red tides", large toxin-releasing blooms that can accumulate in fish and spread through the food web. These incidents have also been linked to widespread illness in birds, sea lion stranding's and whale deaths.

GLOBAL INSECT COLLAPSE [Gurōbaruna konchū no hōkai]: Two scientific studies have revealed a huge decline in insect abundance at European sites over the past two decades. The research adds to growing evidence of what some scientists have called an "insect apocalypse," which is **threatening a collapse in the natural world that sustains humans and all life on Earth**.

THE FOUR MAIN DRIVERS of insect collapse are climate change, habitat destruction, habitat fragmentation and pollution (pesticides, herbicides, air and water pollution--and even LIGHT POLLUTION!)

NOTES:

A third study shows plummeting numbers of aquatic insects in streams. The survey of insects in rural Denmark used data **collected every summer from 1997 to 2017 and found an 80 percent decline i abundance**. It also found a *parallel decline in the number of swallows and martins, birds that live on insects*.

I watched this happen in Colorado—right in front of my eyes. I moved there in 2007. Wilderness area USFS SW Colorado.

Normally, these pine beetles would die off or hibernate during the winter, but when warmer seasons prevailed (due to global warming), these beetles had 2 litters or births each season—And this is the result--**nature out of balance**.

The LOCUST INFESTATION from Iran and Africa to India is must worse than this because it affects crops. Millions of people are now at risk of starvation.

NOTES:
Desert locusts are usually restricted to the semi-arid and arid deserts of Africa, the Near East and South-West Asia that receive less than 200 mm of rain annually. In normal conditions, locust numbers decrease either by natural mortality or through migration. However, the last five years have been hotter than any other since the industrial revolution and since 2009. Studies have linked a hotter climate to more damaging locust swarms, leaving Africa disproportionately affected. Wet weather
also favours multiplication of locusts. Widespread, above average rain that pounded the Horn of Africa from October to December 2019 were up to 400 per cent above normal rainfall amount. These abnormal rains were caused by the Indian Ocean dipole, a phenomenon accentuated by climate change.

Meanwhile, U.S. insect-born diseases from mosquitos, ticks and fleas have tripled in 13 years! Scientists attribute this mostly to warming temperatures (which we know is caused by climate change), expanded insect territories, and earlier springs/later autumn seasons (allowing longer mating and survival periods).

Globally, in mostly tropical climates, a 30-fold increase in dengue fever has been realized in the past 30 years... And in 2015 alone, over 485,000 people died of malaria....Remember Zika? It is also still available for us to contract.

Zoonotic Diseases
人畜共通感染症

Zoonotic diseases are an infectious diseases caused by a pathogen (病原体) (such as bacteria, viruses, or parasites (寄生虫)) **that have jumped from non-human animals** (usually vertebrates (脊椎動物)) **to humans.**

Why is this happening?

- Biodiversity loss
- Deforestation
- Environmental degradation

Zoonotic diseases are very common around the world. Scientists estimate that **more than 6 out of every 10 known infectious diseases in people can be spread from animals**, and **3 out of every 4 new or emerging infectious diseases in people come from animals.**

Increased virus spillover events from animals to humans can be linked to biodiversity loss, deforestation and environmental degradation, as humans further encroach on wildlands to engage in agriculture, hunting and resource extraction they become exposed to pathogens which normally would remain in these areas. Climate change has forced changes in species territory ranges and further pushed us closer together.

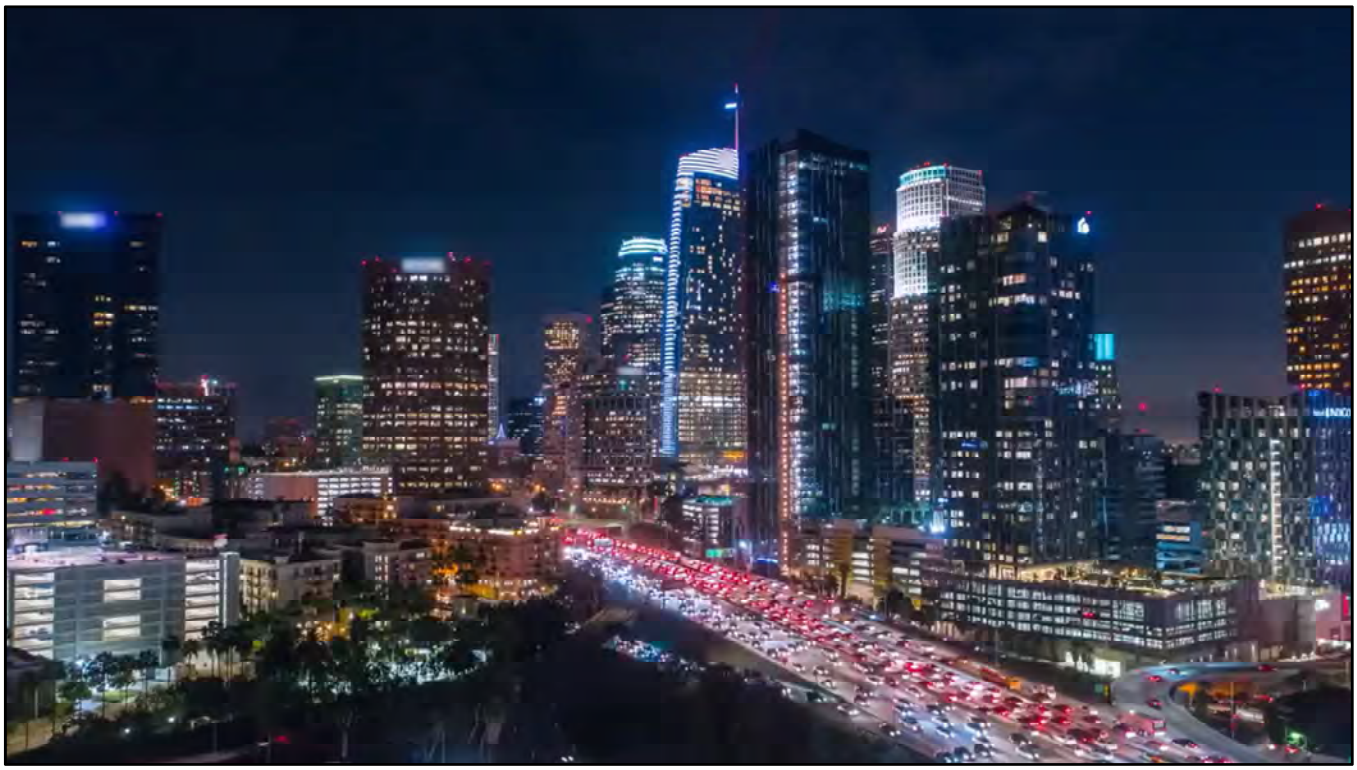
Such virus (animal to human) spillover events **have been tripling every decade since 1980**.

These are some of our "greatest hits" since 1970—just 50 years ago.

BTW, soil can alone support 7X the carbon currently in the atmosphere—we just need more plants/trees to pump it in there, for free.

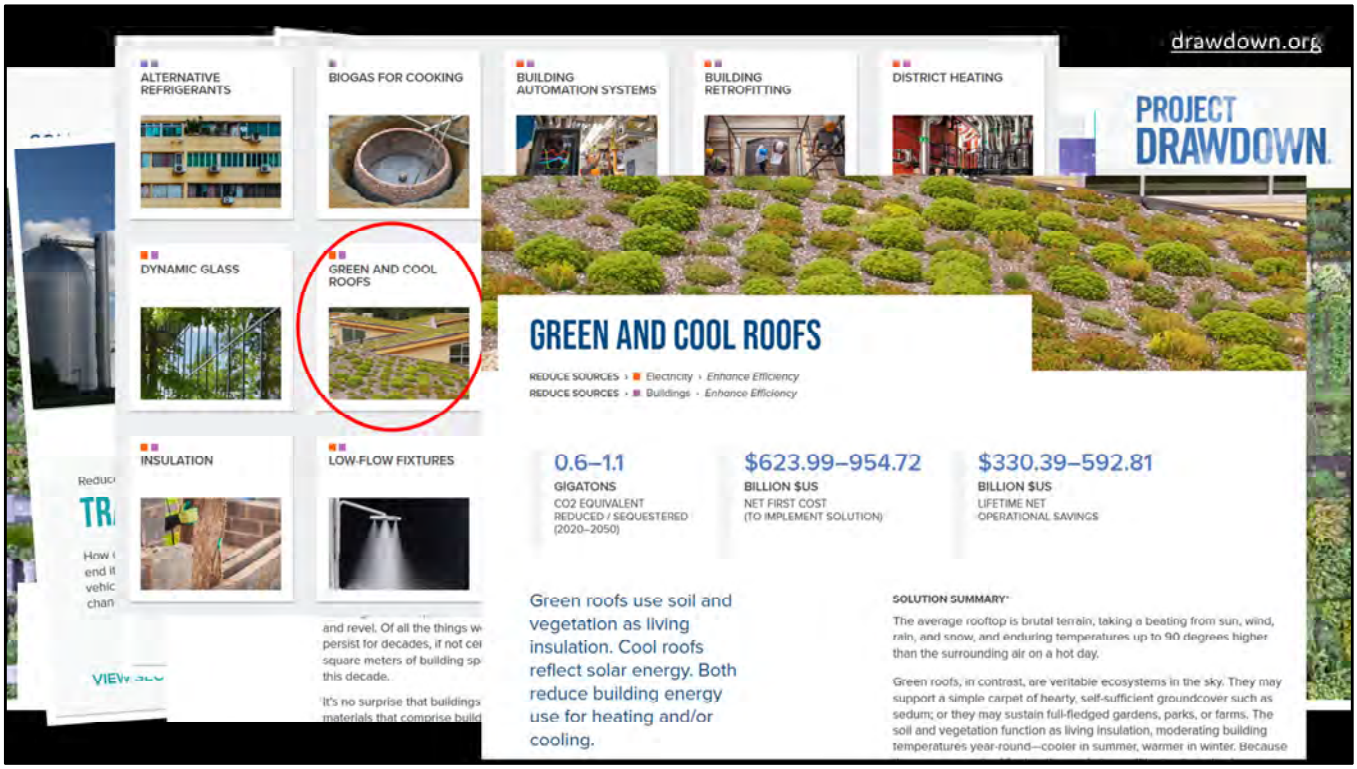
COVID19 is the Earths vaccine.

We are the virus.



3 min. Movie clip

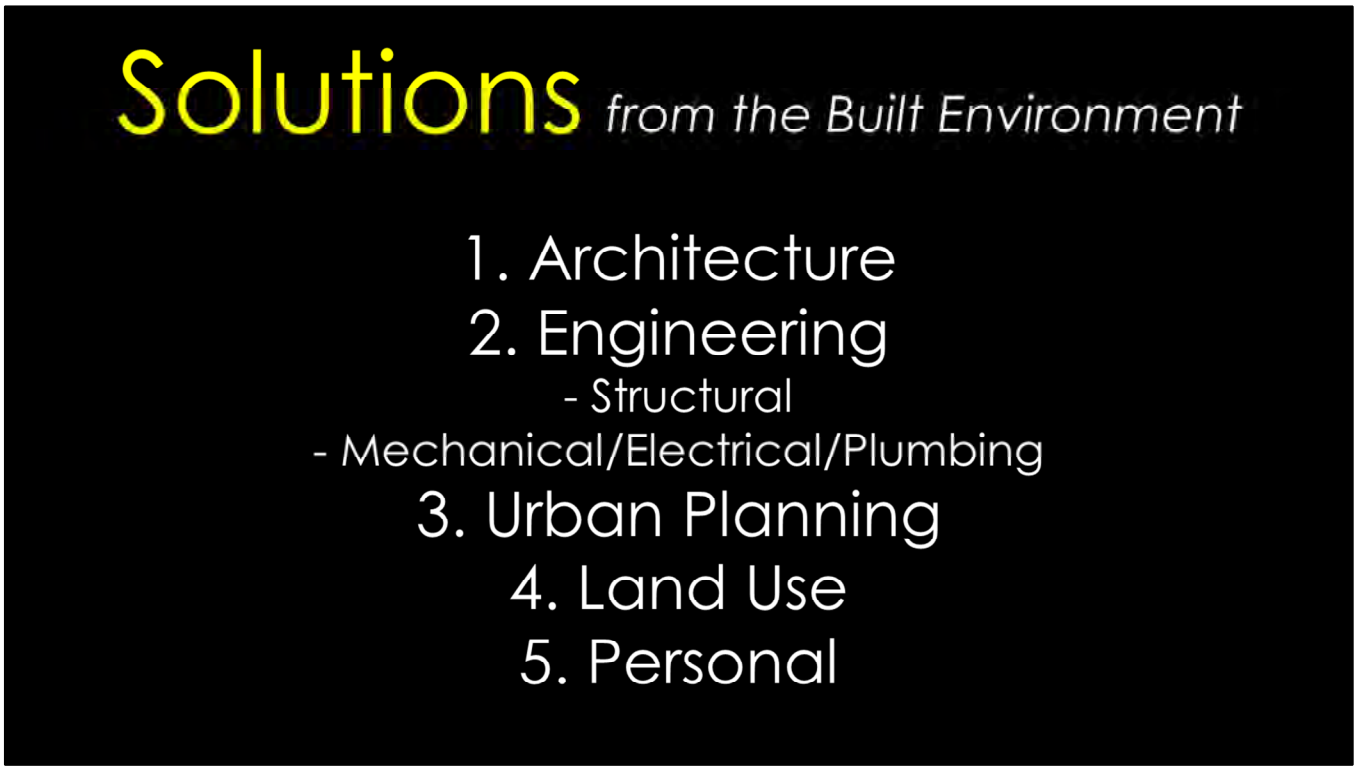
But, please remember, there is hope.



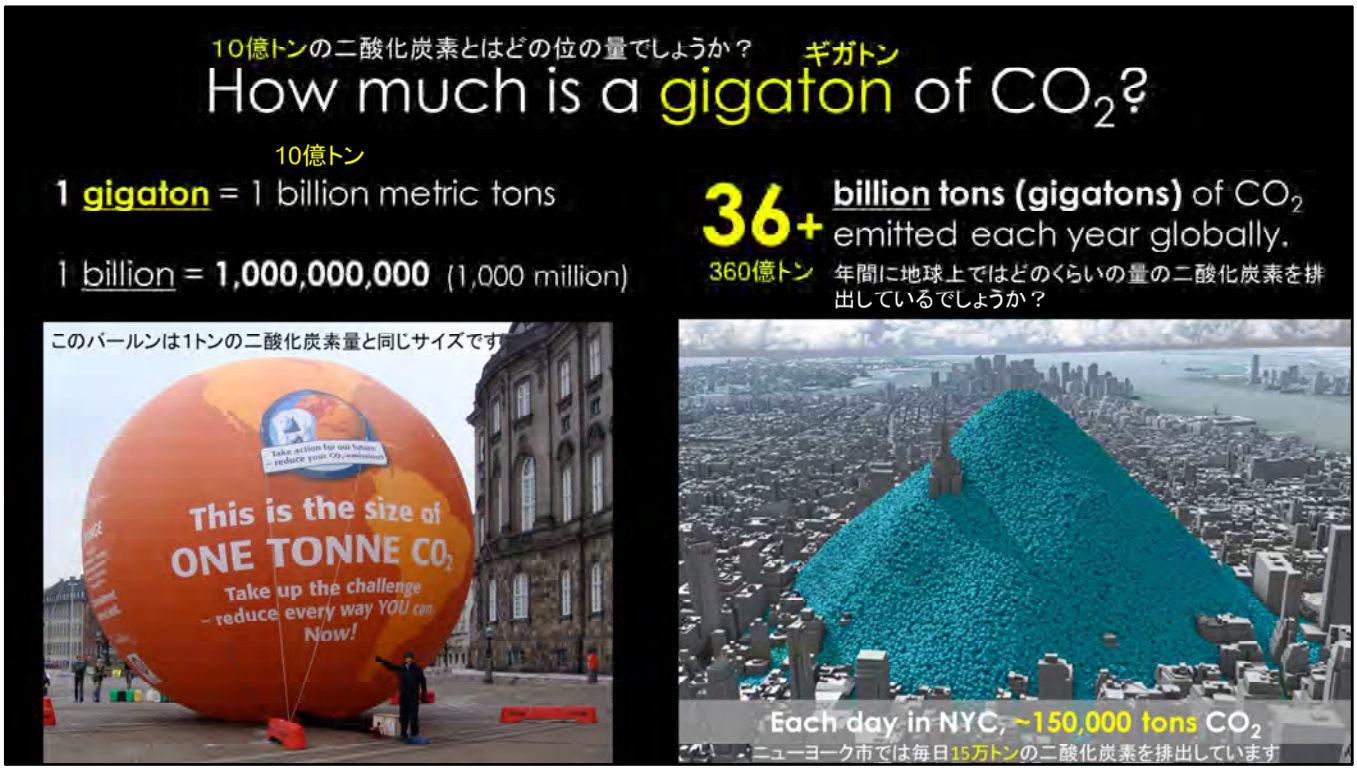
DRAWDOWN is a comprehensive global assessment of practices and technologies that are already available to help us transcend this climate crisis. There are around 80 solutions range from buildings and cities to ecosystems and food, from electricity to materials to transport and social equity.

These are screenshots from the DRAWDOWN.org website. It shows all of the strategies listed in table format, or by categories...lets look at one strategy in the buildings area. Green Roofs. And each solution has data or assumptions in the analysis as well as a technical summary page that explains any assumptions made in conducting the calculations.

www.drawdown.org



I have re-categorized some of the solutions from DRAWDOWN into categories more familiar to us as built environment professionals.



1 BILLION…that's 9 zeros! The orange ball represents one ton of CO2 and is ten meters in diameter.

In 2010, with a single day's CO_2 emissions in NYC, CO_2 "buries" the Empire State Building with almost 150,000 (149,903) ten-meter-diameter spheres, each containing one metric ton of the gas. (over 54 million metric tons annually; 0.054 gigatons)

Globally we emit over 36 billion tons of CO2 per year – and this continues to increase.

Architecture

Many improvements in glass technology have been made over the years including double-glazing, yet adoption of these is limited to 18 percent in global residential buildings and 6 percent in non-OECD (Organization for Economic Co-operation and Development) commercial buildings worldwide. If instead high-performance windows are installed at a **2.75-5 percent annual retrofit rate**, the emissions reductions and cost savings can be as shown on this slide.

Retrofitting buildings with insulation is a cost-effective solution for reducing energy required for heating and cooling. **Assumes (an annual rate of)1.6-2 percent of existing residential and commercial buildings in temperate and tropical countries install insulation** increasingly with low carbon materials.

Air infiltration accounts for 25 to 60 percent of energy used to heat and cool a home—energy that is simply wasted. Commercial buildings are not much better.

5 environmental and economic benefits of having a green roof:

1. Lower heating and cooling costs.

According to the National Park Service, over its estimated lifespan of 40 years a green roof would save about $200,000, of which, nearly two–thirds would come from reduced energy costs.

2. Extended roof life.

Since the plants sit on top of the roofing materials they act as a barrier, protecting the roof from direct ultra–violet radiation, wind, hail and extreme temperatures.

3. Improve property values and marketability.

4. Reduces runoff and improves water quality.

green roofs captured almost 60% more rainwater than a standard roof. Furthermore, the water that does run off a green roof is filtered through the vegetation, so it is much cleaner. This potentially lessens the need for complex and expensive drainage systems and reduces the amount of pollution in our rivers, lakes, and oceans.

5. Naturally absorbs carbon dioxide.

NOTES: The average rooftop takes a beating from sun, wind, rain, and snow, and endures temperatures up to 50 degrees C (90 Deg. F) higher than the surrounding air on a hot day. When solar energy hits a conventional dark roof on a 37.2-degree C day (90 Deg. F), just 5 percent of it is reflected back into space. The rest remains, heating the building and surrounding air (increasing urban heat island effect). A cool roof, on the other hand,

reflects up to 80 percent of that solar energy back into space. Cool roofs reduce the heat taken on by buildings and the overall urban heat island effect in cities.

Engineering
(Structural)

Cement is a vital source of strength in infrastructure, second only to water as one of the most used substances in the world. It is also a major source of emissions, generating 5 to 6 percent annually. Portland cement, a mixture of crushed limestone and alumino-silicate clay, is roasted in a kiln, forming clinker (3-25 mm lumps of material). Common materials can be substituted for cement content in most mix designs.

NOTES:
To reduce emissions from the process of making cement, the crucial strategy is to change the composition of the cement. Conventional clinker can be partially substituted for alternative materials that include **volcanic ash, certain clays, finely ground limestone, ground bottle glass, and industrial waste products—namely blast furnace slag (from manufacturing iron) and fly ash (from burning coal).** These materials leapfrog the most carbon-emitting, energy-intensive step in the cement production process. The average global rate of clinker substitution could realistically reach **40 percent and avoid up to 440 million tons of carbon dioxide emissions annually**. Standards and product scales will be key for realizing the opportunity of alternative cements.

Jan. 2020-Potsdam Institute for Climate Impact Research (PIK). A material revolution replacing cement and steel in urban construction by wood can have double benefits for climate stabilization. **First, it can avoid greenhouse gas emissions from cement and steel production. Second, it can turn buildings into a carbon sink as they store the CO2 taken up from the air by trees that are harvested and used as engineered timber.**

Four scenarios have been computed by scientists for the **next thirty years**. Assuming business as usual, just 0.5 percent of new buildings are constructed with timber by 2050. This could be driven up to 10 percent or 50 percent, if mass timber manufacturing increases accordingly. **This could result in storing between 10 million tons of carbon per year in the lowest scenario and close to 700 million tons in the highest scenario**. In addition, constructing timber buildings reduces cumulative emissions of greenhouse gases from steel and cement manufacturing at least by half. **"Protecting forests from unsustainable logging is key"**

https://www.europeanscientist.com/en/environment/buildings-made-out-of-timber-could-become-an-important-global-carbon-sink/
https://www.sciencedaily.com/releases/2020/01/200127134828.htm

In the Philippine creation story, the first man *Malakas* (Strong One) and the first woman *Maganda* (Beautiful One) emerged from the two halves of a bamboo tree. It is one of many Asian origin myths that features bamboo—a plant that human beings have cultivated for more than a thousand uses, from buildings to food to paper.

This strategy is really about bamboo as a carbon sink—planting it, using appropriate native species, on degraded forest lands.

NOTES:
Just a grass, bamboo has the compressive strength of concrete and the tensile strength of steel. It reaches its full height in one growing season, at which time it can be harvested for pulp or allowed to grow to maturity over four to eight years. After being cut, bamboo re-sprouts and grows again. Because bamboo is an invasive species in many places, which can spread with detrimental effects to native ecosystems, care should be taken to select appropriate locations and manage its growth. *When bamboo is substituted for aluminum, concrete, plastic, or steel, there can be significant avoided emissions; however, these additional benefits are not included.*

IMPACT:
Bamboo is planted on 33.52 million hectares today. We assume that it will be grown on an additional 69.8-174.3million hectares of degraded forest

lands. Our carbon sequestration calculations include both living biomass and long-lived bamboo products, with an annual rate of 2.03tons of carbon per hectare, resulting in a total of 8.3-21.3gigatons of carbon dioxide sequestered by 2050.

Engineering
(Mechanical, Electrical, Plumbing)

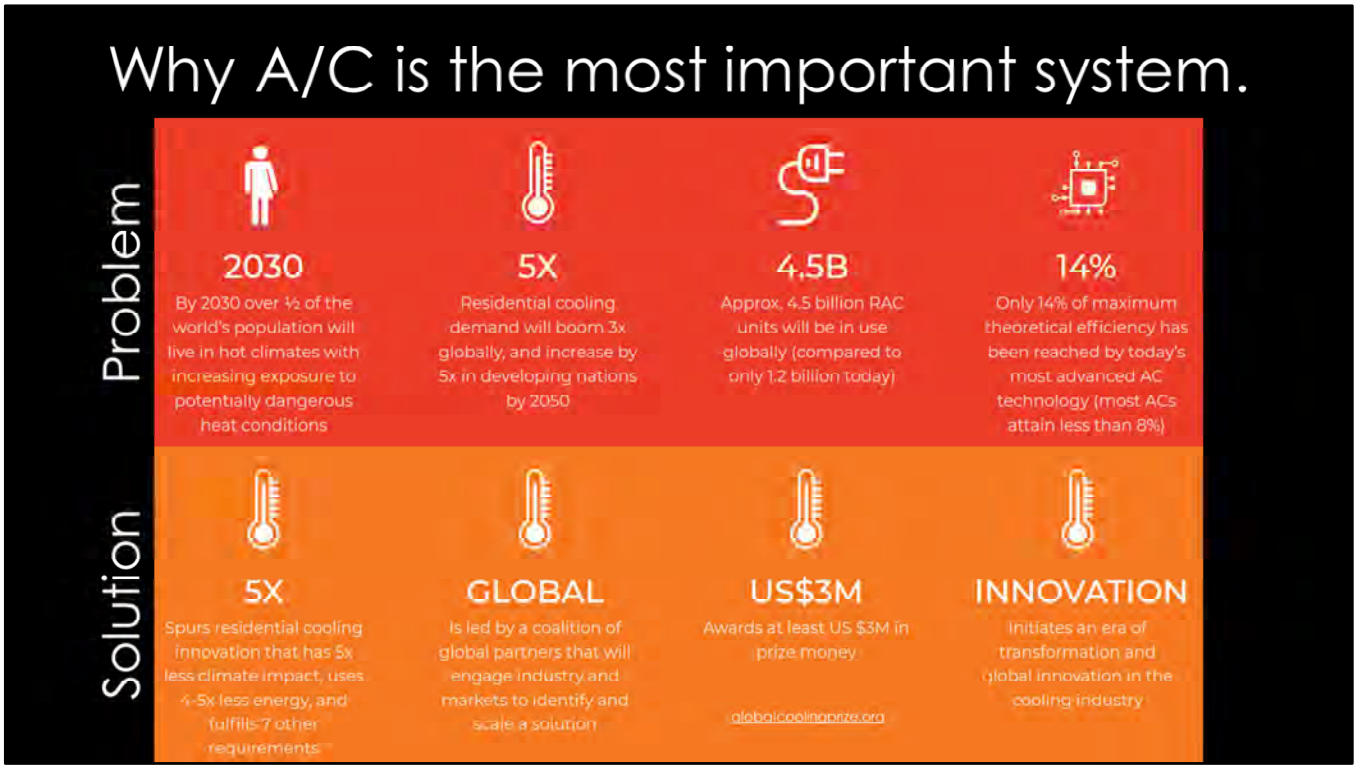
Why A/C is the most important system.

International Energy Agency (IEA)

Rocky Mountain Institute (RMI)

2018

IEA and RMI each released a report in late 2018 discussing the challenges and opportunities for cooling systems worldwide. This is because the growth of the use of cooling systems presents a major potential problem looking ahead…for example [CLICK]



[CLICK] Problem….[CLICK] [CLICK] [CLICK] [CLICK]
[CLICK] Solution….RMI, and their partners launched the Global Cooling Prize…[CLICK] [CLICK] [CLICK] [CLICK] When I heard about this in November of 2018, I convinced NIKKEN that we should team with Daikin and take on the challenge together. So we did.

The GCP attracted….[NEXT]

I am proud to say that the Daikin/NIKKEN team were 1 of 8 finalists, capturing $200k USD in prize money and are now in the final stages of building 2 prototype RAC units for full scale testing in India later this year.

This means primarily working with refrigerants already EXISTING at our buildings. CFCs and HCFCs, were once major culprits in depleting the ozone layer. Thanks to the 1987 Montreal Protocol, CFC's have been phased out and HCFC's are being phased out**. HFCs, the primary replacement**, spare the ozone layer, but have 1,000 to 9,000 times greater capacity to warm the atmosphere than carbon dioxide.

TWO PRIMARY STRATEGIES WERE CONSIDERED in this model:
-Controlling leakages of refrigerants from existing appliances by good management/maintenance practices.
-Ensuring recovery, reclaiming/recycling, and destruction of refrigerants at end of life.

NOTES: No direct upfront costs are applicable for control of leakages from appliances (Purohit and Isaksson, 2016). However, there are operational and maintenance costs per unit of refrigerant for adopting these measures. Only costs of collection, recovery, and destruction were used as operational costs per ton of refrigerant. The annual costs multiplied by the estimated emissions avoided give the total costs and the average annual costs per unit of HFC avoided for different years. The total costs for end of life recovery, removal, and destruction are calculated in a similar way.

Global warming potential (**GWP**) is a measure of how much heat a greenhouse gas traps in the atmosphere, for a specific time horizon, relative to carbon dioxide. **Ozone depletion potential** (**ODP**) of a chemical compound is the relative amount of degradation to the ozone layer it can cause, with trichlorofluoromethane (R-11 or CFC-11) being fixed at an ODP of 1.0. Chlorodifluoromethane (R-22), for example, has an ODP of 0.05.

NOTES: **IMPACT:** Pursuant to the Kigali accord (addendum to the Montreal Protocol) signed in 2016, the replacement of HFC refrigerants with a mix of alternatives can result in a range of emissions reductions equivalent to 43.5-50.5 gigatons of carbon dioxide from 2020-2050. Although the exact mix of alternatives is not projected and so the cost of adoption is not yet modeled, current and emerging refrigerants and appliances (including 'natural' refrigerants such as ammonia, carbon dioxide, and propane) can replace between 67%-82% of HFC refrigerants by 2050.

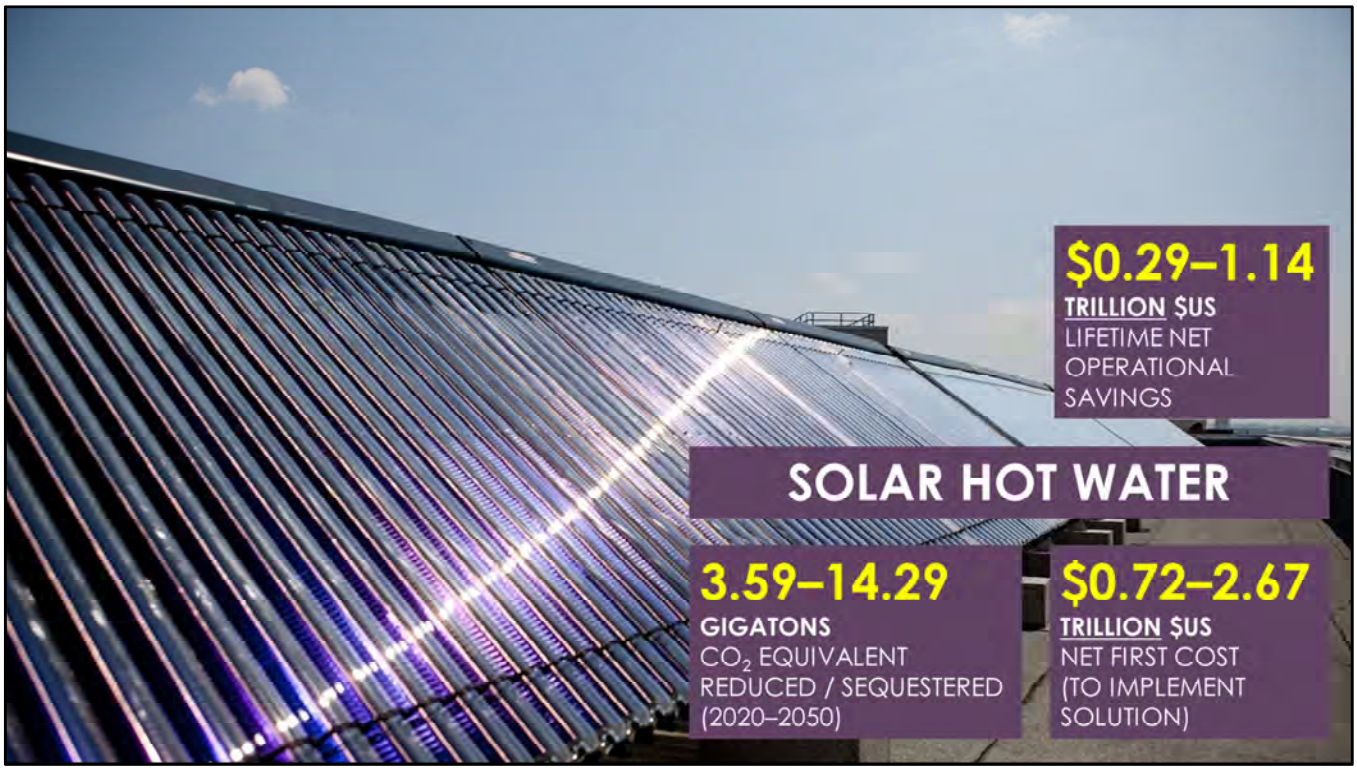
A REGRETS SOLUTION! Nuclear power is slow, expensive, risky, and creates radioactive waste, but it has the potential to avoid emissions from fossil fuel electricity. **There are many reasons for concern**: deadly meltdowns, tritium releases, abandoned uranium mines, mine-tailings pollution, radioactive waste, illicit plutonium trafficking, and thefts of missile material.

Currently, **29 countries have operative nuclear plants**; they produce about **11 percent of the world's electricity**. Nuclear is expensive, and the highly regulated industry is always over-budget and slow in its construction. While the cost of virtually every other form of energy has gone down over time, nuclear is four to eight times higher than it was four decades ago.

These figures assume the share of global electricity generation will change from the current 10.5 percent to figures of 8.6-13.2 percent depending on the total power generation scenarios considered.

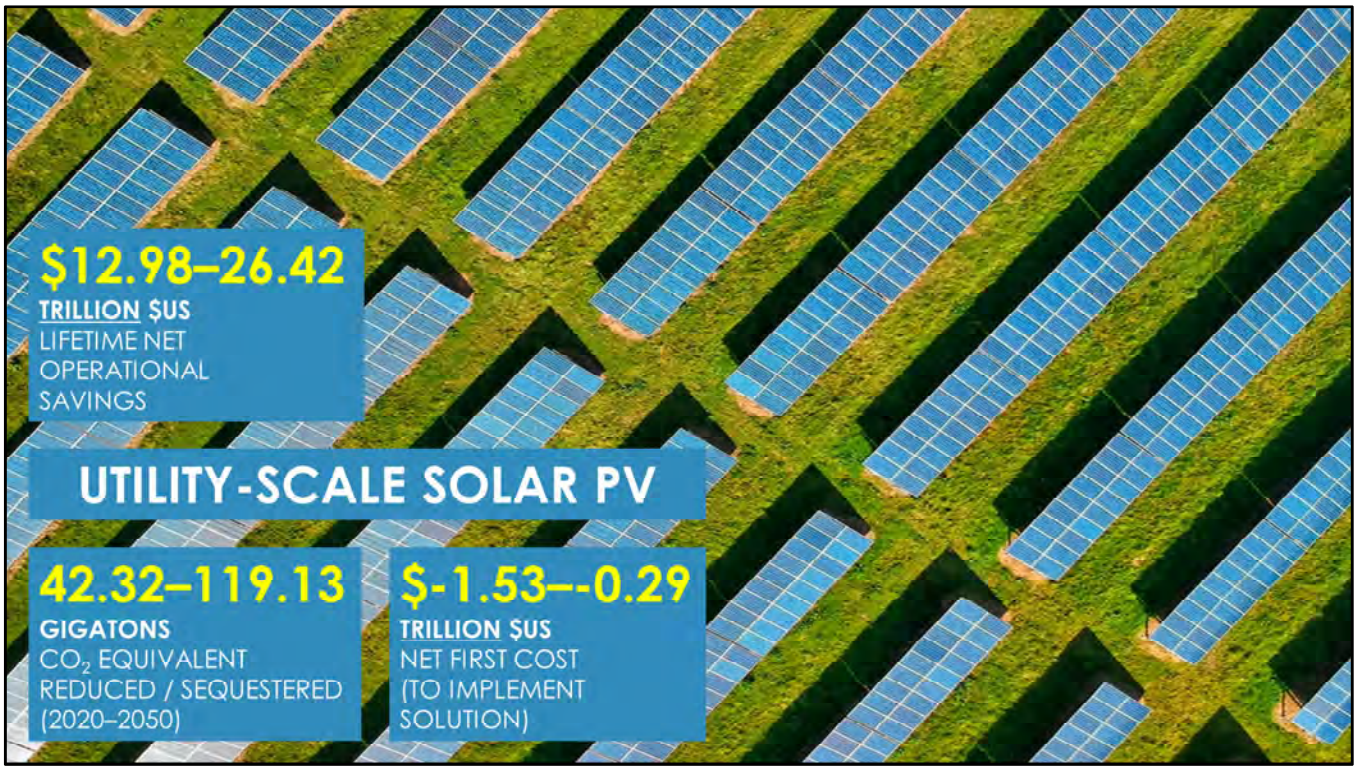
The heat energy contained below the earth's surface is about 100 billion times more than current world energy consumption. Geothermal power—literally "earth heat"—taps into underground reservoirs of steamy hot water, which can be piped to the surface to drive turbines that produce electricity. That feat was first accomplished in Larderello, Italy, on July 15, 1904.

With subterranean resources flowing 24-7, without interlude, geothermal production can take place at all hours and under almost any weather conditions. Geothermal is reliable, abundant, and efficient. While drilling is expensive, the heat source itself is free. According to the Geothermal Energy Association, 39 countries could supply 100 percent of their electricity needs from geothermal energy, yet only 6 to 7 percent of the world's potential geothermal power has been tapped.



IMPACT: If solar water heating grows from 8 percent of the addressable market in 2018 to 15-30 percent, the technology can deliver emissions reductions of 3.6-14.3 gigatons of carbon dioxide. However, if energy costs remain as low as they are today, they may save only $293-1,143 billion over the unit lifetimes for investments of $717-2,700 billion.

NOTES: In our calculations of up-front costs, we assume solar water heaters supplement and do not replace electric and gas boilers hence these investment costs already assume availability of a conventional heater for backup heating.

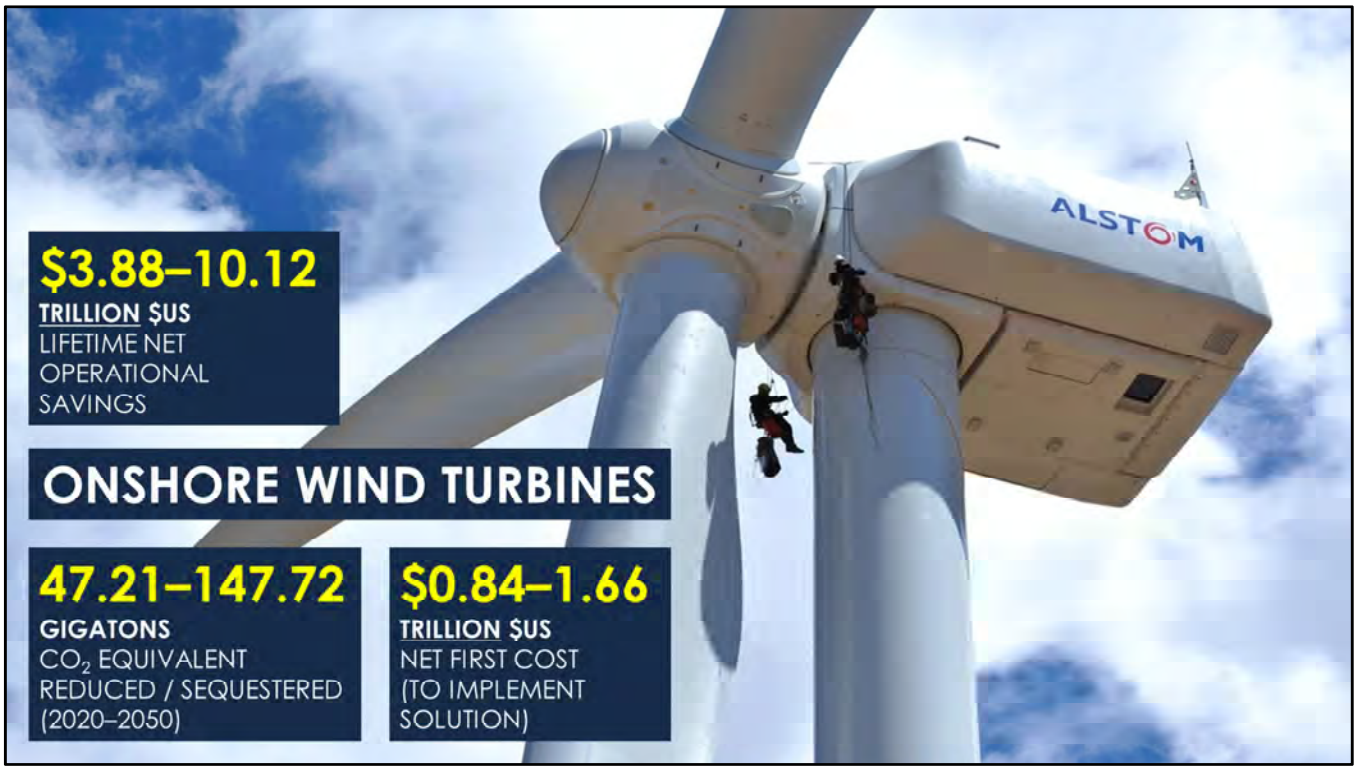


IMPACT: Currently just over 1% percent of global electricity generation is estimated to be from utility-scale solar PV. By 2050, this solution could represent 20-25% of the electricity generation mix, with generation levels of 9,353-17,740 TWh.

NOTES: We assume an implementation cost of $1,733 per kilowatt and a learning rate of 21 percent. This results in cumulative first costs of $3.4-5 trillion, but with a huge amount of lifetime operational savings of $13-26 trillion – one of the financial benefits of producing electricity without fuel. The significant increase of the solution use could avoid 44-119 gigatons of greenhouse gases emissions depending on the climate mitigation ambition and electrification of demand side sectors. The learning rate of 21.0 accounts for independent impact on PV modules and balance of systems; this has the effect of reducing the installation cost to US$490 per kilowatt in 2030 and to US$336 in 2050, compared to US$1,786 per kilowatt for the conventional technologies (i.e. coal, natural gas, and oil power plants) resulting in NEGATIVE FIRST COSTS.

IMPACT: Analysis assumes that distributed solar photovoltaics can grow from 180 TWh of current electricity generation globally to a wide range between 6,235-10,100 TWh by 2050.

NOTES:
This uncertainty of generation potential is linked to the different expectations of energy technologies on different future climate mitigation pathways intertwined with the role of electricity on the energy systems. That growth can avoid 27-69 gigatons of greenhouse gases emissions. With implementation costs reducing by the day, over the lifetime of distributed photovoltaic technologies, it could save $7.9-13.5 trillion in associated operation and maintenance and fuel costs.



IMPACT: This solution is increasingly more mature and has already reached grid parity in several regions of the world. An increase in onshore wind turbines from 4.4 percent of world electricity generation to a wide range from 19.6-26.9 percent by 2050 could reduce emissions by 47-147 gigatons of greenhouse gases.

NOTES:
Marginal implementation costs associated to the lower and high adoption projected scenarios for this solution are calculated to be $843-1,659 billion with also very high technology lifetime savings of $3.9-10.1 trillion. These are conservative cost impact estimates, however. Costs are falling annually and new technological improvements are already being installed, with increasing capacity to generate more electricity at the same or lower cost.

Today, 314,000 wind turbines supply nearly 4 percent of global electricity, and it will soon be much more. Onshore wind farms have small footprints, typically using no more than 1 percent of the land they sit on, so grazing, farming, recreation, or conservation can happen simultaneously with power generation. What's more, it takes one year or less to build a wind farm—quickly producing energy and a return on investment.

Urban Planning

Walkable cities use planning, design, and density to maximize walking and minimize driving, especially for commuting. Emissions decrease as pedestrians take the place of cars.

The six dimensions of the built environment—**demand, density, design, destination, distance, and diversity**—are all key drivers of walkability. Some of these are driven by zoning rules—others by "walk appeal" (what is available and how it looks and feels). Some of you might be familiar with WalkScore.com (an online or smartphone calculator of the walkability of your neighborhood).

NOTES: Our analysis focuses on population density as a proxy for walkable neighborhoods. As cities become denser and city planners, commercial enterprises, and residents invest in the "6Ds," 3.5-5.8 percent of urban mobility can be provided by foot instead of car by 2050. That shift could result in 1.4 -5.5 gigatons of avoided carbon dioxide emissions and reduce costs associated with car ownership by $1.7-6.4 trillion.

Bicycles are on the rise as cities attempt to untangle traffic and unclog skies, urban dwellers seek affordable transportation, and diseases of inactivity and billowing greenhouse gases become impossible to ignore.

IMPACT: In 2018, just under 3 percent of urban trips around the world were completed by bicycle. In some cities, bicycle mode share is over 30 percent. We assume a rise to almost 4-8 percent of urban trips globally by 2050, displacing 3.4–6.1 trillion passenger-km traveled by conventional modes of transportation and avoiding 2.6–6.6 gigatons of carbon dioxide emissions.

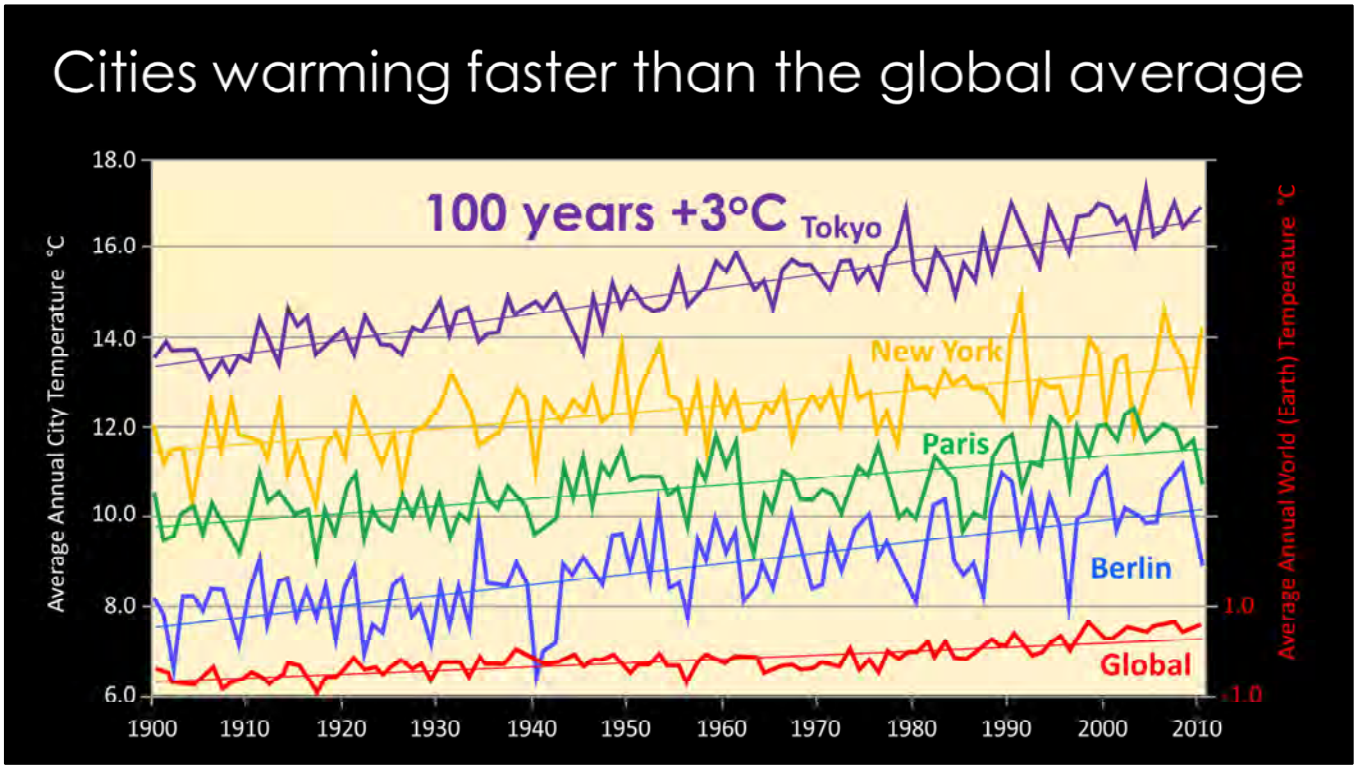
NOTES:
By building bike infrastructure rather than roads, municipal governments and taxpayers can realize $2.7-$7.5 trillion in construction savings and $827-$2,400 billion in lifetime operating savings. Infrastructure is essential for supporting safe, pleasant, and abundant bicycle use, and includes:

- Networks of well-lit, tree-lined bike lanes or paths—the more direct, level, and interconnected the better.
- Well-designed intersections, roundabouts, and points of access, where bicycles and cars meet.
- Access to public transport, secure bike parking, city bike-share programs, and

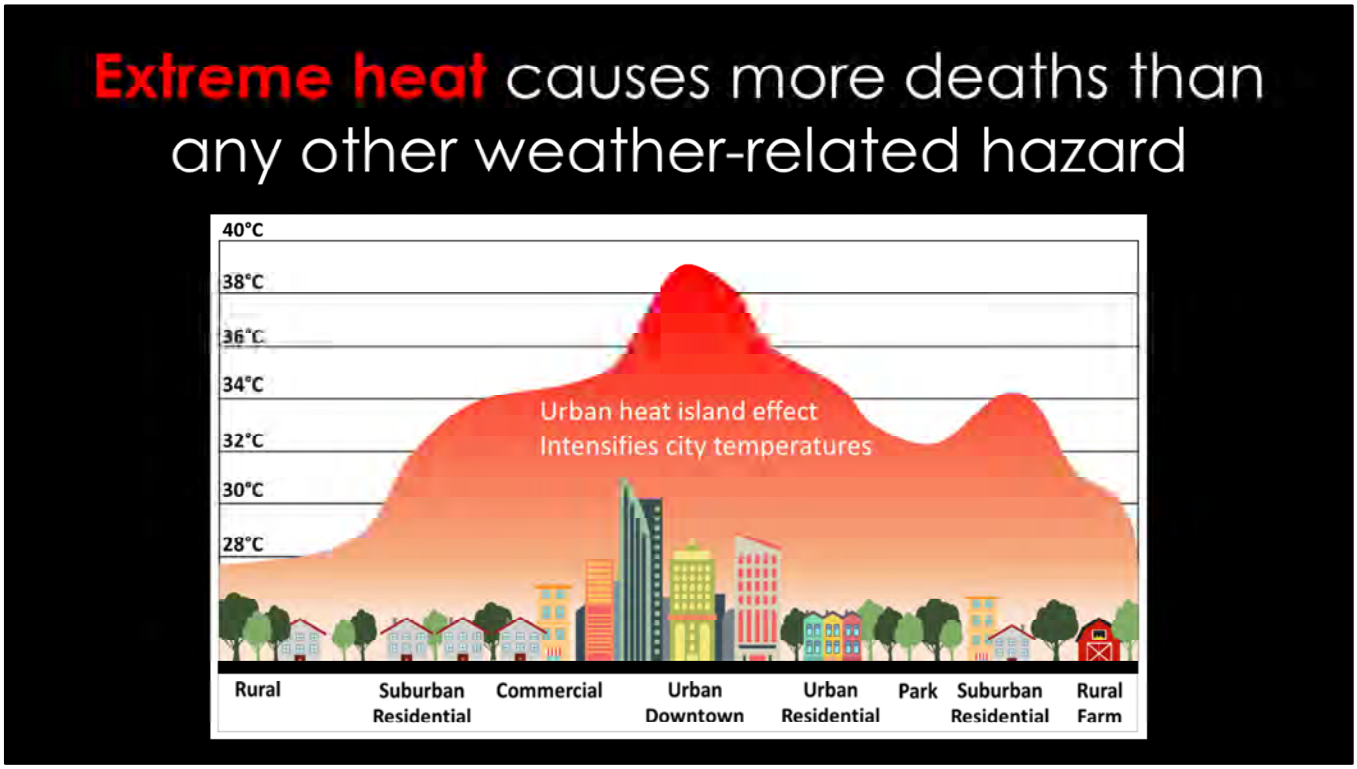
workplace showers.

IMPACT: Use of public transit is projected to decline significantly from 30 percent of urban travel as the low-income world gains wealth. If use is instead managed to decline more slowly by 2050 or even rise slightly to 35 percent, this solution can save 7.5-23 gigatons of carbon dioxide emissions from cars. Consumers would save $2.1-6.6 trillion in mobility costs.

NOTES: Our analysis includes diverse public transit options (bus, metro, tram, and commuter rail) and examines the costs that travelers pay (car purchase and use compared to buying transit tickets). The financial analysis is conducted from the perspective of the user, rather than public transit operators, municipalities, or society as a whole. This is valuable so that those making decisions about whether to travel by public transit or by conventional vehicles have a better idea of the financial and emissions aspects of that decision. *Public transit* first costs have been excluded from this model to prevent misinterpretation of the cost of implementation, but car first costs have been included as a fixed operating cost of depreciation.



Additionally, our cities are warming much faster than the global average. This is mainly due to **URBAN HEAT ISLAND EFFECT caused by rapid urbanization and development**. You can see here that Tokyo has warmed nearly 4X the global average, in the same 100 year period.



Over ¾ of the world's population lives in urban areas. And as these urban areas get hotter, we increase our use of cooling—thereby increasing our carbon emissions. A perpetual "vicious circle" [悪循環-Akujunkan]. This is precisely why urban design and building design solutions, like green roofs, light colored porous pavements, shade trees, high performance glass and so on—are critical to helping us adapt and transcend global climate change.

Many warming cities struggle to build permanent infrastructure to combat urban heat island effect--such as shade trees and planted areas, water features, light colored and porous pavements as these can be expensive and take time to implement in existing developed areas, that are not planning any redevelopment.

This is NIKKEN's idea for a "bridging solution" to urban heat island effect—mobile urban COOL TREEs!

Land Use

In their biomass and soil, forests are powerful carbon storehouses. Protection of forests prevents emissions from deforestation, it shields that carbon, and enables ongoing carbon sequestration. The most critical of all forest types is primary forest, known as old-growth or virgin forest. Examples include the Great Bear Rainforest of British Columbia and those of the Amazon and the Congo. With mature canopy trees and complex understories, these forests contain 300 billion tons of carbon and are the greatest repositories of biodiversity on the planet.

In 2019 alone, we lost 1 football pitch (2.26 hectares) of primary rainforest every 6 seconds! That's 1,358 hectares every hour. Carbon emissions from deforestation and associated land use change are estimated to be 10 to 15 percent of the world's total.

NOTES:
Strategies to stop deforestation and protect forests include:
- public policy and the enforcement of existing anti-logging laws;
- market-driven mechanisms, primarily eco-certification programs that inform consumers and affect purchasing decisions; and
- programs that enable wealthy nations and corporations to make payments to countries and communities for maintaining their forests.

Wetland soils can hold 5 times more carbon than the equivalent area of temperate or tropical rain forests. Around the world, they are also natural habitats for numerous species of birds, fish, plants, insects—a living laboratory of ecosystem biodiversity. Wetlands are also the first line of defense against storm surges and floodwaters, and are a natural filtration system that boost water quality and recharge aquifers.

IMPACT: *Of the 53.2 million hectares of coastal wetlands globally, 12.6 million hectares are protected today. If an additional 17.4-22.1 million hectares are protected by 2050, the resulting avoided emissions and continued sequestration as shown here.*

While doing a few things in your own personal life will not save the planet by itself—it is important to not only do something positive for the planet, but also for your own well-being and your children, grandchildren or just the next generation and the one after that. Here's a few easy ones with potentially big impacts [CLICK]

Shifting to a diet rich in plants is a demand-side solution and is probably the most impact a single person can have on climate change. Meat-rich diets represent one-fifth of global emissions. If cattle were their own nation, they would be the world's third-largest emitter of greenhouse gases.

Plant-rich diets reduce emissions and also tend to be healthier, leading to lower rates of chronic disease. According to a 2016 study, business-as-usual emissions could be reduced by as much as 70 percent through adopting a vegan diet and 63 percent for a vegetarian diet, which includes cheese, milk, and eggs. $1 trillion in annual health-care costs and lost productivity would be saved.

NOTES: **IMPACT:** *Using country-level data from the Food and Agriculture Organization of the United Nations, we estimate the growth in global food consumption by 2050, assuming that lower-income countries will consume more food overall and higher quantities of meat as economies grow. If 50-75 percent of the world's population restricts their diet to a healthy average 2,250 calories per day and reduces meat consumption overall, we estimate at least 43-68 gigatons of emissions could be avoided from dietary change alone. If avoided deforestation from land use change is included, an additional 21.8-23.5 gigatons of emissions could be avoided, making healthy, plant-rich diets one of the most impactful solutions at a total of 64.8-91.5 gigatons avoided.*

I wonder if anyone understands my music reference....(Grow Some Funk of Your Own, Elton John)

Even if you don't give up meat, I recommend that everyone grow a few things at their home. I planted these things this year on my 5th floor apartment balcony. I think growing a few things simply connects us to our food supply chain more and makes us more aware of our climate—it's healthier and saves money too!

A third of the food raised or prepared does not make it from farm or factory to fork. Producing uneaten food squanders a whole host of resources—seeds, water, energy, land, fertilizer, hours of labor, financial capital—and generates greenhouse gases at every stage—including methane when organic matter lands in the global rubbish bin. The food we waste is responsible for roughly 8 percent of global emissions.

IMPACT: *After taking into account the annual adoption of plant-rich diets, if 50-75 percent of food waste is reduced by 2050, avoided emissions could be equal to 10.3-18.8 gigatons of carbon dioxide. Reducing waste also avoids the deforestation for additional farmland, preventing 74.9-76.3 gigatons of additional emissions. We used forecasts of regional waste estimated from farm to household. This data shows that up to 35 percent of food in high-income economies is thrown out by consumers; in low-income economies, however, relatively little is wasted at the household level.*

With the recent global pandemic I think we have all experienced tele-working! Nothing beats face-to-face contact, but telepresence aims to come exceptionally close. By integrating a set of high-performance visual, audio, and network technologies and services, people who are geographically separated can interact in a way that captures many of the best aspects of an in-person experience.

Telepresence affords many other benefits: cost savings from avoided travel, less grueling schedules for employees, more productive remote meetings, the ability to make decisions more quickly, and enhanced interpersonal connection across geographies.

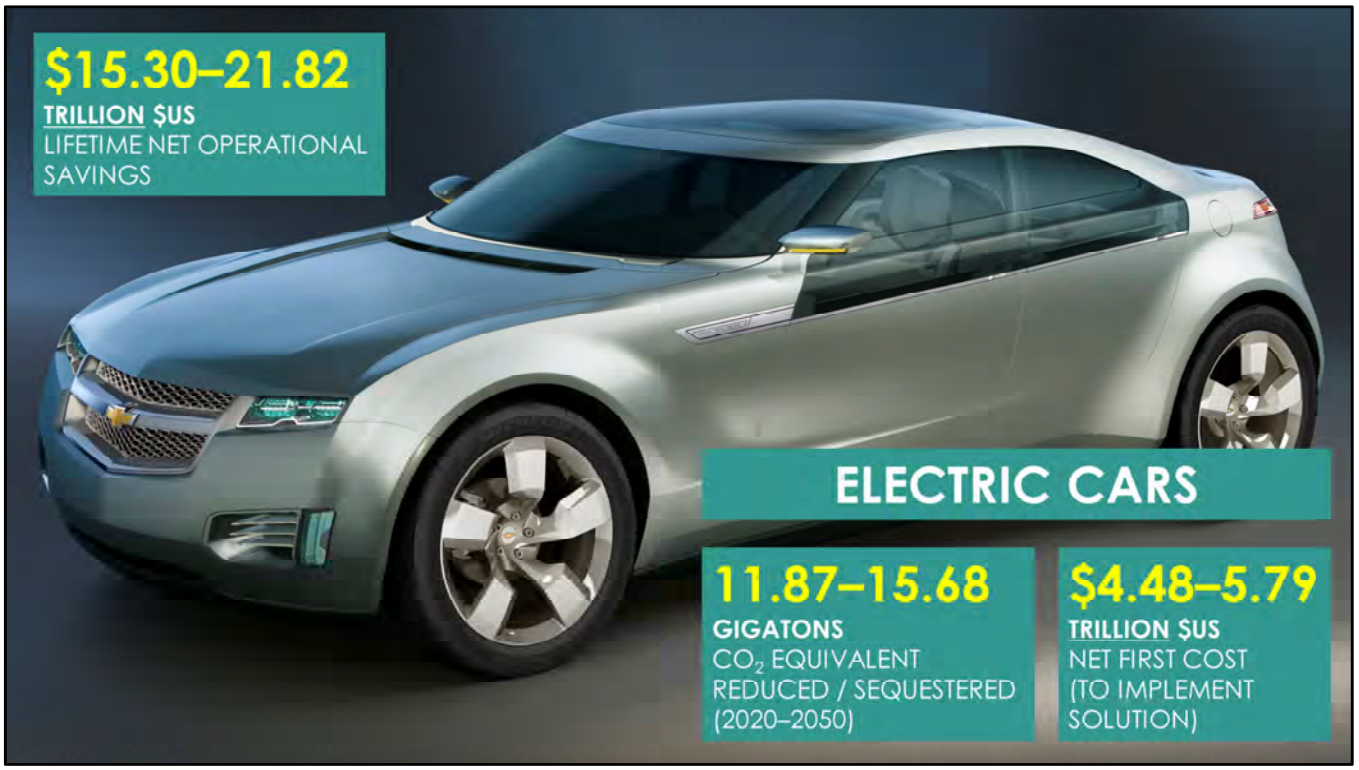
IMPACT: *By avoiding emissions from business air travel, telepresence can reduce emissions by 1-3.8 gigaton of carbon dioxide over thirty years. That result assumes that over 486-676 million business-related trips are replaced by telepresence in 2050. For organizations, the investment of $87-301 billion in telepresence systems pays off with $1.2 -4.4 trillion worth of business travel savings and 107-143 billion fewer unproductive travel hours.*

Globally, we produce roughly 310 million tons of plastic each year. Almost all of it is made from fossil fuels. Experts estimate that 90 percent of current plastics could be derived from plants instead. Bio-based plastics come from the earth, and those that are biodegradable can return to it—often with lower carbon emissions.

IMPACT: *We estimate the total production of plastics to grow from 311 million tons in 2014 to at least 792 million tons by 2050. This is conservative, with other sources estimating over 1 billion tons if trends continue. We model the growth of bioplastics to capture 12-46 percent of the market by 2050, avoiding 0.96-3.8 gigatons of emissions. The cost to produce bioplastics in this scenario is $25-88 billion over thirty years.*

Recently, both Carlsburg beer and Coca Cola announced biodegradable bottles for their products (coming soon). Carlsburg is using a paper-based bottle and Coca Cola will use a bio-plastic from plants. I haven't seen these bio-plastic tableware items in Japan, but they might exist....and the problem with all of these is that they often do not get recycled properly—and some do not bio-degrade as easily as others.

The best thing we can do in regard to plastics is avoid using them whenever possible. These are some of the many re-usable bags I have from conferences and one from Kaldi coffee. I am glad that shops in Tokyo are now required to charge us for receiving plastic bags now.



I have had some of my colleagues tell me that their hobby is driving; my next question is always do you have an electric car or a hybrid? When the answer is no, I ask why not?

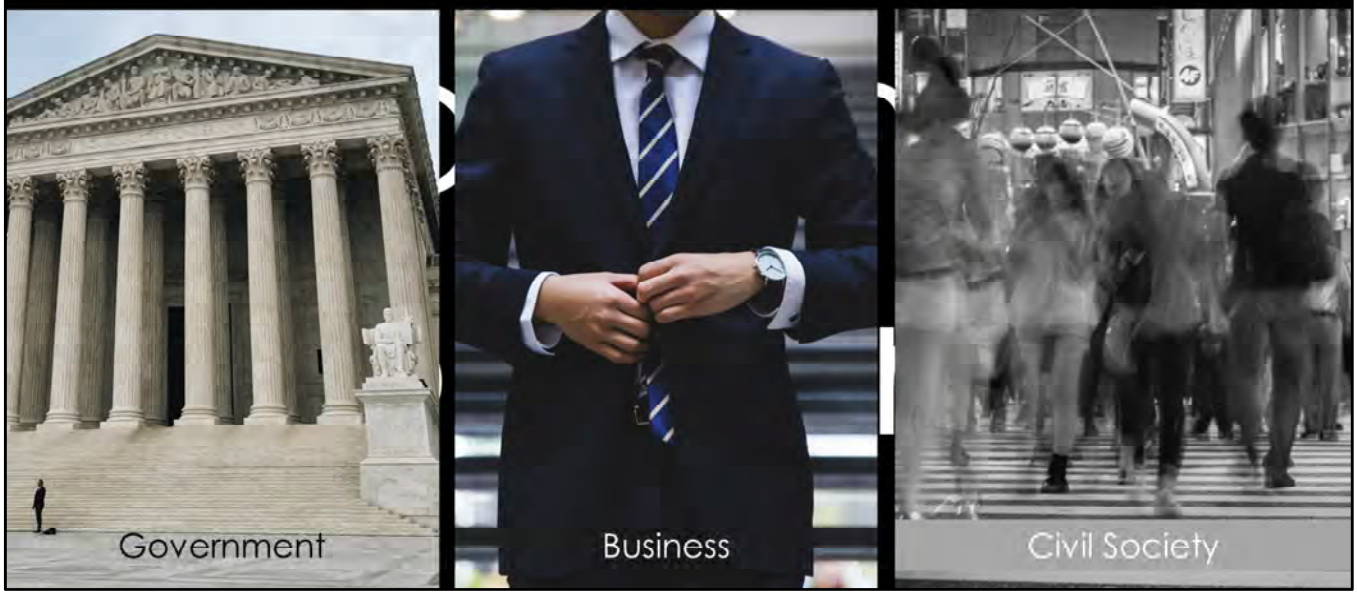
There are now more than 3 million EVs on the road (globally), and the difference in impact is remarkable. Compared to gasoline-powered vehicles, emissions drop by 50 percent if an EV's power comes off the conventional grid. If powered by solar energy, carbon dioxide emissions fall by 95 percent. The "fuel" for electric cars is cheaper too. EVs will disrupt auto and oil business models because they are simpler to make, have fewer moving parts, and require little maintenance and no fossil fuels.

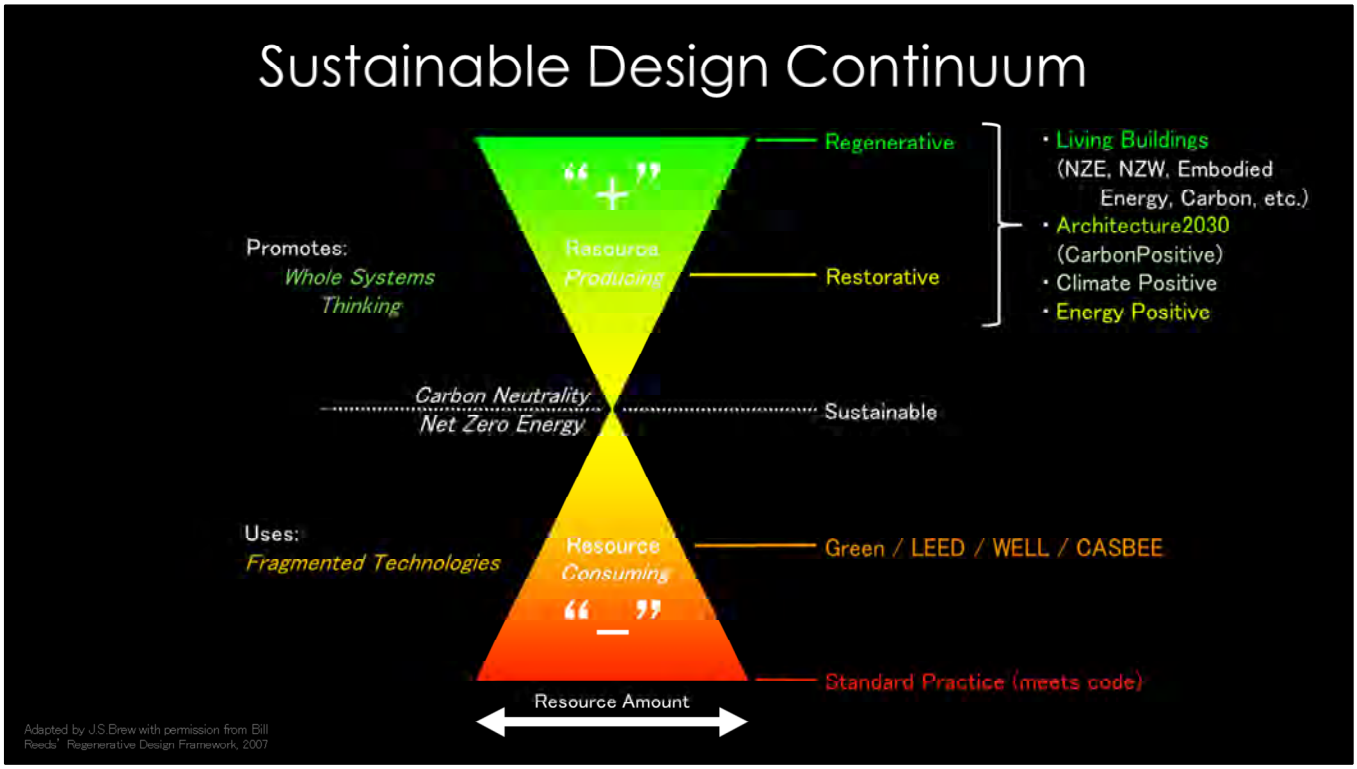
IMPACT: *If electric car ownership rises to 16-23 percent of total passenger km at a first cost of $4.5-5.8 trillion, by 2050, 11.9-15.7 gigatons of carbon dioxide from fuel combustion could be avoided as well as $15.3-21.8 trillion in fuel costs. Our analysis accounts for emissions from electricity generation and higher emissions of producing electric cars compared to internal-combustion cars. Electric cars are several thousand dollars more expensive, but we include slightly declining electric cars prices, expected due to declining battery costs.*

Notes: Chevrolet Volt Concept is a highly advanced, plug-in electric hybrid. However, the 1.0-liter, three-cylinder turbocharged motor never powers the wheels directly. Instead, the Volt uses the combustion engine, which runs at a constant speed to maximize

efficiency, generate electricity to power the electric motor, and charge the lithium-ion battery. The end result is the capacity to travel 60 miles on just 0.4 gallons (3.8 L) of gas, averaging an astonishing 150 miles (241 Km) per gallon (3.8 L).

But what can I do in my work?

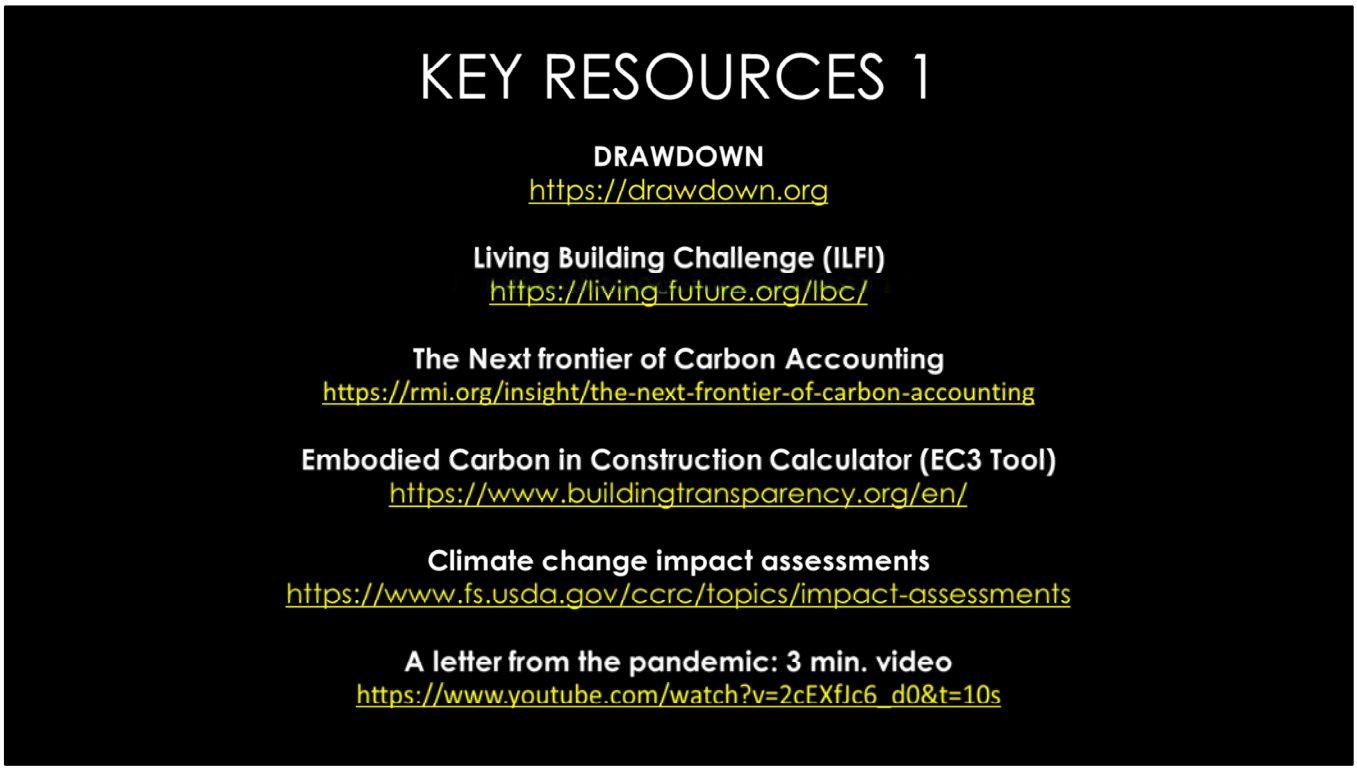




If we think of a vertical scale (Y-axis) where a code compliant, standard, business-as-usual building is the minimum or starting point and a building that gives back more than it uses as “regenerative”, then a scale might look something like this.

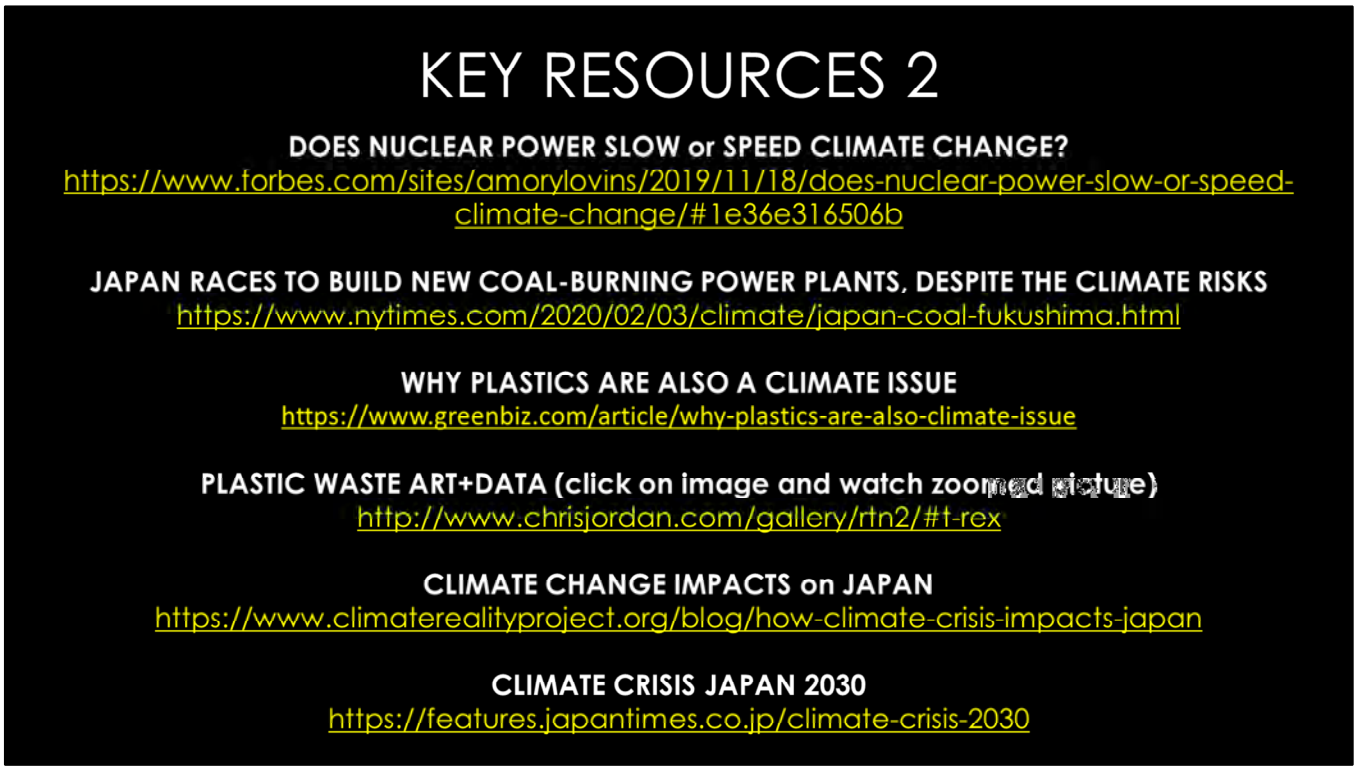
The resources a building uses or produces can be represented on the X-axis by decreasing or increasing triangles and net zero or ZEB would fall at the apex of where the two triangles meet...

It is really up to us—you and me to help drive the change we need to have in the built environment.

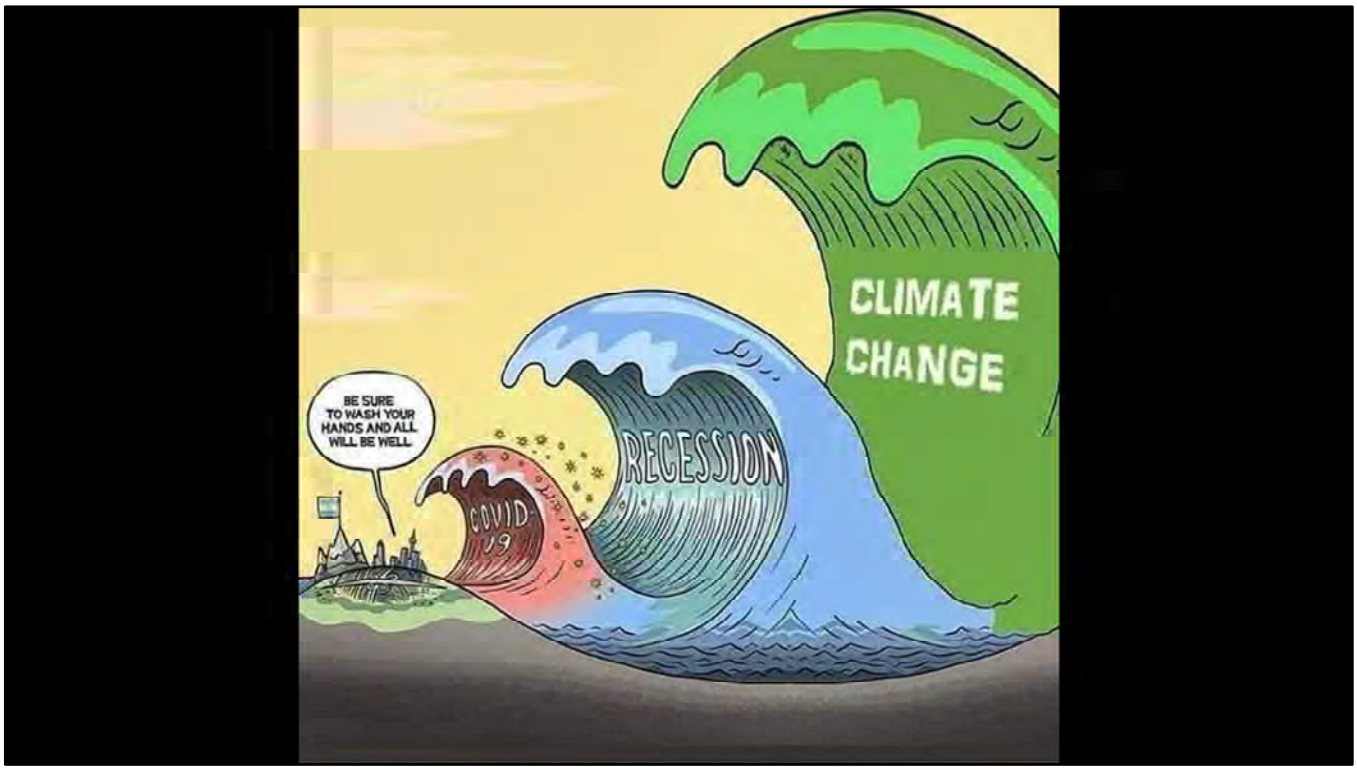


DRAWDOWN is the primary resource for this presentation, though I used about 25 other sites for information and background understanding.

We didn't really talk about **climate change impact assessments, but these seem like something we may all have to do in the future....these assessments:** *characterize*, *diagnose*, and *project* risks or impacts of environmental change on people, communities, business activities, infrastructure, ecosystems, and valued natural resources/services.



I also included some interesting relevant articles and a very cool art website by Chris Jordan. He uses waste (like plastic bags, lighters, water bottles) to make beautiful artwork and when you click on an image it slowly zooms in and reveals the material. He also includes statistics about the waste.



I really like this cartoon. It is interesting if you think about it. Everything we do to work on Climate Change, improves our city, country and the world economy and reduces the chances of more viruses. I hope you will remember this image.

Q&A
+ Comments

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