How to Avoid a Climate Disaster – Summary   Author Bill Gates

I bought this book as I was wanting to learn more about climate change. I read through the book once and was astonished about the amount of detailed information included – it is certainly mind-opening. I decided to read the book again and to make a note of all the key information – see below. In turns of size the words are less than a third of the words in Bill Gates' book. He included explanations, examples, his own view and his persuasive argument for his final plan. The whole reference for the information below is Bill Gates' book. He includes acknowledgements to many people who are involved in understanding climate change and references many sources including websites, books and papers. **I would highly recommend buying 'How to avoid a Climate Disaster' by Bill Gates for you to be convinced that the world needs to take action before it is too late.**

Bill Gates is a technologist, business leader, and philanthropist. In 1975, he co-founded Microsoft. Today he and his wife, Melinda, are cochairs of the Bill & Melinda Gates Foundation – focussed on global health, development, and US education. He also launched Breakthrough Energy, an effort to commercialize clean energy and other climate related technologies.

Contents

Introduction

Key numbers

- **51 Billion – how many tons of greenhouse gases the world adds to the atmosphere every year – generally still increasing**
- **Zero is what we aim for**

Key points

- Every country will need to change its ways
- Virtually every activity releases greenhouse gases – **growing things; making things; getting around**.
- Bill Gates learned about the world in early 2000's – child mortality, HIV, almost a billion people not having electricity
- Realised how income and 'energy use' go hand-in-hand
- In 2006 became interested in climate change and educated himself
    - Read reports issued by the Intergovernmental Panel on climate change (IPCC)
    - Watched 'Earth's Changing Climate', a series of lectures by Professor Richard Wolfson – Great Courses series
    - Read Weather for Dummies
- Realised that making electricity accounts for only 27% of all greenhouse emissions

Bill Gates became convinced:

1. To avoid a climate disaster, we have to get to zero
2. We need to deploy the tools that we have, like solar and wind, faster and smarter
3. We need to create and roll out breakthrough technologies that can take us the rest of the way

He began to speak out much more about climate change in 2015, and in 2019 he divested all his holdings in oil and gas companies.

- Just before COP21 in 2015 Bill Gates set up 'Breakthrough Energy' funded by venture funding, and it is now invested in 40 companies with promising ideas.
- He also helped push the idea of government funding and at COP21 'Mission Innovation' was created, which includes 24 countries and has unlocked $4.6 billion a year in new money for clean energy research.

- He admits that his own carbon footprint is too high and is always looking at ways to reduce it. He is investing in zero-carbon technologies and has put $1 billion into approaches that he hopes will get the world to Zero CO2.

Bill Gates has a belief that we can get down to Zero CO2 emissions and can see an opportunity to solve it. He sees that we already have two of the three things that you need to accomplish any major undertaking:

1. Ambition, thanks to a growing global movement
2. Big goals for solving the problem as more and more national and local leaders around the world commit to doing their part

The 3rd component is a concrete plan to achieve our goals. The book sets out to provide a plan.

Chapter 1 Zero

Key points

- We should aim for Zero CO_2 emissions
- A small increase in the global temperature can make an enormous difference, 1 or 2 DegC.
- Carbon dioxide is the most common greenhouse gas but there are others including nitrous oxide and methane. Methane can cause 120 times more warming the moment it reaches the atmosphere but does not stay around as long as CO_2.
- Greenhouse gases are combined into a single measure "carbon dioxide equivalents". However, this does not account for the important short-term effect as with methane.
- The 51 billion includes 37 billion of CO_2.
- Greenhouse gases absorb heat and trap it in the atmosphere and thus cause warming.
- There is a lot that scientists do know and can state with confidence what will happen if we don't get to Zero.
- The overall trend points towards trouble from a hotter climate.
- Hotter climate means that
    - There will be more frequent and destructive wildfires
    - Sea levels will go up, partly because polar ice is melting and partly because seawater expands as it gets warmer
    - More cyclones, storm surges, and river floods
    - Plants and animals are being affected with a reduction in the geographic range
    - The food we eat is being affected. Climate change could affect the amount of food we get for each acre of crops.
    - Extreme droughts could trigger a regional or even global food crisis.
    - Extra heat won't be good for the animals we eat and get food from – it will make them less productive
    - Seafood will be affected as the seas get warmer resulting in fish and other sea life moving to different waters or dying off.
    - Coral reefs could vanish completely
    - Heatstroke will be a major problem as it is linked to humidity. If the air becomes too humid then the air could not absorb your sweat.
- Simulations have shown that a 2 DegC rise would be 100% worse than a 1.5% rise.
- The effect of climate change scenarios

    - A young farmer in Nebraska in 2050 detailed; Subsistence farmers in India in 2050 detailed
    - Big increase in asylum applications to the European Union
    - By 2080 between 2 to 10% pf Mexicans try to cross the border into the United States
- Death rate for Covid-19 has been about 14 deaths per 100,000 people each year. By 2050 climate change is expected to produce a similar death rate. By the end of the century if emissions stay high then it is expected that climate change will result in 75 per 100,000 people.
- Economic picture is bleak. Modelling shows that climate change is likely to be as bad as having a COVID-sized pandemic every 10 years.
- Possibility of relatively sudden catastrophic climate change – e.g., large sections of the earth's permanently frozen ground gets warm enough to melt and releases the huge amounts of greenhouse gases, mostly methane, that are trapped there.
- We need 'Adaptation' and 'Mitigation'. To stave off disaster, the world's biggest emitters (the richest countries) have to get to Zero emissions by 2050. They have the government funding, research universities, national labs, and start-up companies that attract talent from around the world

Chapter 2 This will be hard

Key points

- Fossil fuels are so pervasive that it can be hard to grasp all the ways in which they – and other sources of greenhouse gases – touch our lives.
- Every-day objects that are touched by greenhouses gases
    - Toothbrush – contains plastic, made from petroleum, a fossil fuel
    - Grains in your toast and cereal were grown with fertiliser, which releases greenhouse gases when it is made
    - Harvested by a tractor made from steel – which is made with fossil fuels in a process that releases carbon – and ran on gasoline
    - Burger for lunch – raising the beef caused greenhouse gases emissions – cows fat and burp methane
    - Growing and harvesting the wheat that went into the bun – as above
    - Clothes made from cotton – also fertilised and harvested – or polyester, made from ethylene, derived from petroleum
    - Toilet paper, trees cut down and carbon emitted
    - Vehicle taken to work, powered by electricity – though the electricity was probably generated using a fossil fuel
    - Trip by train – tracks made from steel, through tunnels made using cement, which is produced with fossil fuels in a process which releases carbon as a by-product
    - Car or bus or bike – made from steel and plastic
    - Roads contain cement as well as asphalt, which is derived from petroleum
    - Apartment blocks made from cement
    - House made from wood, the lumber was cut by gas-powered machines that were made from steel and plastic
    - Home or office has heating or air-conditioning using energy, and the coolant in the air conditioner may be a potent greenhouse gas
    - Chairs may be made of metal or plastic, with more emissions
- The world is using more than 4 billion gallons of oil every day – not easy to stop
- A good reason why fossil fuels are everywhere – they are so cheap – oil costs less than diet coke
- Prices don't reflect the damage they cause – the ways they contribute to climate change, pollution, and environmental degradation
- Other challenges

    - People are living longer and healthier lives. Standard of living are going up leading to energy used per person going up, and the amount of greenhouse gases emitted per person
    - Building the infrastructure will release more greenhouse gases
    - The global population is headed towards 10 billion
    - By 2060 the world's building stock will double
    - 40 % of the world's emissions are produced by the richest 16% of the population – not including the emissions from products made somewhere else but consumed in rich countries.
    - Global energy demand will go up by 50% by 2050
    - It would be immoral and impractical to try to stop people who are lower down on the economic ladder from climbing up
    - History has shown that moving from one energy source to another has taken decades (Oil 1910 – 10% then 30 years to reach 25%; nuclear fission from 0 to 10% in 27 years)
    - Cars – fuel economy improved by less than a factor of three in more than a century.
    - Solar panels introduced in 1970 converted 15% of the sunlight into electricity – now just 25% so not a great increase
    - Energy industry is enormous at around $5 trillion a year – so big and complex that it will resist change. Coal power station costs $1 billion to build and investors put up the money with the expectation that it will run for 30 years
- Laws and regulations are outdated. They need to change to help get to Zero. America's Clean Air Act dates back to the 1970's and no mention of greenhouse gases. America's fuel economy standards date back to the 1970's and no mention of electric vehicles. Current energy policies will only have a limited impact on future emissions
- There is not as much a climate consensus as you might think. 97% of scientists agree that the climate is changing due to human activity. However, there is a small but vocal group of people who are not persuaded by the science. Some others argue that we should prioritise other things like human welfare, like health and education.
- Bill Gates is firmly of the view that we should move fast towards Zero otherwise bad things will happen well within most people's lifetime, and very bad things will happen within a generation.
- We have some of the tools that will help: - solar power; wind power; hydropower; and a few other tools. But we need much more.

- We need global co-operation. The Paris agreement of 2015 was an enormous achievement when 190 countries signed up
- However, the current commitment will not make a big impact – to reduce 3 to 6 billion tons by 2030 so less than 12% of total emissions today at 51 billion.
- Summarising
    - **We need to accomplish something gigantic we have never done before, much faster than we have ever done anything similar.**
    - **We need lots of breakthroughs in science and technology**
    - **We need to build a consensus that does not exist and build public policies to push a transition that would not happen otherwise**
    - **We need an energy system to stop doing all the things that we don't like and keep doing all the things that we do like**

Chapter 3 Five Questions to Ask in Every Climate Conversation

1. **How much of the 51 Billion Tons are we talking about?**

- Convert any investment proposition into what percentage of the 51 billion tons will be saved?
- At Breakthrough Energy they only fund technologies that could **remove 500 million tons a year** if they are successful and fully implemented. That is roughly 1%.

2. **What's your plan for cement?**

- Passenger cars represent less than half of all emissions from transportation, which in turn is 16% of all emissions. Steel and cement accounts for around 10%
- So, getting to zero means zeroing out all categories.
  - Getting around (planes, trucks, cargo ships) 16%
  - Growing things (plants, animals) 19%
  - Plugging in (electricity) 27%
  - Making things (cement, steel, plastic) 31%
  - Keeping warm and cool (heating, cooling, refrigeration 7%
- Though making electricity is only 27% of the problem, it could represent much more than 27% of the solution. With clean electricity, we could shift away from burning hydrocarbons for fuel. Think electric transportation and electric and cooling systems in our homes and businesses. Also, energy-intensive factories using electricity instead of gas.

3. **How much Power are we talking about?**

- Power usage
  - The world 5,000 gigawatts (a billion watts)
  - The United States 1,000 gigawatts
  - Mid-size city 1 gigawatt
  - Small town 2 megawatt (a million watts)
  - Average American house 1 kilowatt
- Whenever you hear "kilowatt", think house; "Gigawatt", think city; a hundred or more "gigawatts", think big country

- You can't just build a 1 gigawatt power station and guarantee that a city will have all the power it needs as some power sources are intermittent.

4. How much Space do you need?

- Power density is the relevant number
  - Energy source — Watts per square metre
  - Fossil fuels — 500-10,000
  - Nuclear — 500-1,000
  - Solar — 5-20
  - Hydropower (dams) — 5-50
  - Wind — 1-2
  - Wood and other biomass — Less than 1
- Notice than the power density of Solar is much higher than Wind
- *Tip: If someone tells you that some source (wind, solar, nuclear, whatever) can supply all the energy the world needs, find out how much space will be required to produce that much energy.*

5. How much is this going to cost?

- The reason that the world emits so much greenhouse gas is that the current energy technologies are the cheapest – ignoring the long-term damage.
- Moving our immense energy economy from "dirty" carbon-emitting technologies to ones with zero emissions is going to cost something.
- The additional costs can be called Green Premiums – there are many different ones depending on what you are replacing and what you are placing it with.
- One example: Gallon of Jet fuel in United States is $2.22. Advanced biofuels for jets is $5.35 per gallon so the Green Premium is $3.13.
- Once we have established all the green premiums that we can start to discuss trade-offs.
- Important to know if the green premium is close to zero, and for the ones that aren't close, thinking about how innovation might bring the prices down.
- If green premiums are low but the solutions are not being deployed, then what else is stopping it – outdated public policies or lack of awareness.

- The Green Premium can act as a measurement system that shows us the progress that we are making towards stopping climate change. Green Premiums measure the cost of getting to zero, sector-by-sector, and highlighting where we need to innovate.

Chapter 4 How We Plug In – 27% of 51 billion tons per year

Key points

- Figuring out how to get all the benefits of cheap, reliable electricity without emitting greenhouses gases is the single most important thing we must do. If we get zero-carbon electricity, we can use it to decarbonise lots of other activities.
- 860 million people don't have reliable access to cheap electricity – sub-Saharan Africa 600 million, India (74 million), rest of the world (186 million).
- Initial electricity was provided by hydropower then in and after World War !!, the demand was met with fossil fuels – 700 gigawatts.
- World's electricity with fossil fuels accounting in 2020 for two-thirds of electricity generated: Coal 36%; Natural gas 23%; Oil 3%; Hydropower 16%; Nuclear 10%; Renewables 11%; Other 1%.
- Many governments take various steps to keep fossil fuels cheap. The International Energy Agency (IEA) estimates that government subsidies for the consumption of fossil fuels amounted to $400 billion.
- Mid-2019, some 236 gigawatts' worth of coal plants were being built around the world; coal and natural gas are now the fuels of choice in developing countries. Demand has skyrocketed.
- Green premium for getting down to Zero in the United States is roughly 15%. Europe is similar at 20%.
- China has lifted millions out of poverty partly by building coal-fired electric plants. Now making a play to attract the next wave of developing countries: India, Indonesia, Vietnam, Pakistan, and nations throughout Africa.
- It is not obvious often why fossil fuels are cheaper when solar farms, wind farms and dams get their fuel for free. Fossil fuels don't factor in the true cost of climate change. And we've spent many decades to extract fossil fuels and to get energy from them.
- Transmission and distribution are responsible for a third of the final cost. Cheap oil and expensive transmission aren't the biggest drivers of the electricity green premium. The main culprits are our demand for reliability, and the curse of intermittency.
- Night-time battery storage is possible but there is a green premium – which might reduce if batteries can be improved.
- Seasonal variation between summer and winter is an even bigger hurdle. Germany has invested enormous sums expanding its use of renewables.

But Germany produced about 10 times more solar in June 2018 than it in December 2018.

- Example of possibly Tokyo having total wind-power generation but then a massive storm rip's the turbines apart. The purchase price of backup batteries would be $400 billion – much too much.
- If we electrify carbon-intensive processes like making steel and running cars and allowing for population growth we will need more than three times the electricity that we generate now.
- Completely decarbonising America's power grid by 2050 will require adding an extra 75 gigawatts of capacity every year for the next 30 years. Over the last decade the average has been 22 gigawatts.
- Renewables should be used whenever possible and are reducing in price (solar 10 times cheaper between 2010 and 2020).
- Transmission is also a key element. Bill Gates is funding a project that involves building a computer model of all the power grids covering the United States. Models like this will be required for around the world.
- In the United States we will save money by building renewables in the best locations, building a unified grid, and shipping zero-emission electrons wherever they are needed.
- Another complication: As our houses rely less on fossil fuels and more on electricity, we'll need to upgrade the electrical service to each household by at least a factor of two (is this true in the UK?)
- The United States has to build renewables much faster – on the order of 5 to 10 times faster – than we're doing now.
- Most countries aren't as lucky as the United States when it comes to renewables. The world is going to need some new clean electricity inventions.

Making Carbon-free Electricity

- Nuclear fission (the process of getting energy by splitting atoms apart)
    1. It's the only carbon-free energy source that can reliably deliver power day and night, through every season, almost anywhere in the world, that has been proven to work on a large scale
    2. United States 20% of energy from nuclear; France 70%
    3. Nuclear plants are number one when it comes to efficiently using materials like cement, steel and glass – chart showing much less than renewables

4. Nuclear power problems: expensive to build; human error can cause accidents; uranium, the fuel it uses, can be converted for use in weapons; waste is dangerous and hard to store.
5. Nuclear kills far fewer people than any fossil fuel.
6. TerraPower, a company set up by Bill Gates in 2008, has created a model that solves all the key problems

- Nuclear Fusion (the process of getting energy by fusing atoms together)
  1. Experimental facility in Southern France called ITER. Construction started in 2010 and is still ongoing. ITER is expected to generate 10 times excess power in the late 2030's.
  2. Bill Gates quotes an old joke: "Fusion is 40 years away and always will be". (I was asked to do research on Fusion almost 50 years ago and was warned off by my father, an engineer, who said that the breakthrough had been going to come for 30 years).
- Offshore wind
  1. Intermittency less of a problem as offshore winds blow more steadily
  2. Only represents a tiny share of the world's total capacity at 0.4% in 2019
  3. Improvements: Turbines being made bigger; Solving some of the problems of placing large metal objects out in the ocean.
  4. The U.K. is the world's biggest user. China is making big investments and will likely be the world's biggest consumer
  5. Holds lots of promise – it's getting cheaper and can play a key role in helping some countries decarbonise.
- Geothermal
  1. Deep underground – as close as a few hundred feet, as far down as a mile - are hot rocks that can be used to generate carbon-free electricity. We can pump water at high pressure down into the rocks, where it absorbs the heat and then comes out another hole, where it turns a turbine or generates electricity some other way.
  2. Estimated that geothermal could meet less than 2 percent of the U.K.'s energy needs, and delivering even that much would require exploiting every square meter of the country and doing the drilling for free.
- Storing Electricity
  1. Despite the limitations of lithium-ion batteries—the ones that power your laptop and mobile phone—it's hard to improve on them. Inventors have studied all the metals we could use in batteries, and it seems unlikely that there are materials that will make for vastly

better batteries than the ones we're already building. I (Bill Gates) think we can improve them by a factor of 3, but not by a factor of 50.
2. However, there is work on affordable batteries that could store enough energy for a city and hold it long enough to get through seasonal intermittency.

- Pumped Hydro
  1. A way of storing city-sized amounts of energy. When electricity is cheap you pump water up a hill into a reservoir; then, when demand for power goes up, you let the water flow back down the hill, using it to spin a turbine and generate more electricity.
  2. Severe limitations right now but several companies are looking at alternatives
- Thermal Storage
  1. The notion here is that when electricity is cheap, you use it to heat up some material. Then, when you need more electricity, you use the heat to generate power via a heat engine.
  2. Research ongoing
- Cheap Hydrogen
  1. We could use electricity from a solar or wind farm to create hydrogen, store the hydrogen as compressed gas or in another form, and then put it in a fuel cell to generate electricity on demand.
  2. Advantages: Use electricity to create carbon-free fuel that could be stored for years and turned back into electricity at a moment's notice; It would solve the location problem as it could be easily shipped.
  3. Problems: it is not as efficient as storing energy in a battery; it is expensive to produce hydrogen without emitting carbon; Hydrogen is a very lightweight gas which makes it hard to store

Other Innovations

- Capturing Carbon
  1. We could keep making electricity as we do now, with natural gas and coal, but suck up the carbon dioxide before it hits the atmosphere
  2. These "point capture" systems have existed for decades, but they are expensive to buy and run
  3. They generally capture 90% of the greenhouse gases but power companies don't gain anything from them so not generally installed – needs a change in public policies

4. Direct Air Capture: It involves exactly what the name implies: capturing carbon directly from the air. DAC is more flexible than point capture, because you can do it anywhere. And in all likelihood, it'll be a crucial part of getting to zero; one study by the National Academy of Sciences found that we'll need to be removing about 10 billion tons of carbon dioxide a year by mid-century and about 20 billion by the end of the century.
5. Companies are working on new materials that are better at absorbing carbon dioxide

- Using less
    1. Realised how much land it will take to generate lots more electricity from solar and wind
    2. Load shifting or demand shifting – using power more consistently throughout the day
    3. Plug in your electric vehicle when you get home and wait for it to charge itself at 4am

Chapter 5 How We Make Things – 31% of 51 billion tons per year

Materials

- Concrete
    - Rust resistant, rot-proof, and non-flammable, which is why it's part of most modern buildings
    - Statue of Liberty made of 27,000 tons of concrete
    - America alone produces more than 96 million tons of cement, one of the main ingredients of concrete
- Steel
    - Put in cars, ships and trains; factory machines, cans of food; even computers
    - It is strong, cheap, durable, and infinitely recyclable
    - Combined with concrete can withstand tons of weight
    - Americans use as much steel as cement
- Plastics
    - In so many products: clothes; toys; furniture; cars; cell phones; they allow fuel-0efficient cars to be so light
- Glass
    - In our windows, jars & bottles, insulation, cars and fibre-optic cables that give you a high-speed internet connection
- Aluminium
    - Soda cans, foil, power lines, doorknobs, trains, planes, beer kegs
- Fertiliser
    - Helps feed the world
- Paper
    - Still being used though electronic communications has become more common

Key points:

- Materials are just as essential to modern life as electricity. We will be using more of them as the world's population grows. It is claimed that we will be using 50% more steel by 2050 than we do now.
- Making all these materials emits lots of greenhouse gases, responsible for about a third of all emissions worldwide.
- For concrete we don't have a practical to make it without producing carbon

Focussing on Steel, concrete and plastic

- Steel
    - To make steel you need pure iron and carbon. On its own iron isn't very strong but add carbon – less than 1% - gives the steel its most important properties
    - To make steel you need to separate the oxygen from the iron ore at a very high temperature in the presence of oxygen and coke. The outcome is that for every 1 ton of steel produced you get 1.8 tons of carbon dioxide
    - By 2050 the world will be producing 2.8 billion tons of steel every year– roughly 5 billion tons of CO2 being released.
- Concrete
    - Contains cement. To make cement you need calcium. To get calcium, you start with limestone which contains calcium plus carbon and oxygen and burn it in a furnace with other materials. You get 1 ton of cement and 1 ton of CO2.
    - By 2050 it is expected that 4 billion tons will be being produced so 4 billion tons of CO2.
    - Nobody knows of a way of making cement without going through this process.
- Plastics
    - Lots of different plastics and they all contain carbon. They get the carbon by refining oil, coal, or natural gas and then refining it in various ways. Plastic is cheap because fossil fuels are cheap.
    - When we make plastics about half of the carbon stays in the plastic. Carbon likes bonding with oxygen and hydrogen and isn't inclined to let go – thus taking hundreds of years to degrade.
    - Plastics in the oceans cause all types of problems but the carbon in the plastics does not add to climate change.

Green Premiums for Steel, concrete and plastic

- Emitting greenhouse gases can be split into three stages (1) when we use fossil fuels to generate the electricity that factories need to run their operations – covered in Chapter 4, (2) When we use them to generate heat needed for manufacturing processes, like meting iron ore to make steel, (3) when we actually make materials, like the way cement manufacturing creates CO2.
- Stage 2 – how can you generate heat without burning fossil fuels? The high temperature means that you will either need to use nuclear or use carbon capture – which adds to the cost.

- Stage 3 - Short of simply shutting down these parts of the manufacturing sector, we can do nothing today to avoid these emissions. If we wanted to go all in on eliminating them using whatever technologies we have available today, our options would be as limited as they were in the second stage. We'd have to use fossil fuels and carbon capture—which, again, adds to the cost.
- Green premiums: for Ethylene (plastic) 9-15%; Steel 16-29%; Cement 75-149%.
- There are different ways to bring the premiums down. One is by using public policies to create demand for clean products—for example, by creating incentives or even requirements to buy zero-carbon cement or steel. Businesses are much more likely to pay the premium for clean materials if the law requires it, their customers demand it, and their competitors are doing it.
- Possible approach for removing CO2 out of cement - involves making cement out of seawater and the carbon dioxide captured from power plants. The inventors behind this idea think it could ultimately cut emissions by more than 70 percent.
- Possible approach for removing CO2 out of steel - A company has developed a new process called molten oxide electrolysis: Instead of burning iron in a furnace with coke, you pass electricity through a cell that contains a mixture of liquid iron oxide and other ingredients. The electricity causes the iron oxide to break apart, leaving you with the pure iron you need for steel, and pure oxygen as a by-product. No carbon dioxide
- Possible approach for removing CO2 out of plastic - Various companies are trying to get carbon from plants. Finally, we'd need a zero-carbon source of heat—which would likely also be clean electricity, hydrogen, or natural gas fitted with a device to capture the carbon it emits.
- To sum up, the path to zero emissions in manufacturing looks like this:
    - Electrify every process possible. This is going to take a lot of innovation.
    - Get that electricity from a power grid that's been decarbonized. This also will take a lot of innovation.
    - Use carbon capture to absorb the remaining emissions. And so will this.
    - Use materials more efficiently. Same.

Chapter 6 How We Grow Things – 19% of 51 billion tons per year

Key Points

- Bill Gates has cut down on eating beefburgers because of what he learnt about beef and other meats having an effect on climate change. Raising animals for food is a major contributor of greenhouse emissions
- With agriculture, the main culprit isn't carbon dioxide but methane—which causes 28 times more warming per molecule than carbon dioxide over the course of a century—and nitrous oxide, which causes 265 times more warming.
- Each year's emissions of methane and nitrous oxide are the equivalent of more than 7 billion tons of carbon dioxide, or more than 80 percent of all the greenhouse gases in this ag/forestry/land use sector.
- Innovation prevented mass starvation. Norman Borlaug, the brilliant plant scientist who sparked a revolution in agriculture that led to the gains in India and elsewhere. Borlaug did it by developing varieties of wheat with bigger grains and other characteristics that allowed them to provide much more food per acre of land—what farmers call raising the yield. (Borlaug found that as he made the grains bigger, the wheat couldn't stand up under their weight, so he made the wheat stalks shorter, which is why his varieties are known as semi-dwarf wheat.) As Borlaug's semi-dwarf wheat spread around the world, and as other breeders did similar work on corn and rice, yields tripled in most areas. Starvation plummeted, and today Borlaug is widely credited with saving a billion lives – Nobel Peace Prize in 1970. The downside of these new varieties is that they need lots of fertilizer to reach their full growth potential.
- A chicken has to eat two calories' worth of grain to give us one calorie of poultry—that is, you have to feed a chicken twice as many calories as you'll get from the chicken when you eat it. For pigs the ratio is three and for cows it is six.
- Meat consumption around the world. It's basically flat in the United States, Europe, Brazil, and Mexico, but it's climbing rapidly in China and other developing countries.
- Assuming we don't make any improvements in the amount of food we get per acre of pasture or cropland, growing enough to feed 10 billion people in 2050 will drive up food-related emissions by two-thirds – a disaster for the climate.

- I'll (Bill Gates) use Green Premiums to show why getting rid of these greenhouse gases is too expensive today, and to make the case that we need some new inventions.
- Around the world, there are roughly a billion cattle raised for beef and dairy. The methane they burp and fart out every year has the same warming effect as 2 billion tons of carbon dioxide, accounting for about 4 percent of all global emissions.
- There's another cause of greenhouse gas emission that's common to every animal: poop. When poop decomposes, it releases a mix of powerful greenhouse gases—mostly nitrous oxide, plus some methane, sulphur, and ammonia. About half of poop-related emissions come from pig manure, and the rest from cow manure. There's so much animal poop that it's actually the second-biggest cause of emissions in agriculture,
- The amount of methane produced by a given cow depends a lot on where the cow lives; for example, cattle in South America emit up to five times more greenhouse gases than ones in North America do, and African cattle emit even more. If we can spread the improved breeds and best practices more broadly—especially crossbreeding African cows to be more productive and making higher-quality feed available and affordable—it'll reduce emissions and help poor farmers.
- We can cut down on meat eating while still enjoying the taste of meat. One option is plant-based meat. (in the U.K. Quorn). Another approach is akin to plant-based meat, but instead of growing plants and then processing them so they taste like beef, you grow the meat itself in a lab. It has somewhat unappealing names like "cell-based meat," "cultivated meat," and "clean meat," and there are some two dozen start-up companies working on getting it to market.
- In Europe, industrialized parts of Asia, and sub-Saharan Africa, more than 20 percent of food is simply thrown away, allowed to rot, or otherwise wasted. In the United States, it's 40 percent. When wasted food rots it produces enough methane to cause as much warming as 3.3 billion tons of carbon dioxide each year. Two companies are working on invisible, plant-based coatings that extend the life of fruits and vegetables; they're edible, and they don't affect the taste at all.
- Fertiliser is important - Africa, where the typical farmer gets just one-fifth as much food per acre of land as an American farmer gets largely because of lack of fertiliser. Why is fertilizer so magical? Because it provides plants with essential nutrients, including phosphorus, potassium, and the one that's especially relevant to climate change: nitrogen. But nitrogen also

makes climate change much worse. Worldwide, crops take up less than half the nitrogen applied to farm fields. The rest runs off into ground or surface waters, causing pollution, or escapes into the air in the form of nitrous oxide—which, you may recall, has 265 times the global-warming potential of carbon dioxide. Fertilizers were responsible for roughly 1.3 billion tons of greenhouse gas emissions in 2010, and the number will probably rise to 1.7 billion tons by 2050. There's no equivalent of carbon capture for nitrous oxide. We need significant innovation in this area.

- We'll also have to do something about deforestation and other uses of land, which together add a net 1.6 billion tons of carbon dioxide.
    - According to the World Bank, the world has lost more than half a million square miles of forest cover since 1990.
    - If trees are burned down, they quickly release all the carbon dioxide they contain. Also, you disturb the soil, and it turns out that there's a lot of carbon stored up in soil (in fact, there's more carbon in soil than in the atmosphere and all plant life combined). When you start removing trees, that stored carbon gets released into the atmosphere as carbon dioxide.
    - Because food is a global commodity, what's consumed in one country can cause land-use changes in another. As the world eats more meat, it accelerates the deforestation in Latin America. More burgers anywhere mean fewer trees there.
    - Nigeria, which has had one of the highest deforestation rates in the world, has lost more than 60 percent of its forest cover since 1990, and it's one of the world's biggest exporters of charcoal, which is created by charring wood.
- Planting trees as a way to capture carbon dioxide from the atmosphere. Many factors involved:
    - How much carbon dioxide can a tree absorb in its lifetime? It varies, but a good rule of thumb is 4 tons over the course of 40 years.
    - How long will the tree survive? If it burns down, all the carbon dioxide it was storing will be released into the atmosphere.
    - What would've happened if you hadn't planted that tree? If a tree would've grown there naturally, you haven't added any extra carbon absorption.
    - In what part of the world will you plant the tree? Trees in snowy areas cause more warming than cooling, trees in tropical Trees forests cause more cooling than warming, in the

midlatitudes—between the tropics and the polar circles—are more or less a wash.

- the math suggests you'd need somewhere around 50 acres' worth of trees, planted in tropical areas, to absorb the emissions produced by an average American in her lifetime. Multiply that by the population of the United States, and you get more than 16 billion acres, or 25 million square miles, roughly half the landmass of the world.
- But there's no practical way to plant enough of them to deal with the problems caused by burning fossil fuels. The most effective tree-related strategy for climate change is to stop cutting down so many of the trees we already have.

Chapter 7 How We Get Around – 16% of 51 billion tons per year

Key Points

- Gasoline – nothing else in our daily lives comes close to delivering as much energy per gallon at such a low cost.
- The burning of fuels in our cars, ships, and planes emits carbon dioxide that's contributing to global warming. To get to zero, we'll need to replace those fuels with something that's just as energy dense and just as cheap.
- We won't just need to eliminate the 8.2 billion tons of carbon we produce from transportation today; we'll need to get rid of even more than that. The Organization for Economic Cooperation and Development predicts that demand for transportation will keep growing through at least to 2050. It's aviation, trucking, and shipping—not passenger cars—that account for all the emissions growth in this sector. Maritime shipping now handles nine-tenths of the goods traded around the world by volume, producing nearly 3 percent of global emissions.
- Nearly all the growth in transport-related carbon is coming from developing countries as their populations grow, get richer, and buy more cars. Example China – doubled in last decade.
- Bill Gates has a strong belief, "We should be glad that more people and goods are moving around", personal freedom, meet people from other countries helps us understand our common goals, food choices.
- CO_2 emissions: Cars, SUV's, motorcycles – 47%; Garbage trucks, buses, 18 wheelers – 30%; Cargo, cruise ships – 10%; Airplanes 10%; Other 3%.
- Cars
    - About a billion cars on the road in the world
    - All electric cars can now be bought – huge decrease in battery cost - 87% since 2010. They come with a modest green premium. His prediction that it will be zero by 2030.
    - Using them to avoid carbon emissions works only if we're generating electricity from zero-carbon sources.
    - If we wanted to have every passenger car in America running on electricity by 2050, EVs would need to be nearly 100 percent of auto sales within the next 15 years as cars last on average 13 years. Today they're less than 2 percent.
- Garbage trucks, buses, and
    - Garbage trucks & buses can use batteries as short distance travelled, parking in the same place at night to recharge.
- 18-wheelers

- Batteries are a less practical option due to weight of the vehicle, distance to travel and limitations on battery size.
- Pound for pound, the best lithium-ion battery available today packs 35 times less energy than gasoline. In other words, to get the same amount of energy as a gallon of gas, you'll need batteries that weigh 35 times more than the gas.
- A study indicated that an electric cargo truck capable of going 600 miles on a single charge would need so many batteries that it would have to carry 25 percent less cargo.
- Because we can't electrify our cargo trucks, the only solutions available today are electrofuels (green premium 234%) and advanced biofuels (green premium 103%).
- Advanced biofuels are made from plants that aren't grown for food – they are drop-in fuels meaning that they can be used in conventional engines.
- Electrofuels - We can also use zero-carbon electricity to combine the hydrogen in water with the carbon in carbon dioxide, resulting in hydrocarbon fuels. Because you use electricity in the process, these fuels are sometimes called electrofuels, and they have a lot of advantages. They're drop-in fuels, and because they're made using carbon dioxide captured from the atmosphere, burning them doesn't add to overall emissions. However, they're very expensive. You need hydrogen to make them, and it costs a lot to make hydrogen without emitting carbon.

- Ships and planes.
  - Batteries will never be light and powerful enough to move planes and ships anything more than short distances.
  - Our best bet is to replace jet fuel with electrofuels (green premium 296%) and advanced biofuels (green premium 141%) but look at the hefty premiums that come with them.
- Cargo ships
  - Shipping alone accounts for 3% of all emissions so using clean fuels would give a meaningful reduction.
  - Again, jet fuel can be replaced with electrofuels (green premium 601%) and advanced biofuels (green premium 326%), but the green premiums are very high.
- Four Ways to cut down on emissions from transport
  - One is to do less of it—less driving, flying, and shipping.

  - Cut down on emissions by using fewer carbon-intensive materials in making cars
  - The third way to cut down on emissions is to use fuels more efficiently.
  - We can move toward zero emissions from transportation: switching to electric vehicles and alternative fuels.
- Possibilities for Ships, planes and cargo
  - We need a massive effort to explore all the ways we can make advanced biofuels and cheap electrofuels.
  - We should also be exploring nuclear-powered container ships
    - military submarines and aircraft carriers run on nuclear power already.

Chapter 8 How We Keep Cool and Stay Warm – 7% of 51 billion tons per year

Key Points

- 90 percent of American households now have some type of air conditioner. Air-conditioning is no longer simply a pleasant luxury that makes summer days bearable; the modern economy depends on it. Worldwide, there are 1.6 billion A/C units in use, but they're not evenly distributed. Japan, United States and South Korea have over 80% households with A/C whilst some of the hottest countries don't have A/C. By 2050, there will be more than 5 billion A/C units. In fact, the International Energy Agency projects that worldwide electricity demand for cooling will triple by 2050.
- All the electricity used by buildings—for air-conditioning as well as lights, computers, and so on—is responsible for nearly 14 percent of all greenhouse gases.
- Most people simply don't buy the most energy-conscious air conditioners on the market. According to the IEA, the typical A/C unit sold today is only half as efficient as what's widely available and only a third as efficient as the best models.
- Furnaces (boilers) and water heaters account for a third of all emissions that come from the world's buildings. And unlike lights and A/C units, most of them run on fossil fuels, not electricity.
- The path to zero carbon for heating actually looks a lot like the path for passenger cars: (1) electrify what we can, getting rid of natural gas water heaters and furnaces (boilers), and (2) develop clean fuels to do everything else.
- In most locations, your overall costs will go down if you get rid of an electric air conditioner and gas (or oil) furnace (boiler) and replace both with an electric heat pump (true in U.K.?).
- The green premium is negative (16 to 27%) for installing a heat pump as compared to a natural gas boiler in the United States.
- If heat pumps are such a great deal, why are they in only 11 percent of American homes? The replacement cost!
- Today around half of all furnaces sold in the United States run on gas; worldwide, fossil fuels provide six times more energy for heating than electricity does.
- We need Advanced biofuels and electrofuels so we don't have to replace all the furnaces (boilers) that are installed now—ones that can be run in the furnaces and water heaters we have today, without modification, and

that don’t add more carbon to the atmosphere. However, they come with a big green premium – electrofuels 234 to 425%, Advanced Biofuels 103 to 142%.

- The world is undergoing a huge construction boom. To accommodate a growing urban population, we’ll add 2.5 trillion square feet of buildings by 2060. The good news is that we know how to build Green Buildings but they do come with a green premium.

Chapter 9 Adapting to a Warmer World (chapter needs to be read)

Key Points

- Just about everyone who's alive now will have to adapt to a warmer world. As sea levels and floodplains change, we'll need to rethink where we put homes and businesses. We'll need to shore up power grids, seaports, and bridges. We'll need to plant more mangrove forests and improve our early-warning systems for storms.
- The people will suffer the most from a climate disaster and who deserve the most help are the low-income people, and for them climate change could have the worst consequences of all. And their stories capture the complexity of fighting poverty and climate change at the same time.
- In Kenya roughly one-third of the population works in agriculture. Worldwide, there are 500 million smallholder farms, and about two-thirds of people in poverty work in agriculture. Yet despite their large numbers, smallholder farmers are responsible for remarkably few greenhouse gas emissions, because they can't afford to use nearly as many products and services that involve fossil fuels. The typical Kenyan produces 55 times less carbon dioxide than an American, and rural farmers produce even less.
- As the climate gets warmer, droughts and floods will become more frequent, wiping out harvests more often. Livestock eat less and produce less meat and milk. The air and soil lose moisture, leaving less water available for plants; in South Asia and sub-Saharan Africa, tens of millions of acres of farmland will become substantially drier. Crop-eating pests are already infesting more acreage as they find more hospitable environments to live in. The growing season will also get shorter; at 4 degrees Celsius of warming, most of sub-Saharan Africa could see it shrink by 20 percent or more.
- One study found that the number of additional heat-related deaths could approach 10 million a year by the end of the century (that's roughly as many people as are killed by all infectious diseases today), with a large majority of the deaths occurring in poor countries. And the children who don't die will be far more likely to suffer from stunting—that is, to not fully develop physically or mentally.
- So, we need to help the poorest improve their health. I (Bill Gates) see two ways to do that.
    - One, we need to raise the odds that malnourished children will survive. That means improving primary health-care systems,

    doubling down on malaria prevention, and continuing to provide vaccines for conditions like diarrhoea and pneumonia.
  - Then—in addition to saving the lives of malnourished children—we need to make sure that fewer children are malnourished in the first place. With population growth, the demand for food will likely double or triple in regions where most of the world's poor live. So, we need to help poor farmers grow more of it, even when droughts and floods strike.
- CGIAR is the world's largest agricultural research group: In short, it helps create better plants and better animal genetics. No other organization is in a better position to create the innovations that will help poor farmers adapt to climate change in the years ahead.
- CGIAR has developed dozens of new maize varieties that could withstand drought conditions. Thanks to CGIAR's efforts, new types of rice that can tolerate drought are spreading rapidly in India, where climate change is causing more dry spells during the rainy season.
- Bill Gates's Commission on Adaptation makes three other recommendations related to agriculture, (1) Help farmers manage the risks from more chaotic weather, (2) Focus on the most vulnerable people, (3) Factor climate change into policy decisions.
- What else it's going to take to adapt to a warmer climate.
  - The first involves reducing the risks posed by climate change
  - Preparing for and responding to emergencies.
  - There's the recovery period. We'll need to plan for services for people who've been displaced
- Four of the big headlines on adaptation:
  - Cities need to change the way they grow.
  - We should shore up our natural defence's.
  - We're going to need more drinking water than we can supply.
  - Finally, to fund adaptation projects, we need to unlock new money. We need to make adaptation an attractive investment.
- But the commission I'm (Bill Gates) involved with priced out spending in five key areas (creating early-warning systems, building climate-resilient infrastructure, raising crop yields, managing water, and protecting mangroves) and found that investing $1.8 trillion between 2020 and 2030 would return more than $7 trillion in benefits.
- Extreme poverty has plummeted in the past quarter century, from 36 percent of the world's population in 1990 to 10 percent in 2015. Climate

change could erase some of these gains, increasing the number of people living in extreme poverty by 13 percent.

- Geoengineering is the only known way that we could hope to lower the earth’s temperature within years or even decades without crippling the economy - One idea involves distributing extremely fine particles—each just a few millionths of an inch in diameter—in the upper layers of the atmosphere. Scientists know that these particles would scatter sunlight and cause cooling, Chapter 10 Why Government Policies Matter

Key Points

- In this book, I've (Bill Gates) been emphasizing the inventions we need to get to zero—new ways of storing electricity, making steel, and so on—but innovation is not just a matter of developing new devices. It's also a matter of developing new policies so we can demonstrate and deploy those inventions in the market as fast as possible.
- Now it's time to turn the world's policy-making experience to the challenge at hand: zeroing out our greenhouse gas emissions.
- National leaders around the world will need to articulate a vision for how the global economy will make the transition to zero carbon. Government officials can write rules regarding how much carbon power plants, cars, and factories are allowed to emit. adopt regulations that shape financial markets and clarify the risks of climate change to the private and public sectors. They can be the main investors in scientific research, as they are now, and write the rules that determine how quickly new products can get to market. And they can help fix some problems that the market isn't set up to deal with—including the hidden costs that carbon-emitting products impose on the environment and on humans.
- Many decisions need to be made. At each step, someone will have to decide whether to go with the green alternatives.
- The private sector systematically underinvests in R&D on energy. Companies in the energy business spend an average of just 0.3 percent of their revenue on energy R&D. The electronics and pharmaceutical industries, by contrast, spend nearly 10 percent and 13 percent, respectively. We'll need government policies and financing to close the gap, focusing especially in areas where we need to invent new zero-carbon technologies.
- We can also raise the cost of fossil fuels by incorporating the damage they cause into the prices we pay for them. Today, when businesses make products or consumers buy things, they don't bear any extra cost for the carbon involved, even though that carbon imposes a very real cost on society.
- We can reduce Green Premiums by making carbon-free things cheaper (which involves technical innovation), by making carbon-emitting things more expensive (which involves policy innovation), or by doing some of both. By progressively increasing the price of carbon to reflect its true

cost, governments can nudge producers and consumers toward more efficient decisions and encourage innovation that reduces Green Premiums.

- Now that the movement to address climate change is getting serious, we'll need to focus on the hard parts too: electricity storage, clean fuels, cement, steel, fertilizer, and so on. And that will require a different approach to policy making. In addition to deploying the tools we already have, we'll need to invest more in R&D on the hard stuff and—because much of it is core to our physical infrastructure, like roads and buildings—use policies specifically designed to get these breakthroughs created and into the marketplace.
- When we focus on three important things at once—technology, policies, and markets—we can encourage innovation, spark new companies, and get new products into the market fast.

Chapter 11 A Plan for Getting to Zero

Key Points

- I'll (Bill Gates) propose a plan for how we can avoid a climate disaster, focusing on the specific steps government leaders and policy makers can take.
- Science tells us that in order to avoid a climate catastrophe, rich countries should reach net-zero emissions by 2050 – note that 2030 is unrealistic.
- If you want a measuring stick for which countries are making progress on climate change and which ones aren't, don't simply look for the ones that are reducing their emissions. Look for the ones that are setting themselves up to get to zero by 2050.

The Plan

- Innovation and the Law of Supply and Demand
  - Climate science tells us why we need to deal with this problem but not how to deal with it. For that, we'll need biology, chemistry, physics, political science, economics, engineering, and other sciences.
  - Innovation is not just a matter of inventing a new machine or some new process; it's also coming up with new approaches to business models, supply chains, markets, and policies that will help new inventions come to life and reach a global scale. Innovation is both new devices and new ways of doing things.
  - Two categories. One involves expanding the supply of innovations—the number of new ideas that get tested—and the other involves accelerating the demand for innovations.
- Expanding the Supply of Innovation
  - Technologies needed:
    - How We Plug-in
      - Next-generation nuclear fission
      - Nuclear fusion
      - Carbon capture (both direct air capture and point capture)
      - Grid-scale electricity storage that can last a full season
      - Underground electricity transmission
      - Geothermal energy
      - Pumped hydro
      - Thermal storage

            - Hydrogen produced without emitting carbon
        - How We Make Things
            - Zero-carbon cement
            - Zero-carbon steel
            - Zero-carbon plastics
        - How We Grow Things
            - Plant- and cell-based meat and dairy
            - Zero-carbon fertilizer
            - Drought- and flood-tolerant food crops
            - Zero-carbon alternatives to palm oil
        - How We Get Around
            - Electrofuels
            - Advanced biofuels
        - How to Keep Cool and Stay Warm
            - Coolants that don't contain F-gases
- To get these technologies ready soon enough to make a difference, governments need to do the following:
    - Quintuple clean energy and climate-related R&D over the next decade.
    - Make bigger bets on high-risk, high-reward R&D projects.
    - Match R&D with our greatest needs - We need more government programs that integrate basic and applied research in the areas where we most need breakthroughs.
    - Work with industry from the beginning.
- Accelerating the Demand for Innovation
    - The demand side is a little more complicated than the supply piece. It actually involves two steps: the proof phase, and the scale-up phase.
    - Ideas currently in the proof phase include low-carbon cement, next-generation nuclear fission, carbon capture and sequestration, offshore wind, cellulosic ethanol (a type of advanced biofuel), and meat alternatives.
    - The proof phase is a valley of death, a place where good ideas go to die.
    - Governments (as well as big companies) can help energy start-ups make it out of the valley alive because they're massive consumers. If they prioritize buying green, they'll help bring more products to market by creating certainty and reducing costs.

    - Every bureaucrat who makes purchasing decisions should have an incentive to look for green products
    - Create incentives that lower costs and reduce risk. In addition to buying things themselves, governments can give the private sector various incentives to go green.
    - Build the infrastructure that will get new technologies to market. Even cost-competitive low-carbon technologies won't be able to gain market share if the infrastructure isn't in place to get them to market in the first place. Governments at all levels need to help get that infrastructure built.
    - Change the rules so new technologies can compete. Once the infrastructure is built, we'll need new market rules that allow the new technologies to be competitive.
    - Put a price on carbon. Whether it's a carbon tax or a cap-and-trade system where companies can buy and sell the right to emit carbon, putting a price on emissions is one of the most important things we can do to eliminate Green Premiums.
    - Clean electricity standards - Allows any clean energy technology—including nuclear and carbon capture—to count toward meeting the standard. It's a flexible, cost-effective approach.
    - Clean fuel standard - A clean fuel standard applied to the transportation sector would accelerate deployment of electric vehicles, advanced biofuels, electrofuels, and other low-carbon solutions.
    - Clean product standards - Performance standards can also help accelerate the deployment of low-emissions cement, steel, plastics, and other carbon-intensive products.
    - Out with the old. In addition to rolling out new technology as fast as possible, governments will need to retire inefficient, fossil-fuelled equipment—whether power plants or automobiles—faster than they might otherwise.
- Who's on First?
    - We'll need action at all levels of government, from local transportation planners to national legislatures and environmental regulators.
    - Every national government needs to do three things. First, make it a goal to get to zero—by 2050 for rich countries, and as soon after 2050 as possible for middle-income countries. Second, develop specific plans for meeting those goals. To get to zero by 2050, we'll

need to have the policy and market structures in place by 2030. And third, any country that's in a position to fund research needs to make sure it's on track to make clean energy so cheap—to reduce the Green Premiums so much—that middle-income countries will be able to get to zero.
    - There's the matter of how we finance the work it'll take to get to zero - it will require massive investment.
    - Bill Gates gives a list of agencies that have a role to play in the United States – it would be similar in the U.K. and includes Local government.
- How do we get Countries on-board?
    - It's hard to impose higher costs now in exchange for a better climate later. The Green Premiums give countries, and especially middle- and low-income countries, a major incentive to resist cutting their emissions. We've already seen example after example around the world—Canada, the Philippines, Brazil, Australia, France, and others—in which the public makes it clear with their votes and their voices that they don't want to pay more for gasoline, heating oil, and other basics.
    - It helps to set ambitious goals and commit to meeting them, the way countries around the world did with the **2015 Paris Agreement**. It's easy to mock international agreements, but they're part of how progress happens.
    - What about those who refuse to go along? It's notoriously difficult to hold a country accountable for something like its carbon emissions. But it's not out of the question. For example, governments that adopt a price on carbon can create what's called a border adjustment—making sure that the carbon price on some product is paid whether that product was made domestically or imported from somewhere else.
    - Governments can say to each other, "If you want to do business with us, you'll have to take climate change seriously."
    - Countries like the United States shouldn't see investing in clean energy R&D, and reducing green premiums, as just a favour to the rest of the world. They should also see it as an opportunity to make scientific breakthroughs that will give birth to new industries composed of major new companies, creating jobs and reducing emissions at the same time.

Chapter 12 What Each of Us Can Do

Key Points

- Engaging in the political process is the most important single step that people from every walk of life can take to help avoid a climate disaster.
- Policy makers can take on only so many problems at once. And they decide what to do, what to prioritize, based on what they're hearing from their constituents.
- Make calls, write letters, attend town halls.
- Look locally as well as nationally. Know who your representatives are and keep in touch with them.
- As a Consumer
  - install a smart thermostat to reduce your energy consumption
  - You can also send a signal to the market that people want zero-carbon alternatives and are willing to pay for them. When you pay more for an electric car, a heat pump, or a plant-based burger, you're saying, "There's a market for this stuff. We'll buy it."
  - Sign up for a green pricing program with your electric utility.
  - Reduce your home's emissions.
  - Buy an electric vehicle; Try a plant-based burger.
- As an Employee or Employer
  - Planting trees to offset emissions, for instance, is a good thing to do for environmental and political reasons.
  - Shareholders and board members will have to be willing to share in this risk, making it clear to executives that they'll back smart investments even if they don't ultimately pan out.
  - If the world's biggest private-sector consumers of materials like steel and cement got together and demanded cleaner substitutes—and committed to investing in the infrastructure needed to make them— it would accelerate research and shift the market in the right direction.
  - Demanding that governments set up regulatory structures in which new technologies can succeed.
  - Set up an internal carbon tax in big companies against its divisions.
  - Prioritize innovation in low-carbon solutions.
  - Be an early adopter. Help early-stage innovators get across the valley of death.
  - Engage in the policy-making process.
  - Connect with government-funded research.

13 Bill Gates's Afterword:

- When we have a fact-based view of climate change, we can see that we have some of the things we need to avoid a climate disaster, but not all of them. We can see what stands in the way of deploying the solutions we have and developing the breakthroughs we need. And we can see all the work we must do to overcome those hurdles.
- I'm an optimist because I know what technology can accomplish and because I know what people can accomplish. I'm profoundly inspired by all the passion I see, especially among young people, for solving this problem. If we keep our eye on the big goal—getting to zero—and we make serious plans to achieve that goal, we can avoid a disaster. We can keep the climate bearable for everyone, help hundreds of millions of poor people make the most of their lives, and preserve the planet for generations to come.
- I expect to spend much of my time in 2021 talking with leaders around the world about both climate change and COVID-19. I will make the case to them that many of the lessons from the pandemic—and the values and principles that guide our approach to it—apply just as well to climate change.
    - We need international cooperation.
    - We need to let science—actually, many different sciences—guide our efforts.
    - Third, our solutions should meet the needs of the people who are hardest hit.
    - Finally, we can do the things that will both rescue economies from the COVID disaster and spark innovation to avoid a climate disaster.
- We should spend the next decade focusing on the technologies, policies, and market structures that will put us on the path to eliminating greenhouse gases by 2050.