

FIGHT the FIRE

Green New Deals
and Global Climate Jobs



Jonathan Neale

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Advance Praise for Fight the Fire

“Jonathan Neale has unusual gifts for writing science, technology and politics, ideas and practical plans in ways everyone can understand. He used these gifts in One million climate jobs – a project for trade unionists, activists and political workers in the UK. In *Fight the Fire: Green New Deals and Global Climate Jobs*, Jonathan Neale has developed them for the world.”

– *Barbara Harriss-White, Professor of Development Studies, University of Oxford*

“Jonathan Neale has produced a magnificent book, readable and accessible – an analytical tour de force and a grounded, forceful call for practical action. Central to any green new deal, with a caring economy at its core, must be the commitment to cut greenhouse gas emissions rapidly. New jobs to do that are needed – climate jobs – for those losing their old high-carbon jobs, and for many others besides. It will require a reinvigorated public sector. Looking at both the global North and South, Neale spells out, sector by sector, exactly how we can do it. Inspiring, life-affirming and, above all, practical.” – *Richard Kuper, Red Green Labour*

“Neale’s writing provides a compelling argument and guide for climate justice activists. The force of its logic, ideas and inspiration is unassailable and many will keep this one by the bedside for years to come.” – *Rehad Desai, Director, Miners Shot Down*

"'I want a concrete plan, not just nice words', said Greta Thunberg. Jonathan Neale knows the meaning of concrete when it comes to climate action. With brutal realism and die-hard optimism, he explains why climate jobs must be at the centre of Green New Deals.

No book, no plan, no Netflix documentary can reassure us as we face the fire of global warming. Yet the words of Jonathan Neale are powerful, detailed and honest. Whether the chapter is about chickens or hydrogen, this monumental book clears away obstacles in the necessary process of building mass movements for climate jobs."
– **Andreas Ytterstad, Chair, Concerned Scientists Norway**

"This is a stirring call to action that is as practical as it is bold and radical. With detailed arguments made in plain prose, longtime organizer, writer and climate justice activist Jonathan Neale puts forth how we can cool the planet by stoking the heat and organization of working people. A how-to guide for building the kind of mass movement for climate jobs we need to avoid climate breakdown. Read it, share it, organize by it."
– **Chris Williams, author Ecology and Socialism**

"Climate change affects us all – and yet it took a sixteen-year-old girl to make the world listen. Jonathan Neale's extraordinary book cuts through the smoke screens to explain what global warming is, and how it affects us all in one way or another. Until now the debate has sometimes been deliberately obscured in an effort to blind us to the realities. Jonathan has cleared the smoke away to allow us to see and make sense of what is happening. In a language anyone can understand. But this book is not a prediction of a coming apocalypse. It is a handbook on how we can stop it."
– **Mike Gonzalez, author of The Politics of Water**

"This book is one of the most accessible, rich and inviting interventions on the climate question today. It provides great insights and convincing arguments as to why green new deals and global climate jobs should be a priority. Neale covers a wide breadth of topics and does a great job at situating the climate crisis within a global system that clearly needs to change. The main strength of this book is that it does not only raise the alarm, but it tells us exactly why the situation is alarming; and it does not simply call for a change, but it also tells us how to do it."

– *Rima Majed, Professor of Sociology, American University of Beirut*

"Jonathan Neale's latest book is his most important and impressive. Beautifully and simply written against the background of impending climate collapse and the inability of those who hold immense economic and political power to cut greenhouse gas emissions, Neale presents a clear and penetrating analysis of what is at stake and how the struggle for climate jobs lies at the heart of a working class programme to prevent runaway climate change. Working class activists, in both the Global South and North, have a powerful and easily readable aid with which to convince their constituencies that there are real and viable solutions to capitalist induced climate change and the larger ecological crisis threading life on our planet. This book must be read, discussed and its proposals fought for. A masterpiece."

– *Brian Ashley, editor of Amandla*

"This is a timely book. At a time when the world is still reeling from the ravages of Covid-19 and the massive economic dislocation that it engendered, now is the perfect time to reinvigorate the campaign for climate jobs, or, as in the case of the Philippines, to launch it. And this book is just what any climate jobs campaigner would need. It provides the big picture, the science and the politics of climate change, as well as the nuts and bolts of what such a campaign would look like. More than that, it is replete with lessons that the author has gained from a life spent fighting in the trenches of various campaigns."

– *Josua Mata, Secretary-General, SENTRO union federation, Philippines.*

Other books by Jonathan Neale

Nonfiction

Memoirs of a Callous Picket

The Cutlass and the Lash

Tigers of the Snow

You are G8, We are 6 Billion

A People's History of the Vietnam War

What's Wrong with America?

Stop Global Warming—Change the World

Novels

The Laughter of Heroes

Mutineers

For Young People

Lost at Sea

Himalaya

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For Nancy Lindisfarne

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FOREWORD

My father was a climate activist to the end. Ken Montague was a boomer, born among the bomb craters of the East End of London in what would now be considered abject poverty. The experience instilled in him a desire to take care of those around him. And when I say, 'those around him' I mean all of humanity. His concern was global and universal. When I became a teenage environmentalist, he was concerned this might be a distraction from fighting for social justice. Nonetheless, he was among the first to fully comprehend the threat of climate breakdown, and, once he had, he dedicated much of his remaining life trying to find a solution.

Hundreds of people came to his funeral, and fittingly there were several events to mark his passing. At one such event one of his many friends and activist allies stood up to speak. And for a few minutes he said nothing at all. We allowed the sadness, the grief, to grow into the silence. He held a space for all of us to feel, and did not fill an awkward silence with platitudes or his own reminiscences. When he spoke he came exactly to the point. He told those gathered there on that day about why climate activism was important to my father, and why my father had been important to the climate movement. He read the room.

That man was Jonathan Neale.

We have entered an unprecedented time in human history. Pick up any book from the shelves today about the environment and there will be page after page about climate breakdown, biodiversity collapse,

the harm of pollution and pesticides. Our forests are being ravaged, our oceans are turning to acid and filled with poison. These are important books. We need to understand the threats that we now face, the urgency of change. But we have been making this same case for 50 years - indeed this book marks the 50th anniversary of the launch of *The Ecologist*. The argument is settled and the results are in.

We need now to focus on solutions. And this is where Jonathan has once again shown his remarkable ability to read the room, to allow us to feel, and to know exactly what needs to be said. This book sets out a clear and precise prescription for how we can avert the climate crisis. It works methodically from basic principles to explain exactly what drives climate change. He begins with the physics, the chemistry, and then through to the more complex social and political questions.

This book is an invaluable guide for anyone who needs to get up to speed on the complex issue of climate breakdown. It is also an invaluable resource for seasoned campaigners: a store of useful facts and figures to help you put the case when campaigning on the streets and online.

But what inspires me most is that his solution not only confronts climate breakdown head on, but it also begins and ends with the same concerns my father had as a child growing up in the immediate aftermath of the Second World War. In solving the climate crisis we can at the same time solve some of the apparently most intractable problems we face as a society: social inequality, job insecurity, underproduction in parts of the Global South and hyperconsumption in much of the Global North.

Jonathan's solution can be summarized in two words, and then one word. The two words are climate jobs. This book sets out with extraordinary clarity the challenge we face in driving down carbon dioxide and other greenhouse gasses. It works through sector by sector how we can rewire the world for renewable, lower impact, energy. He talks about the millions of jobs this will create, the institutions we would need to build, and the policies that will make this transformation possible.

But he also gets down to the core value that will drive this change: solidarity. Climate breakdown is a global problem that requires a global solution. This really does mean millions, billions, of human beings working together. We cannot limit our concerns to our own nations. We need breakthrough struggles that can inspire action and change around the world. For these struggles to take place, we need a clear

vision, a clear narrative of how we can get from here to there. And that is precisely why Jonathan has taken a step back, surveyed the evidence and charted a course to a new world.

There has been much ink spilled and emotions expressed about how the baby boomers have somehow revelled in all that is good and left behind a world that is hostile and cruel. This forgets that many of this generation had seen the impacts of war on their parents. They had marched for peace. They fought for justice in the wake of the international AIDS crisis. They tried to stop the National Union of Mineworkers in the UK being crushed. They opposed apartheid in South Africa. And they learned important and difficult lessons along the way. Some, like my father, have passed on. Some remain in the heat of struggle.

The youth climate strikes have been a huge inspiration for Jonathan as they have been for millions of people of all ages. It is absolutely clear to everyone who is paying attention that we have a generation of young adults around the world who are smart, empathic, determined, and united. They have shown extraordinary resolve and resourcefulness in the fight against school shootings, racism, misogyny and all forms of injustice. They will lead the transition to a society that can provide both climate stability and social justice. And I am sure many will lead with a well thumbed and well referenced copy of Jonathan's book in their (digital) back pocket.

Brendan Montague

Co-Editor

The Ecologist

November 2020

PART ONE

**THE TASK
BEFORE
US**

**THE OCEANS
ARE RISING
AND SO
ARE WE**

*Climate striker
Oxford, UK*

*At the beginning of each chapter you will find a slogan like this.
Most of them are copied from home-made placards, usually
on cardboard, carried by young climate strikers around the
world in 2019 and 2020.*

CHAPTER 1

CLIMATE JOBS AND GREEN NEW DEALS

As I write, we are in the midst of a global pandemic which reveals every kind of cruelty and inequality. Worse is to come. We are entering into a global recession and mass unemployment. Looming beyond that is the threat of runaway climate change. But this is also a moment in history. It may be possible, now, to halt the onward rush of climate breakdown.

A door is opening. In every country in the world, a great debate is beginning. The question is, what can be done about the economy? In every country, one answer will be that the government must give vast sums of money to banks, hedge funds, oil companies, airlines, corporations and the rich. And that the government must pay for all this by cutting hospitals, education, welfare and pensions.

The other answer will be that we must spend vast sums of money to create new jobs, build a proper healthcare system, meet human needs and stop climate change.

Who do we rescue? Their banks and their corporations, or our people and our planet?

The answer in favour of helping people, not the rich, is called a "Green New Deal". The idea of a Green New Deal has been around for a decade in many countries. But the decisive moment came in 2017, when Alexandria Ocasio-Cortez and Bernie Sanders in the United States decided to back a Green New Deal. That resonated widely. As we entered the pandemic, that idea was already there.¹

But those three little words, Green New Deal, can mean everything, anything and nothing. We want one particular kind of deal. The words need to mean something real and particular if the deal is to make a difference.

The Cry of the Xcluded, an alliance of unions and unemployed movements in South Africa, issued a call in May of 2020. The Xcluded want the South African government to hire three million workers immediately. Two million of them would work in health care, building decent housing, building sanitation and other ways of meeting human need. A million would work in climate jobs that could cut greenhouse gas emissions by more than 80% in fifteen or twenty years.²

The details, the numbers and the balance of jobs will vary from country to country. But central to the idea is something very simple. We want the jobs now, and our governments must create them now. Three million jobs is a clear, simple slogan – something you can build a movement to fight for.

This book is about the nuts and bolts of what a Green New Deal could look like and why we need it. First, I will outline how the sort of climate jobs project we want would look in the US. Then I describe a vision of a wider Green New Deal in South Africa. These two examples suggest the variety of national projects that would come in between.

Climate Jobs in the US

One example is worth a thousand generalities. So here are the basics of a climate jobs project for the United States.

The government hires eight million new workers over twelve months. That's 667,000 hires a month. These workers are hired into a government-run public company. In Britain the climate jobs campaign has suggested a National Climate Service, because the National Health Service is the most respected public institution in the country. In the US the most respected institution would probably be the military. So maybe they could call it the Climate Corps.³

Many of these new workers will already have the needed skills, but the rest will receive proper training. The project will take fifteen to twenty years. In that time, it will cut CO₂ emissions by 90% from current levels, and total greenhouse gas emissions by 85%.

Some people will change jobs in those fifteen to twenty years. They could, for example, move from building railroads to operating wind farms. But the job status will be permanent, and for most workers the security will last much more than twenty years.

These workers would do “climate jobs.” That’s a bit different from green jobs. Green jobs can be anything useful and ecofriendly. Climate jobs are jobs that directly reduce the emissions that heat the world.

In the US almost four million of those eight million workers would be in renewable energy. About two million of those jobs would be in manufacturing wind turbines and solar power. The other two million would be in building a grid and operating and maintaining the new energy sources. The result, in fifteen to twenty years, would be a completely renewable system – no emissions from burning coal, gas or oil for electricity. And we would have enough electricity to transform transportation, to heat buildings and to power industry.⁴

Another two and a half million workers would build and run a massive expansion in public transport. About half of these workers would be bus drivers. Buses would have reserved lanes and express services so they get people to work quicker, more cheaply and with less stress than other commuters. Within three years all new cars, trucks and buses would by law have to be electric. And within fifteen years all that electricity would be renewable.

About three quarters of a million workers would convert every home and building so they used much less energy and heated only with renewable electricity. Exactly what this means would differ from house to house. But usually it would include insulating the attic, roof and outside walls, changing the windows and installing more efficient water boilers. The Climate Corps would do the conversions for free. And new codes would require all new buildings to be built to very low emission standards, with all electric heating.

Then there are all the industrial processes that burn coal, oil, gas and biomass to heat materials. Most of that would be replaced over twenty years by renewable electricity. This will not be simple, because industries have to compete nationally and globally, and because electricity is an expensive way to heat materials. But it can be done.

In addition to the jobs in the Climate Corps, there would be about four million more jobs working for private companies in the supply chain. That would be 12 million jobs in all, in a country where at the time of writing there are 21 million unemployed, desperate and wanting things to change.

This program of climate jobs, taken together, will cut total greenhouse gas emissions by about 80%. The last 20% of emissions are in areas where they are harder to cut. The main ones are raising

sheep and cattle, using fertilizer and manure, airplanes, gases in the byproducts of industrial processes, and decaying waste. In ways that we will discuss later, it should be possible to cut emissions in these areas by about half.

Having a Climate Corps as a public sector company, run by the government, has many advantages. The first is transparency. Trying to let out thousands of contracts with trillions of dollars over many years in the zoo that is Congress is a recipe for a project that grinds to a halt, and where ordinary people can never judge what is going wrong. If we say eight million new workers in two years, everyone can see if that promise is kept. And once it is kept, it stays kept.

Probably the biggest reason for a public sector company is the fate of the people who will lose their jobs in the old high carbon economy. These include power station workers, oil and gas workers, coal miners and some airline workers. If the Climate Corps is a public body, we can promise every one of those people a climate job if they need it – decently paid secure work, with proper retraining. If private companies do the work, we can't make that promise.

Global heat is not the fault of the workers in the high carbon economy. They deserve security. And if we don't take care of them, we will divide communities, the working class and the country.

Moreover, a public company can put the work where it needs to be. Of course, transport and building jobs will go where people live. Jobs operating wind farms and solar farms will mostly be in rural America, where these workers can anchor communities that are facing many troubles right now. About a quarter of the total jobs will be in manufacture of renewable energy. The Climate Corps can put those jobs anywhere. That means they can put them in the old coal fields of West Virginia and in the old auto plants of Detroit and Flint.

Another reason for a public company is money. People like Donald Trump come right out and defend cooking the Earth. But most people who want to defend coal, oil and gas emissions don't do that. Instead, they say a Green New Deal would cost too much. Or they say green jobs are a wonderful idea, and then they nickel and dime everything to death in committee.

Let's be clear here. It does not matter how much it costs. Stopping global heat is like paying for a cancer operation that will save your child's life. You do it.

But if the work is done by private companies, we will pay enormous amounts of taxpayer dollars into their troughs. That will

discredit the whole project and make further contracts harder to defend. Moreover, everywhere in the world, massive public spending on private contracts is a recipe for pervasive corruption. Just look at how the arms industry works in every country.

But if the Climate Corps is public, we don't have to shovel trillions into corporate profits. So the Corps is cheaper.

The remaining costs, as we will show, can be covered in three ways.

First, every time the government hires an unemployed worker, she stops receiving benefits and starts paying all kinds of open and hidden taxes. The government can save about 20% of the total cost that way.

Second, the Climate Corps is making electricity and public transport, and people pay for those. That will raise another 40% of the total cost. That leaves 40% still left to raise. We can raise about half of that by several different ways of taxing the rich. Finally, we can raise the last 20% through government borrowing in various ways, such as "deficit spending", "quantitative easing", or "climate bonds". We'll explain how that works in Part Six.

Moreover, let's turn round that thing the opponents of climate jobs always say: it will cost too much. Think what "costs too much" actually means. What it will "cost" is millions upon millions of decent, dignified jobs for people who need the work. All those jobs will get the economy moving again.

Another good reason for public jobs is political. Once eight million people have good steady jobs, then all their families and friends and all the workers in the supply line will be a formidable political power defending the Green New Deal.

Once you move beyond the market you can also make quite different decisions about how to cut emissions. At the moment, almost every innovation and measure has to justify itself in terms of competition in the market. And that's often difficult. Renewable energy is expensive. Using electricity for industrial heating is expensive. Building high speed rail is expensive. There are, as we will see, many more such examples. If you make cutting emissions your holy grail, not making profits, you can make different decisions.

A Green New Deal in South Africa

That's how climate jobs would work in the United States. Here is one vision of what the other jobs in a green new deal would look like in South Africa. I quote at length from an article by the Cry of the Xcluded on the *Daily Maverick* website in 2020. The Cry of the

Excluded are an alliance of unions and unemployed workers groups. First they explain why their country needs a million climate jobs. Then they talk about the other two million jobs:

“The epidemic has been a searchlight, so that every injustice and inequality in South Africa stands out against the night. Those inequalities show us what work needs to be done.

“There are so many living in shacks without enough room, without good water, without sanitation. They are completely defenseless in the face of a crisis. We need to build decent housing, spacious, near to parks and work. We need proper water, sanitation and sewage lines. And we want that housing to break the neo-apartheid segregation of the rich and poor.

“There are tremendous opportunities for decent work in building brigades.

“Obviously, we need a decent health service for all, so the poor and rural people also get the treatment the rich do now. Again, this means jobs.

“The community health workers have been heroic, a foretaste of a better future. But they are on casual, precarious employment. They must have contracts and permanent jobs.

“The lockdown has exposed the scale and the number of people living hand to mouth, day to day, with informal and casual work. In the lockdown people went from waste pickers scratching in bins on Day One to no income on Day Two. Never again. People need jobs.

“It is impossible to understand the barbarity, the collapse of the social fabric, the violence to women, the xenophobic attacks, outside of the catastrophe of unemployment. Jobs will not solve all our problems. But we will not solve them without jobs.

“The lockdown has exposed just how many millions of South Africans are going to bed every night extremely hungry, not able to afford a meal. This will continue as long as food production is in the hands of less than 40,000 commercial farmers and four major supermarket chains. We need local food production and local food market. Farm workers face eviction – they need security of tenure. Two million small scale farmers need land reform – not the new layer of commercial farmers who do nothing to break the hold of industrial agriculture. We need food....

“We are now trapped in a minerals and energy economy focused on export. That economy built apartheid. It made the great mining houses and our millionaires rich. That economy is in decline now, and at increasing speed. The minerals corporations grow ever more

desperate for foreign investment to survive. The government grows ever more focused on tempting in foreign investment and currency. That money can, and does, flood out again in an instant, leaving us in currency panics and debt traps.

"We remain, as we have been for more than a century, the playthings and the source of value for the financial empires of Europe and North America.

"We cannot stop this decline without equality in South Africa. Because we can only move away from dependence on foreign exchange if our working people have incomes enough to buy what we make. We need a steel industry again, to produce the steel that will be needed for wind turbines, a new electricity grid and electric vehicles. We need a renewables industry to kick start many other industries. We need plants making electric vehicles of every kind that can run on electricity from renewable sources.

"In short, we need a new green industrial sector.

"And we need to think not of rescuing airlines so foreign tourists can come. We need to ask instead: When can people from Khayelitsha swim in the ocean, walk in the mountains, and stand in awe of our wildlife?"⁵

New Deals in Other Countries

The details of the emissions to cut will vary from country to country, because of geography, size, the shape of the carbon economy, and more. And of course the details of the health, housing and other services will vary from place to place as well. What people will want to do, what they will need, will also vary greatly from one country to another.

Still, I think it is obvious in Britain, my home, that many of the new jobs should go to two areas. The first is health care. The systematic understaffing of the National Health Service has been exposed by Covid 19, but it has been a running sore for years.

The other area is care homes. I have worked in care homes and on geriatric wards in Britain. My mother died in a care home in Massachusetts. In both countries, the thing that makes the most difference to the lives of those who live there is the staffing levels. If there are enough staff, someone talks to you. Someone holds your hand when you cry, gets you to the phone in time when your daughter calls, takes the time to listen when you are distressed, and takes the time to chat when you're just normal. Above all, when you ring, a staff member can get to you before you wet yourself, and sit in helpless humiliation.

All those things that staff with time can do add up to one big thing. The resident is less distressed, less likely to cry out or scream in rage. That means the staff are far less likely to routinely drug residents to the eyeballs with psychiatric medications that make your body tremble and reduce your brain to mush.

So in Britain, certainly, the health service and care homes need help. We could even introduce the National Care Service. In the US the obvious and crying need is for a free and comprehensive health service for everyone. Indeed, health care will be top of the list in many countries.

Some people suggest that we rebrand caring jobs, and childcare, as green jobs. I think this would be a mistake, for two reasons. The first is that it is important to keep the distinction clear between climate jobs and other jobs. Climate jobs are jobs which work directly to halt climate breakdown. If we lost that distinction, it is going to be much harder to stop climate change.

The other reason has to do with the dignity and necessity of other work. The jobs that the majority of people do meet some sort of human need. Pizza delivery and steel mill work are not green jobs, but we need food and steel. To imply that a job has to be green is to insult all the people who deliver pizzas and work in steel.

We need to be careful about words here. Climate jobs are jobs that work directly to reduce greenhouse gas emissions. A New Deal is a package of measures to create jobs in an economic crisis, like President Franklin Roosevelt's New Deal in the 1930s in the United States. A Green New Deal is a combination of the two. It will include climate jobs. But it will also include other jobs that meet human needs, like nursing, care for the elderly, education, the arts, sports and public housing. The deal as a whole is green. But not all the jobs in the deal have to be green. If we insist that they do, we will get lost in word games.

Failing Corporations

There is one more thing to say about new deal jobs, and this relates to all countries. It's a point that is often left out of discussions. The starting point here is the cascade of failing businesses that we are beginning to see. Government policy in most countries seems set on letting the small businesses fail, and rescuing some of the largest and best-connected corporations by giving money to the owners.

There is another way. A new deal campaign could argue that if workers lose their jobs as a company closes, the government should

take over and save those jobs. When I say argue, I don't just mean issue position papers and press releases, although that will also be necessary. I mean that workers should be encouraged to strike and occupy those workplaces. In the present circumstances, an occupation of a car factory by workers demanding a government takeover would become a national sensation in most countries. The moral, and political, force of that occupation would be much greater if the workers say they are part of the Green New Deal, and that they are fighting for jobs for everyone. If there was enough support, and publicity, for the first occupation, the example could spread from workplace to workplace, creating a tsunami that could force governments to act.

Two industrial examples in Britain spring to mind. One is that here, as in many other countries, some airlines are failing and others are laying off many of their workers. The airlines are pleading for government money, and mostly not getting it. Many environmentalists are happy that the airlines are failing. This is a failure of empathy and a political mistake. Airline workers can occupy airports, which would have an enormous economic and political impact.

Better yet if the airline workers were arguing for the kind of limits to aviation expansion I detail in a later chapter – limits that would not endanger their jobs. But airline workers will not argue that way if there is not already a serious and visible new deal campaign that starts from the necessity of backing workers in the old carbon economy no matter what.

The other example from Britain is the universities. The universities are facing financial crisis, particularly because the government's abject failure at dealing with Covid 19 is leading to an exodus of foreign students and the fees they pay. The management reaction is mass layoffs of graduate student teaching assistants and other low-paid, casual teaching staff. This is accompanied, in many cases, by layoffs of permanent teachers and other staff, and it looks likely that some universities will close. The solution is proper government funding of all the universities, of the kind we had twenty years ago. An all-out staff strike and student occupations across the country could win that.

If those strikes and occupations also said, we want the jobs we win to be part of any Green New Deal, so much the better. This would mean, though, that parts of the new deal project were in fact delivered by public sector bodies that were not specifically reducing emissions. This makes sense – part of the purpose of any new deal is preserving jobs.

These suggestions may seem to some readers like fantasies, and utterly out of touch with reality. In one way, that's true. Right now it would be very hard to get workers to support such occupations anywhere. But right now all we need to do is to get the idea out there by every possible means. If one group of laid-off nurses in California, airline workers in Paris or car workers in Chennai occupy, word will spread in that country. If occupations spread across the country, then it won't seem like a fantasy any longer. We can say in Cape Town or Manila, "let's do what they did". Then that will seem normal.

Why I Wrote this Book

I'm a writer. I grew up in the United States and India, and I live in Britain. I have been a trade union activist all my adult life, and in 2000 I got involved in the new global anti-capitalist movement. At the end of 2004 I had finished one book on the anti-capitalist demonstrations in Genoa, and another on what neoliberalism had done to the United States. I was looking around for something else to do. I came home one evening and asked my stepson Ru and my partner Nancy what to write about next.

"Climate change," Ru said.

"Climate change?"

"Climate change," Nancy said.

OK. I thought it would be interesting, and because it was trendy there would be a market for the book. God forgive me.

For the research, I got involved with a climate action group – the Campaign against Climate Change – and started reading. Several months later I began having the same nightmare most nights for months. In that nightmare I was trying to tell some people something, and they were not listening. I tried to scream, but they could not hear.

I had understood from my reading what was going to happen.

I spent the next five years in the Campaign against Climate Change helping to organise global demonstrations at the time of UN climate talks, the COP, each year. Our best year, 2009, we had marches or protests in more than fifty countries.

Along the way, I wrote *Stop Global Warming: Change the World* in 2008, and from 2009 on I spent most of my time working with trade union campaigns for a just transition and climate jobs. I wrote, edited or helped with long reports for unions and campaigns in several

countries up to 2016. I liked the work. I like numbers, facts and details, and I like union people. I feel at home with them. So I became an expert in two things. One was all the jobs people will have to do and the changes we will have to make to stop climate breakdown. The other was how to explain that to union activists.

That took me to the UN climate talks in Paris in 2015. That was a disaster. And the election of Trump in 2016 demoralized the global climate movement even more. Then three things happened.

One was Greta Thunberg started the student climate strikes in 2018. I watched them on television and on the street. Greta was saying that all the leaders of the world had failed utterly, and from here on in, the movement should make no compromise. "Yes", I thought, "yes, yes, yes". The students were striking. I like strikes, and they have changed the world before. And a new generation was on the streets. I could see the future.

The second thing that happened was Representative Alexandria Ocasio-Cortez from New York got the world talking about a Green New Deal. So I started work on this book, to explain to a new generation what I have learned about how climate jobs and a green new deal can work, and what work we will have to do.

The third thing was Covid 19 – an environmental disaster that is leading to mass unemployment. Time for climate jobs. So I've been writing this book like my hair is on fire. I hope you find it useful.

The Plan of the Book

The next chapter of Part One explains the science of climate change – the different greenhouse gases, feedbacks and tipping points. Chapter Three outlines the sources of the different warming emissions. Parts Two, Three and Four explain how climate jobs can reduce emissions from different sectors. Part Two is about electricity. Three is about transport, industry and buildings, and Four looks at farming and forestry.

The rest of the book deals with the politics of climate jobs. Part Five explains why the leaders of the world have done so little to reduce emissions, and points out some of the lessons of the Covid 19 pandemic. Six deals at length with the problem of how to find a fair way to reduce emissions in both the richer countries and the poorer countries. Finally, Seven looks at what will happen if we enter a state of climate breakdown, and suggests some ways we can organize to prevent that.

**HOW
DARE YOU**

Climate striker, Kolkata, India

CHAPTER 2

THE SCIENCE

This chapter starts with the basic science of carbon dioxide, methane, nitrous oxide and f-gases. Then I explain what we know about the various feedback mechanisms in climate change. From there I move on to the complex uncertainties of tipping points. I explain that there will not be one tipping point after twelve years. Instead, there will be several tipping points, and the timing is unknown.

You may well already be on top of all this. If so, you can skip this chapter. But you might want to skim and dip instead, because I am explaining the science in a particular way that anchors the arguments I make later in the book. We need a clear understanding of the problem before we begin designing our solutions.

The Chemistry

Humans are putting four different kinds of “greenhouse gases” into the air. These are the gases that warm the air and power manmade climate change.

Carbon dioxide (CO₂) was responsible for 73% of the total warming in 2019. That is almost three quarters of total warming. The other quarter of the warming comes methane, nitrous oxide and F-gases. We have to cut emissions from all four gases. But we will start with the big one, CO₂. Global warming is basically trees and plants gone bad. Here’s how that works.

Ninety-four elements have been found in nature. Three of those elements are crucial to our story:

Hydrogen (H)

Carbon (C)

Oxygen (O)

Chemical elements can combine into molecules. But each element will only combine with a few other elements, and only in particular ways. Three molecules are crucial to our story:

Carbon dioxide (CO₂)

Water (H₂O)

Methane (CH₄)

Those letters and numbers tell us how the elements are combined. CO₂ is one atom of carbon and two atoms of oxygen. H₂O is two atoms of hydrogen and one atom of oxygen. CH₄ is one atom of carbon and four atoms of hydrogen.

(From here on we will write CO₂, not carbon dioxide.)

When plants or trees go right, they take up water through their roots and CO₂ from the air through their leaves. Then the plant or tree uses the energy of sunlight to combine the H₂O and CO₂ into "carbohydrates".

Carbohydrates are the basic building blocks of plants. They come in many forms, but they all contain carbon, hydrogen and oxygen. You probably already know carbohydrates. They are the plant-based bread and pasta you eat on a high carb diet. And they are the carbs you avoid on a low-carb diet. You can have too much carbohydrate, but you cannot live without some carbs.

Eventually the plant dies and the carbohydrates break down. Sometimes this happens when plants or trees burn. Then the energy from the sun that held the carbohydrates together is released. That is why a forest fire is hot – it's the energy of the sun going back into air. Then the carbon in the carbohydrates combine with oxygen in the air to make CO₂, which escapes into the air.

The plants grow, the plants die and break down. It's a circle. CO₂ in, CO₂ out. Like breathing. Nothing has gone wrong yet.

Of course, plants and trees don't usually burn. Mostly they die and then something eats them – bacteria, fungi, tiny bugs, larger insects, animals or people. Chemically, the process is the same as

burning. The carbon in the plants and trees combines with oxygen to make CO₂, which escapes into the air. When the carbohydrate breaks down like this, it releases the trapped energy of the sun. That energy feeds the bugs or animals. It's what we call calories.

It's still a circle.

At various times in the history of the Earth, carbohydrates have become trapped under the crust of the Earth. The carbohydrates were compressed over time and turned into three "fossil fuels":

Coal is almost pure carbon.

Oil is a complex combination of hydrogen and carbon, a "hydrocarbon".

Natural gas is another hydrocarbon. It's almost all methane – CH₄.

Still nothing wrong, because coal, oil and natural gas were trapped under the crust of the Earth for hundreds of millions of years.

But here's the problem. We human beings began to dig them up and burn them. Lots of them. First coal, then oil and then natural gas.

We have seen that when plants break down, they release the stored energy of the sun. The same thing happens when we burn coal, oil and gas. These fossil fuels are the stored, concentrated, powerful energy of hundreds of millions of years of trees and plants. And we have been burning through them steadily for two centuries.

When we burn fossil fuels, the carbon in them combines with the oxygen in the air to produce CO₂. It's the same process as when plants burn or decay. But it's immensely speeded up.

In 2018 humanity put a global total of about 40 billion tons of CO₂ into the air. Roughly a quarter of that CO₂ went right back into plants and trees. Another quarter went into the oceans immediately.

The remaining 20 billion tons of each year's pulse of CO₂ remains in the atmosphere for a long time. Gradually, over decades, that remaining CO₂ combines with carbonate ions in the oceans to form bicarbonate.

This process should take about 100 years to dispose of most of the CO₂. But there is a snag. We are now putting so much CO₂ into the air so quickly that there are not enough carbonate ions in the ocean to absorb all of it. The result is that some of the new CO₂ is going to remain in the atmosphere for a very long time indeed.⁶

So after about 50 years, there will be 10 billion tons in the air. After 100 years, about 6 billion tons will remain. And that 6 billion tons can take centuries, or even tens of thousands of years, to dissipate.

Let's put that in a table:

How much CO₂ remains in the atmosphere, in billion tons

Annual emissions	40 billion tons
Into vegetation	10
Into oceans	10
Remaining after one year	20
Remaining after 50 years	10
Remaining after 100 years	6

And those 6 billion tons of CO₂ can remain in the atmosphere for thousands of years, or longer.

The more CO₂ there is in the air, the hotter the air gets. We know this from basic physics. CO₂ in the air only traps heat in one direction. The CO₂ allows the rays of sun to pass through on their way to the surface of the earth. The heat from the sun is then reflected back from the surface of the Earth into space. But that heat is reflected back as infrared light. CO₂ blocks that wavelength. So the more carbon dioxide there is in the air, the more heat gets trapped.

The atmosphere of Venus is 96% CO₂. A human being on the surface of Venus would burn in seconds. Jupiter has almost no CO₂. The air on Jupiter would freeze you in seconds. Humans and the planet we know need just the right amount of CO₂ in the air.

Other Greenhouse Gases

Sometimes the plants or trees die in a place where there is no contact with air. That means there is no oxygen to make CO₂. Examples would be underwater in lakes or swamps. But nature is resourceful. Bacteria or bugs eat the plants and trees, and they mix the carbon with the hydrogen in water to make CH₄. This is called methane, and it's the main ingredient in natural gas.

Methane is a much stronger greenhouse gas than CO₂. Crucially, it works much more quickly. Over a period of 100 years, one molecule of methane has 25 times the impact of one molecule of CO₂. So in the first twelve years in the air, methane has 200 times the impact. But methane stays in the air for an average of only 12 years. As we have seen, CO₂ stays in the air far longer.

The two other greenhouse gases are nitrous oxide and the family of F-gases. Nitrous oxide – laughing gas – comes mainly from the

use of fertilizers and manure, and is responsible for about 6% of total man-made warming emissions each year. F-gases are mainly used in refrigeration and computers, and account for 3% of total emissions.

The Fierce Urgency of Now

Scientists have looked at the fossil record and drilled down into glaciers, ice sheets and the ocean floor. What they have found confirms what we would expect – that the more CO₂ there was in the air, the warmer the Earth was. And the less CO₂, the colder.

For at least the last 800,000 years, the Earth has gone back and forth between two steady states of climate. One state was an ice age. Snow and ice covered half the land area of the planet, winter and summer. The level of CO₂ in the air was a steady 180 parts per million.

That number means that 180 out of every million molecules in the air was CO₂. That's just a bit less than 2 molecules in ten thousand. But a small amount of CO₂ in the air makes a big difference. For the moment, the important thing to remember is that number – 180.

The other steady state was a warm state. Year-round snow and ice were limited to the polar areas and the high mountains. That's how the world was in the year 1750, before we really started burning fossil fuels. The level of CO₂ was 280 parts per million. That's 100 more parts than an ice age.

Why did an ice age turn into a warm age? The answer is a bit complicated. But basically, it was the result of gradual small changes in the orbit of the Earth around the sun. The result was changes in the amount of sunlight hitting the Earth, where it hit the Earth, and the angle of the sunlight as it hit.

When the sunlight increased, some of the snow and ice began to melt and become water vapour. With that, there was more CO₂ circulating in the atmosphere. As sunlight increased, so did CO₂, and both of them warmed the world. That continued until a new steady state was reached.

It worked the other way too. When the effects of the orbit changed again, the impact of the sunlight was less. Growing ice and snow meant less CO₂ in the atmosphere. The world cooled until a new steady state was reached in a new ice age.

Then we started burning coal, oil and gas. In 1750 there were 280 parts per million of CO₂ in the air. That level had been steady for 10,000 years. In 2020 there will be 415 parts per million.⁷

Here is how the levels of CO₂ in the air changed:

Parts per million of CO₂ in the atmosphere

<i>Year</i>	<i>Parts pm.</i>
Ice Age	180
1750	280
1952	313
1984	347
2004	380
2020	317

Let's think about those numbers. The difference between an ice age and a warm period was 100 parts per million. The difference between the beginning of the fossil fuel era in 1750 and now is 137 parts. We are pushing the system far, far faster than we have ever happened before. Here are the figures for the speed of change:

Increase of CO₂ in the atmosphere in parts per million

<i>Period</i>	<i>Years</i>	<i>Increase</i>
Ice Age to 1750	13,000 years	100 ppm
1750 to 1952	202 years	32 ppm
1953 to 1984	32 years	35 ppm
1985 to 2004	20 years	33 ppm
2005 to 2020	16 years	37 ppm

One quarter of the increase in CO₂ levels took place between 1750 and 1952. That was 202 years. The second quarter of the increase took place between 1952 and 1984 – that is, in 32 years. That is seven times the pace of the two centuries before.

1984 was four years before organised scientists began to warn the world of what they saw coming. The UN brought together the governments of the world at the Rio Conference in 1992, and they promised to do something.

The third quarter of the new change took place between 1984 and 2004. This took only twenty years. The pace was increasing. It was now ten times the pace of the first two centuries. This happened as the leaders of the world were all signing pledges to do something.

The fourth quarter of the new change happened in the sixteen years between 2004 and 2020.

If the rate stays steady now, and does not increase, we will reach 480 parts per million by 2049. By then we will have added 200 parts per million. That's double the 100 parts between an ice age and a warm period.

However, the last fifteen years have also been the time of peak climate bullshit. Most of the leaders of the world have told us how hard they are trying to reduce emissions. They have told us it is the greatest threat to the future of humanity. Many have set goals for 2050, or even 2040. The results of the UN climate conferences each year have been hailed as steps forward. And all the time we have been moving backward.

It's not that the leaders of the world have failed. It's worse than that. Their actual policies have made things worse, faster. We can argue about the details of which policy had what effect. But the cumulative effect is clear and incontrovertible. That is what the rising CO2 levels are telling us.

There is a political lesson here. We need to replace the current leaders and rulers of the world, and we need to do so quickly. The next section explains why climate feedbacks and tipping points make the situation even more urgent.

Feedbacks

There is confusion in the minds of many climate activists about feedbacks, tipping points and how long we have to act. What many people have been encouraged to believe is wrong. So I am going to spend some time explaining these matters. Bear with me. Here's how scientists were alerted to the problem of climate feedbacks:

By the 1980s scientists understood that climate change was a clear and present danger. So they knew that they had to find out how quickly climates had changed in the past. The best place to find the data they needed was Greenland. Most of that country was covered in ice, in some places two miles thick. Two scientific expeditions, one European and one from the USA, began drilling down through the ice pack.⁸

The winter ice in Greenland was a different colour from the summer ice, and had a different chemical composition. As the scientists drilled down, they could see the contrast of winter and summer in lines like tree rings. They could count the yearly rings back two hundred

thousand years. Not perfectly – there was slush, melting and bending. But pretty well.

The scientists found air bubbles trapped in the ice. From those they could tell the levels of CO₂ and methane in the air each year. They also found pollen blown by the wind onto the snow. From that they could tell what sort of plants were growing nearby, and therefore what the climate was like. And they found ways of measuring traces of the temperature when the ice was first laid down.

Using all these techniques, they were able to build a picture of the temperature rise. They knew what they were expecting to find because they already knew how the world warmed and cooled.

The scientists on the ice cap knew the temperature changed because of small changes in the way the Earth moved around the sun. There were three different kinds of changes in the Earth's orbit. One change took 25,000 years, one took 41,000, and the third took 100,000. Together, these small changes in the orbit created small changes in the ways sunlight hit the Earth. And those changes in sunlight changed the amount of vegetation, and where the plants and trees grew. That in turn changed how much or how little CO₂ plants emitted, which changed the level of CO₂ in the air. And that, as we saw, warmed the air.

That sounds complicated, but the scientists understood it well. So they expected to see a gradual change in CO₂ levels and temperatures in the Greenland ice record. What they saw instead frightened them.

In some ways the Greenland data matched what they had expected to find. In the times when the world cooled, both CO₂ and temperatures went down gradually together. As the world warmed, CO₂ and temperatures also started changing gradually. Again, they were in lock step. Surprisingly, methane levels were also changing in lockstep with CO₂ as the world cooled and warmed. The scientists did not know why.

But then the data showed a sudden increase in temperatures and CO₂ levels. This change was measured in tens, not thousands, of years. The scientists found this kind of sudden change in 24 out of 24 of the warming periods in the Greenland ice record. Later drilling in the ice of Antarctica also revealed a record of sudden changes as the Earth warmed back to 800,000 years ago.

The scientists understood what those sudden changes meant. Some kind of feedback effect greatly speeded the process when the

Earth warmed from an ice age. They did not know what the feedback effect was. They still don't know.

What they do know is there will be feedback effects from global warming this time too. And because the process is so much faster this time, those feedback effects will probably come sooner and move faster. But they still don't know what feedback effects will be most important, or when they will kick in.

Of course, as soon as the results came in from Greenland, scientists began to imagine what the feedback effects might be this time. Once they imagined the feedbacks, they began to look for them. It turned out almost all of them were already happening. But so far they don't know how fast those feedbacks will move. And they don't know which ones will be most important. That's why we can still can't put a date on when things are going to get really bad.

At least eight possible feedbacks have been identified: the albedo effect, forest die-off, melting permafrost, gas hydrates, the clean air effect, land sinks, ocean sinks and ice crystals in clouds.⁹

Let us very briefly look at each in turn.

One) The albedo effect. Snow and ice are dazzling white. They look white because they bounce back all the rays of the sun, and all the colours of the rainbow. When snow and ice melt, they are replaced by dark seas, dark tundra and dark Northern forests. They look dark because they absorb most of the rays of the sun.

When snow and ice bounce sunlight back, they keep the surface of the Earth cool. When seas, tundra and forests absorb the sunlight, they warm the air above the surface. As climate change warms the Earth, the melting snow and ice increases that warming. As that warming increases, more snow and ice melts, and so on.

That's a feedback. It's called the "albedo effect," and is already happening on a large scale.

Two) Forests die. As the atmosphere gets warmer, forests begin to die. They also begin to burn more. In both cases, the carbon in the trees and the soil goes into the air as CO₂. That warms the air further all over the world. And so forests die more quickly, and more CO₂ enters the air. The world warms more quickly still, and forests die faster. And so on.

This feedback has begun happening on a small scale. For the moment, human tree cutting is more important.

Three) Melting permafrost. In the far north of Eurasia and Canada there are enormous amounts of permafrost, land permanently frozen,

winter and summer. As the world warms, that permafrost begins to melt. In the permafrost there are large amounts of frozen methane. That methane melts too, and the gas bubbles into the air. Methane, we have seen, is a much stronger greenhouse gas than CO₂. Crucially, it works much more quickly. That makes any permafrost feedback dangerous. Recent research by Edward Schuur and colleagues, however, has found that the carbon released from the frozen soil and peat will probably have a greater warming effect. They suggest that this process is likely to take decades – not years, but also not centuries. The permafrost has already begun to melt.¹⁰

Four) Gas hydrates. These are frozen methane deposits found in the Arctic Ocean and other northern seas. Some of these underwater methane deposits are on the continental slope, and some on the sea floor. They have been frozen for hundreds of thousands of years, and they are mostly quite far under the ocean surface. But as the sea warms, the methane will melt and bubble up into the air.

That will warm the air, and in turn melt more frozen methane undersea, which will release more methane. And so on. This is already happening. Russian scientists have reported large explosions and plumes as melted methane gas hits the surface.¹¹

So far this is only a tiny portion of the frozen methane undersea. Most of the methane released is eaten and broken down by bacteria before it reaches the surface. But if much of the frozen methane melts, that would be the worst of all the feedbacks. It's not impossible, but most scientists currently think it is very unlikely.¹²

Five) The clean air effect. Burning coal puts a lot of dark particulate matter in the air. You can see it in the smog in India and China. Those dark particles block sunlight and keep the air cool. It's called "global cooling". But as we begin to do something about climate change, we will burn less and less coal. Ironically, that will make the world warmer, because the air will become clearer and let in more sunlight. We can't keep burning the coal, though, because the CO₂ from the coal is a much bigger problem than the clean air effect.

This is not, strictly speaking, a feedback. But it will increase the effect of the other feedbacks.

Six) The land sink. At the moment half of the CO₂ we put into the air stays up in the atmosphere. But half of it disappears almost immediately into two "sinks". One of these is into vegetation – plants and trees – on the land. The other sink is the ocean.

Without these sinks, we would already have had an enormous increase in CO₂ in the air. Over the last fifty years, luckily, the land sink has kept pace with CO₂ levels. Fifty years ago, plants and trees took half the CO₂ out of the air. Today they take half of a much larger amount of CO₂ out of the air. That has been good for the growth of forests and harvests. The crops and vegetation grow more and more lush. This has happened especially in the middle latitudes.

But at some point, the plants and forests will not be able keep absorbing more and more carbon. We will hit the limits of the other nutrients plants need, above all water. And the rising heat will begin to cut back on the harvests and forest growth – and make them need more water.

Seven) The ocean sink. This sink works in several different ways. But basically, about one half of the global carbon sink is CO₂ going from the air into the ocean. This is a physical process. Where the ocean meets the atmosphere, there is constant adjustment so that there is roughly as much CO₂ in the water and the air.

Then, as we have seen, over decades the remaining CO₂ in the air gradually combines with carbonate ions in the ocean to form bicarbonate. But in future this process will not work completely, because there are not enough carbonate ions in the ocean for the levels of CO₂ we are emitting.

That is one problem. A larger problem is that the more CO₂ there is in the ocean, the more acidic the water becomes. As the ocean becomes more acidic, more and more of the carbonate ions are broken down, and less and less bicarbonate is formed. Past a certain point, the ocean will become too acidic for bicarbonate to form at all. At the moment the ocean sink is still working. But the water is becoming more acidic, so we are gradually approaching a breaking point.

Eight) Clouds hold a lot of water. The warmer the air, the more water the clouds absorb. Some of that water is in the form of ice crystals. They partly bounce back the rays of the sun, and keep the air cooler. Some of that water is in liquid form, and lets the sun through. The warmer the air, the fewer the ice crystals in the clouds.

We don't know if this is happening yet. We do know that scientists have recently discovered there is a much lower proportion of ice crystals in clouds than they had expected. More worryingly, many of the computer models being developed for the 6th IPCC report, due in 2022, are showing changes in cloud cover that are likely to lead to

temperature rises of 5 degrees or more. This would be from the level of emissions that has previously been expected to produce rises of 3 degrees. This is ominous. It is not clear yet how reliable these models will be, but the signs are worrying.¹³

I have just listed the big potential feedbacks. There are others, but for the moment they don't seem as serious. Of course more may be discovered.

But the biggest problem is the feedback of feedbacks.

Each of these feedbacks will warm the air. And as the air warms, each of these feedbacks will get worse. So each feedback reinforces the others. At some point the spiral will reach a point where change could come very fast indeed and is irreversible when it does. The usual name for this is the "tipping point."

Tipping points

Hang on, though. When we talk about tipping points, we need to be careful. People often say that if we don't act in the next twelve years, we will hit the tipping point. After that we're goners, and there will be no point in doing anything.

However, feedbacks, tipping points and irreversible change are three different things.

A tipping point happens when a gradual change becomes a sudden change. One example is boiling water. You gradually heat water, degree by degree, until suddenly a tipping point is reached and it boils. But this tipping point is not irreversible. If you cool the air, the steam condenses back into water.

So, not all tipping points are irreversible. Moreover, we can have irreversible change without any tipping points. A good example is the global warming humanity has already created. On any time scale that matters to the next few generations, that warming is a done deal. It's not reversible. The best we will be able to do is to prevent things from getting much worse.

Climate commentators also use the word "tipping point" to mean two different things. An example of the first way would be to say that we will pass a tipping point and then the Arctic will be free of ice in the summer. That is a tipping point for the state of Arctic ice. But it is not a tipping point in a feedback.

An example of a tipping point in a feedback would be the point where frozen methane releases from Arctic soil and under Arctic waters grow so strong that they heat the atmosphere on a scale of

years, not decades. Then the Artic land and undersea methane melt far more quickly, and we are in runaway climate change territory.

When people say tipping point they usually mean the first sort of point, which has an effect on something important, but does not create a runaway warming feedback. Then they assume that this actually means runaway change, and game over.

Moreover, we have no firm idea of the timing of runaway change. Remember, we don't know which feedback or combination of feedbacks caused the rapid increases after the ice ages. We don't know if it will be same feedbacks now. We don't know how fast each of the feedbacks will move. We don't know when each will move into high gear. We don't know which of the feedbacks will be most important. And we don't know at what speed they will reinforce each other.

We do know that there are feedbacks and will be more. But so far we have no idea of the timing. Maybe we have 20 years, or 50 years, or more. It's not just that we don't know yet. We can't know, because this has never happened before.

This is a serious matter. And when we humans don't know something serious, it is dangerous to pretend we do.

But not knowing makes people anxious. So faced with uncertainty, people often guess. Climate activists are particularly tempted to make dark guesses. One reason is that we want people to act. We know humanity has to act fast. It's easy to be frustrated with how slowly everything moves. That means it's all too easy to scream the worst thing you can think. That way maybe you can get people to move.

Another reason for believing the worst is that many climate activists, deep down, don't think people are worth much. Sure, they love individual people. But they don't think much of people collectively. So they think people will be too selfish or short sighted or stupid to do what needs to be done. They assume people will only act out of fear or anger.

There's yet another political problem. For hundreds of years the people who don't want the world to change have said it is too hard to change anything. The people who want change, the "left", have insisted that we can fight back and win. In the last thirty years many of the people who identified themselves as on the left have begun to agree with the right. Many of them now think that the system is too powerful for us to change anything. If you say this very fast, and shout when you say it, and use lots of examples, and show how much you hate the system, this hopeless rage can sound left wing. It is not. It becomes a helpless cry, one that works against change.

Be Careful

It is possible there will be one decisive tipping point, after which the process will spiral endlessly out of control. But it is much more likely there will be a series of tipping points. Each of those tipping points will make the next one come sooner. The tipping points will cascade. Things will get much worse. Then they will get worse than that. Then much worse than that. But there will not be a point where it will make sense to stop trying to limit the damage.

We need to choose our words carefully here. People often say that if we do not act in the next twelve years, we will do irreversible damage. That's true. Indeed, there is already irreversible damage in many places. But that is different from saying that there is only one tipping point and it will happen in twelve years, so why bother after that?

An example will help to tease out some confusions here. Myles Allen is a professor of geophysics at the University of Oxford. He is an important climate scientist, one of the two lead coordinating authors of the UN Report on 1.5 degrees of climate change in 2017. Allen is on our side. When the school students went on strike in Oxford, Allen went down to talk with them. He was elated they were striking. It gave him hope.

The school students told Professor Allen that we have only twelve years to act. After that, we will slide into "irreversible climate chaos."

Professor Allen knew that was not true, because he was one of the two main editors of the report the students were relying on.¹⁴

On one level Professor Allen was entirely right to be annoyed. He had spent decades trying to alert the world to danger. That was the whole point of his report. If the students wanted to base what they were saying on the science, they had to listen to the science.

But the students had reasons to be suspicious too. Every time a new report comes out from the IPCC, we discover that things are much worse than they were. More important, we discover that the predictions have become worse than they once were. The scientific reports have been consistent in under-estimating the dangers. And under-estimating them by a lot.

I will return to the reasons for these mistakes at length in the chapter on *The Politics of Confusion*. For the moment, my point here is that Professor Allen and the striking school students were talking about two different things. He was talking about how long we have to prevent the world heating more than 1.5 degrees above the temperature in 1900. That is what his report was about. The main

point of the report was that a world 2.0 degrees hotter than it was in 1900 would be a great deal worse than a world 1.5 degrees hotter, and that we would not be able to fix that damage.

The students were talking about the tipping point, where the pace of change suddenly starts to speed up and multiple feedbacks reinforce each other, and the world starts to heat much faster. So they were at cross purposes.

These are two different states. Over 2.0 is bad, but runaway change is much worse.

This distinction matters because there are serious problems in telling people that if we don't act in the next twelve years all is lost.

The first problem is you don't know that. You can't point to a scientist who says that. That means when challenged you can only get angry, but you can't argue.

The second problem is that most people don't believe we can put together the necessary movement in twelve years to make the changes we need. For those people, saying we only have twelve years is not a call for action. It's a call for not trying. And that problem is worse if you say, as many do, that we have to act in the next two years, or the next five.

The third problem comes in twelve years. If we have not hit an endless spiral then, people will stop believing you.

What we have to do is accept the reality. We don't know. The odds are things will be worse than the scientists predict. We don't know how much worse. We don't know when. We can't know.

We also don't know how fast we can build mass movements all over the world to make the governments act. Or more likely, replace them. We are up against almost all the established powers on the globe.

We have to push as hard as we possibly can, right now. That is why this moment of economic crisis is such an important time for Green New Deals. But we must also be prepared for a long and desperate struggle.

**DON'T BE
A TRUMP**

*Primary school climate striker
Hong Kong*

CHAPTER 3

EMISSIONS

Some of the best books on climate change start from anti-capitalism, or from socialism. Some good books start from the relationship between humanity and our environment, and some from our relationship with other animals. Some are concerned with the planetary limits to growth, the metabolic rift or the Anthropocene. Some are centrally engaged with an argument between reform and revolution, and others start with the role of trade unions in a just transition.

I have learned from all these approaches. But here I start with the emissions which are warming the world and where they come from. Then I go through, in some detail, what we need to do to cut each kind of emissions as swiftly as possible. I spend time on the solutions that will cut emissions the most, and on the priorities that come from the science, and not on the ones that are most important politically. I do it that way because it makes sense. It begins with what the scientists explain is true for everyone, not from the different political perspectives we each have.

And I do it that way because I have learned from experience. Between 1988 and 1994 I was an HIV counsellor in the UK, before we had the retroviral drugs which save lives now. What I learned from how gay men responded to that epidemic is where I begin here.

When the HIV epidemic started in the US, the first instinct of many activists was to downplay the risk and defend the bathhouses in order

to protect gay men from stigma and persecution. This rapidly gave way to a different approach, pioneered by men in the United States who were dying or at risk.

Those men created communities by caring for friends who were ill, and by reaching out to others, especially lesbians and family members. Gay men also invented safe sex which saved countless lives. They celebrated the joy of many kinds of sex, but also included the injunction to use a condom. Gay men and lesbians then built a mass direct action movement that forced the US government to fast track research on anti-viral drugs.

When those drugs were finally developed, the great majority of people with AIDS in Eastern and Southern Africa could not afford them. But gay men in South Africa were instrumental in founding the Treatment Action Campaign. Soon the activists in that campaign were mostly black, working class HIV positive women. They launched a mass struggle, using every tactic that came to hand. They eventually won free drugs for South Africans, and for many Africans in other countries too.

These exemplary campaigns did far more to strengthen gay communities and fight prejudice and racism than downplaying the threat of HIV and AIDS could ever have done.

Covid 19 can teach us the same lessons about how to fight climate change. Faced with a novel coronavirus, the point was not to prove that capitalism causes epidemics, or that the planet is out of joint. The point is to find the ways to stop this virus and force employers and governments to move with speed.

The lessons of HIV and Covid 19 can be applied to climate breakdown. The key to stopping climate change will be stopping the emissions which cause climate change as fast and efficiently as possible.

Numbers

You don't need algebra or calculus to read this book. You mostly just need to be able to add and subtract. Sometimes there is a bit of multiplication. I have rounded almost all the numbers too. I don't say the population of the world is 7.75 billion people, for example. I say 8 billion instead – not to exaggerate, but to make it easier to get our heads around what is involved.

As a bonus, we can avoid what scientists call "false precision." Maybe there really were 2.97 billion tons of methane leaks globally last year. Maybe more, maybe less. So we say 3 billion tons.

False precision deceives you about what we know, and what we don't. Avoiding false precision has a terrific upside. It's easier to use and remember round numbers. You can add them, subtract them, divide them. You can get a feel for what those numbers actually mean. And these are skills we need to make sense of everything we read about climate change.

The Sources of Emissions

We need to cut CO₂ and other warming emissions deeply and quickly. But how?

To answer that question, we have to look at the whole pattern of emissions to see what needs to be done. That will also tell us where most emissions are coming from, because that's where we need to concentrate our efforts.

There are four greenhouse gases warming the Earth – carbon dioxide (CO₂), methane, nitrous oxide and F-gases. Scientists measure emissions each year in tons. But methane, for example, is much more powerful than carbon dioxide. So scientists don't usually say one ton of methane emissions. Instead, they say one ton of CO₂ equivalent (or CO₂e). That means the amount of the methane that has the same warming effect as one ton of CO₂.

Writers on climate often say that methane is a much more powerful greenhouse gas than CO₂. This can be confusing. A bit more explanation may help.

One molecule of methane has a much more powerful effect than one molecule of CO₂. Remember, CO₂ warms the earth by letting sunlight from space go through to the surface of the Earth. Then CO₂ traps infrared radiation coming back off the Earth, heading for space. The CO₂ reflects that infrared back down to the surface, warming Earth. Methane does the same thing. But the particular physical structure of the methane molecule means it reflects a much larger portion of the infrared back down to Earth.

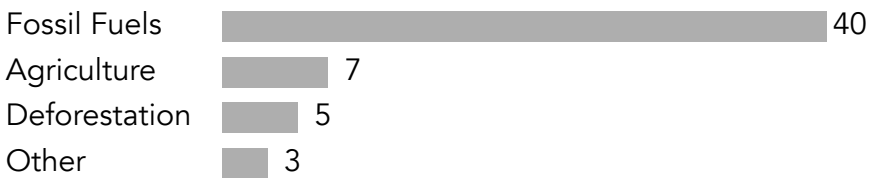
That makes each methane molecule much more powerful. But there is far less methane in the atmosphere. CO₂ in the air is measured in parts per million. Methane is measured in parts per billion. When we say one ton of CO₂ is also one ton of CO₂ equivalent (CO₂e), we mean 1,000 kilos of actual CO₂. When we say a quantity of methane is one ton of CO₂e, we mean that about 40 kilos of methane have the same effect as 1,000 kilos of CO₂.

Here are the total annual emissions in billion tons of CO₂ equivalent:

Global emissions in 2018 in billion tons of CO₂e¹⁵

Burning Fossil Fuels	40 billion tons
Manufacturing electricity	15
Transport	10
Heating industrial materials	5
Natural gas leaks	4
Industrial byproducts	3
Heating buildings	3
Agriculture	7 billion tons
Cattle and sheep	3
Fertilizers	3
Rice	1
Other	8 billion tons
Deforestation	5
Landfills and Sewage	1.5
F-gases	1.5
TOTAL	55 billion tons

Bar Chart: Total Annual Emissions, in billion tons



Reducing fossil fuel emissions is two-thirds of what we have to do. Agriculture is just over an eighth of the total. Not cutting down trees is about a tenth. But we are going to have to try to reduce emissions in every area.

Methane

To understand the difference cuts in emissions will make, we have to explain why methane emissions are different.

We have seen that when plants and trees decay in places without oxygen, the carbon combines with hydrogen to make methane. Nowadays methane escapes into the air from landfills, sewage systems, rice paddies, the stomachs of cattle, and natural gas leaks.

There is one key difference between methane and CO₂. When methane goes into the atmosphere, it stays there for an average of 12 years. That means that if we can cut the amount of man-made methane emissions in half, pretty soon we have cut the total amount of man-made methane in the atmosphere by half. Cutting methane emissions would reduce the amount of the gas in the atmosphere, so the world heats less.¹⁶

CO₂, on the other hand, stays up in the air for a long time. When CO₂ emissions go into the atmosphere, about half of the total is absorbed into the ocean or taken up plants and trees on land. The other half of that CO₂ stays in the atmosphere for a very long time, some of it for centuries or thousands of years.

So cutting man-made CO₂ emissions to almost zero can stop the world growing hotter. But it won't make the world cooler. Cutting methane emissions can do that.

However, cutting methane emissions on their own only buys some time. If we cut methane emissions in half and still keep pouring CO₂ into the air, then the CO₂ levels keep rising. Pretty soon the CO₂ is high enough to cancel out all the effect of cutting the methane emissions. The temperature is back to where it was. And after that the temperatures will keep rising.

Reducing methane emissions only buys time to get our house in order. But our house is on fire, and we need that time.

There are two other, less important, greenhouse gases – nitrous oxide and the family of F-gases. They also stay up in the atmosphere for a long time. Basically, they have the same long-term effects as CO₂. When we are counting the effects of reductions in emissions, we will count methane in one table, and CO₂, nitrous oxide and F-gases in the other.

Now let's look at methane emissions in more detail. The different sources of methane in 2018, measured in billion tons of CO₂ equivalent, are as follows:

Global methane emissions

Natural gas leaks	4
Cattle, sheep and goats	3
Landfills and Sewage	1.5
Rice paddies	1
TOTAL	9.5 billion tons of CO₂e ¹⁷

This table only includes the emissions of methane that result from human activity. The rest are the emissions of methane from decaying trees and plants, and from the digestion of wild animals. These happen without human intervention, and were happening before this bout of global warming began. These natural processes still produce about one third of the methane in the atmosphere now. We will ignore them, because they were here before us, and will continue even if we reduce all the man-made methane emissions to zero.

As you will see in later chapters, if we try very hard, we can probably reduce those man-made emissions as follows:

Reductions in methane emissions, in billion tons of CO₂ equivalent

	Before	After
Natural gas leaks	4	0.25
Cattle, sheep and goats	3	1.50
Landfills and sewage	1.5	0.50
Rice paddies	1	0.75
TOTAL	9.5	3 billion tons ¹⁸

That is a reduction of more than two thirds in methane emissions. How much difference will it make? Michelle Cain and Myles Allen of Oxford University put it this way. They suggest we treat a methane emissions reduction of one ton of CO₂ equivalent as having the same effect as a one-off reduction of 100 tons of CO₂. But that's a one-off reduction.¹⁹

If we can reduce methane emissions by 6.5 billion tons a year, 70%, we have a one-off reduction equivalent to 650 million tons of CO₂.

Long-lasting gases

Now let's look at the possible reductions in CO₂ and the other long-lasting gases – nitrous oxide and F-gases.

At the moment these emissions each year are, in billion tons of CO₂ equivalent:

Long-lasting emissions each year in billion tons of CO₂e

Manufacturing Electricity	15
Transport	10
Industry	8
Deforestation	5
Heating Buildings	3
Fertilizers	3
F-gases	1.5
TOTAL	45.5 billion tons of CO₂e a year²⁰

In this book I show how we can reduce those emissions as follows:

Possible reductions in emissions, in billion tons of CO₂e

	Before	After
Manufacturing Electricity	15	0.5
Transport	10	2
Industry	8	2
Deforestation	5	0
Heating Buildings	3	0
Fertilizers and manure	3	1.5
F-gases	1.5	0
TOTAL	45.5	6 billion tons

That's a reduction in global emissions of 87%.

Forests

There is one final, important, step we can take. We can plant new forests to replace almost half of the trees humanity has cut down since the invention of farming 12,000 years ago. That will take CO₂ out of the air. The effect will be the same as a one-off reduction of 370 billion tons in emissions.²¹

It may also be possible to change farming and grazing methods so we can store more carbon in the soil. There is a great deal of disagreement over how much difference this could make. I explain why in Part Four on *Forests and Farms*. It is difficult to be precise, but my estimate is that soil carbon will have the same effect as a one-off reduction of 100 billion tons of emissions.

Carbon Budgets

So, in this book I explain how to cut emissions of methane and long-lasting gases, and how to remove CO₂ from the air by planting forests. To see how all three strategies will fit together, we need to understand carbon budgets.

The idea of explaining risks in terms of climate budgets has been gaining ground among scientists. The turning point came in 2018, when the IPCC issued their authoritative 600-page report on the dangers of a temperature increase of more than 1.5 degrees Celsius (2.7 Fahrenheit) since 1900.²²

The IPCC scientists explain carbon budgets like this:

Let's say we put another 290 billion tons of CO₂ into the air after 1 January 2021. Then there is a 33% chance the average global temperature increase since 1900 will be more than 1.5 Celsius. That's not 290 billion tons per year. That's a grand total of 290 billion tons over the next century, or longer.

If we put a total of 450 billion tons of CO₂ into the air, there is a 50% chance that the increase will exceed 1.5 Celsius. And if we put 710 billion tons into the air, there is a 67% (two-thirds) chance the increase will exceed 1.5.

Here are those numbers in a table. The IPCC estimates were for emissions after 1 January 2018. That horse has left the stable, so I have adjusted their numbers for starting from 1 January 2021.

Will we exceed a temperature rise of 1.5 Celsius?

290 billion more tons	possibly (33%)
450 billion more tons	50-50
710 billion more tons	Probably (67%) ²³

Remember, at the moment global emissions of CO2 and other long-lasting gases are 45.5 billion tons a year. At that rate, maybe we will exceed 1.5 Celsius in five years. There is a 50-50 chance we will exceed 1.5 in ten years. Probably we will exceed it in fifteen years.

Not good. That’s what will happen without climate jobs and Green New Deals.

The IPCC also made estimates of the carbon budget before we exceed a rise of 2.0 degrees Celsius (3.6 Fahrenheit). Here are those numbers in a table:

Will we exceed a temperature rise of 2.0 Celsius?

980 billion more tons	Maybe (33%)
1370 billion more tons	50-50
1900 billion more tons	Probably (67%)

Those figures mean maybe we will exceed 2.0 degrees in 20 years, and probably we will in 37 years.

The first thing to say is that these are consensus estimates by the IPCC. There are a lot of other estimates out there. Some are more hopeful. Recent work suggests, however, that the effects of clouds on temperature rises means these IPCC figures are altogether too hopeful. At this point, we don’t know. But we will go with these figures.²⁴

The IPCC also makes allowances for the possible effects of feedbacks. They estimate that feedbacks will reduce the allowable carbon budgets by 100 to 300 billion tons. There is something a bit strange about estimating nonlinear processes. But for the moment we will use these numbers.²⁵

Now let’s calculate the effects of our proposed emissions reductions on these carbon budgets.

Let’s imagine that green new deals of the kind I propose here have begun in most of the countries of the world by 1 January 2025. Critically, this has to include massive climate jobs projects in China and the United States by then. (This is a big assumption.)

I will give the figures first in a table, and then explain the calculations. Remember, my aim is to show how we can:

- Cut annual emissions of CO₂ and other long-lasting greenhouse gases from 45.5 to 6 billion tons of CO₂e.
- Cut methane emissions so we have the equivalent of a one-off reduction of 650 billion tons of CO₂ emissions.
- Plant new forests so we have the equivalent of a one-off reduction of 370 billion tons of CO₂ emissions.
- Change farming practices to store more carbon in the soil, for the equivalent of a one-off reduction of 100 billion tons of CO₂ emissions.

Carbon budget for global climate jobs from 2025 Added emissions in billion tons of CO₂e

Until 2025	180
Transition	500
Feedbacks	100 to 300
TOTAL	+ 780 to 980 billion tons ²⁶

Effect of emission reductions

Methane reductions	650
Reforestation	370
Soil carbon	100
TOTAL	minus 1120 billion tons of CO₂e

The offset emissions are larger than the added emissions. That means we can probably stay more or less where we are now. And we can probably avoid a temperature rise of more than 1.5 degrees.

The calculation is a bit different if we have to wait until 1 January 2030 before most countries, including China and the United States, have embarked on serious climate jobs programs. Then the total added emissions after 2020 will be between 1,000 and 1,200 billion tons. The offset emissions will still be 1,070 billion tons. But we are nonetheless more or less where we are now, and probably under 1.5 degrees.

We will be sailing along the edge. We will stay on that edge of 1.5 for the twenty years while we build renewable energy, cut methane emissions and plant forests.

If we don't have serious climate jobs projects across the world by then, we will be in very serious trouble. If we do, we will probably be just about alright. Probably – if there is no big explosion in feedbacks, and if we reach no serious tipping points. This also assumes also that the IPCC estimates are right about how much the temperature will increase with a particular level of CO₂ in the air. If all those things work in our favour, we are in with a chance.

Where the Emissions Come From

There is one more important thing to explain about emissions – where geographically they come from. At the moment about 38% of global greenhouse emissions come from the rich countries of the world. That includes Europe, the United States, Canada, Japan, South Korea, Taiwan, Singapore, Australia and New Zealand. The other 62% of global emissions come from the rest of the world, the countries of the global South.

That means we will not be able to reduce global emissions without all countries reducing their emissions to about 1 ton of CO₂ per person per year. That means we will need climate jobs programs all over the world. And in the economic winds to come, people in the South are going to need the jobs that will come from a new deal.

This is not a bad thing but it is controversial. I have devoted Part Six of this book, on *Solidarity South and North*, to all the issues involved. There I explain in detail how much emissions different countries have, and how the industrialization of the global South is changing the world. I talk about "extractivism", about how to find a fair way of reducing emissions, about climate finance, and about how to build solidarity. But for now I want to move on to the question – how can we cut emissions?

PART TWO

**REWIRE THE
WORLD**

**I CAN'T
BELIEVE I'M
MARCHING
FOR FACTS**

*Climate striker
Sydney, Australia*

CHAPTER 4

FOSSIL FUEL EMISSIONS

Electricity from renewable energy can reduce fossil fuel emissions by more than 90%. The key to this is that we do not simply replace current electricity production. We also have to use renewable electricity to run almost all vehicles, heat almost all buildings, and for all processes in industry. And we need massive new supergrids to deliver that electricity.²⁷

However, the market cannot deliver renewable electricity on this scale. The reasons are inherent in the technology. We will need public ownership of the grid and the main electricity providers if this is going to work.

Total global emissions of all greenhouse gases are 55 billion tons a year. Of that 36 billion tons is CO₂ from burning coal, oil and gas. This is the big one. Right now these emissions break down as follows:

Global CO₂ from burning fossil fuels in 2018

Producing electricity	15 billion tons
Transport	10 billion tons
Industry	8 billion tons
Heating buildings	3 billion tons
TOTAL	36 billion tons

Most of the electricity in the world is currently made by burning coal and gas. Some is made by burning oil. Those fossil fuels produce the heat that powers the turbines which create electricity. Renewable

energy can replace all those fuels. Some electricity is also made by hydropower from dams or by nuclear power. There are, however, serious problems with both these power sources. I will come back to those problems in a later chapter.

Renewable electricity could also replace most of the fossil fuels used to heat industrial materials like iron, steel, cement and plastics.

Currently almost all transport is powered by oil, usually in the form of diesel or petroleum. We could switch all cars, trucks, buses and trains to run on electricity from renewable sources. That would cut emissions from ground transport to almost nothing. But we would still have emissions from ships and planes.

Coal, oil and natural gas also provide most of the heating in homes and businesses. Biomass like wood, mainly burned by poor rural people, provides the rest. Electricity from renewables could replace all those fossil fuels, and much of the biomass.

Once we have converted electricity production, industry, transport and heating to renewable electricity, the global CO₂ emissions will look like this:

Global CO₂ from fossil fuels in 20 years

Producing electricity	0.5 billion tons
Industry	2 billion tons
Transport	2 billion tons
Heating buildings	0 billion tons
TOTAL	4.5 billion tons

That's a cut of 87% in global emissions from fossil fuels. It's a cut of more than 60% in all greenhouse gas emissions.

It's also an enormous project. In most countries, it means increasing electricity production by three or four times, and building a whole new smart grid as well. But the poorer countries, where most of humanity live, will need even more electricity. In most of the global South, the majority of people need more warmth, more cooling, more housing space and more light. They need more and better transport than they have now. If their economies develop, their industries will need more energy as well.

These extra demands are not a frill. As we have already argued, it will not be possible to stop climate change without the active support of the working people of the poorer countries. That's why any global

climate jobs project has to deliver a decent standard of living. Energy is central to that.

We won't need more energy in the rich countries. Energy use is already at a plateau there.²⁸ But still, outside of the rich countries, the supply of energy will have to double or triple. Almost all of that increase can be supplied by building new renewable electricity. But when you combine that with the effects of using electricity for transport, heating and industry, we are going to need at least a six-fold increase in global electricity production.

That gives you some idea of the scale of the task facing us. It will take massive government projects to achieve this. The sheer scale means that the market cannot possibly achieve that in 15 or 20 years. In each country, and between countries, it will require coordination and coherent planning, something the market cannot deliver.

Shovel Ready

The next few chapters lay out what it would actually take to rewire the world on the necessary scale. My account here differs in two important ways from other scenarios you may have seen for a low carbon future. One is that I assume most of the work will be done in the public sector. I will explain why this is necessary as I go along.

The other is that I am going to paint a picture of what can be achieved using the technology we have now. This is an important limit. Many scenarios for the transition assume that new technologies will come on stream that will make the transition far easier.

In one way, that is bound to be true. Twenty years and an enormous investment of human work and research will produce technological progress. Some technologies will become far cheaper, and new ones will be found to work.

But there are dangers in making these assumptions. One is that we do not know which technologies will become far cheaper, and which will be seen to work. Moreover, one of the things I am trying to do here is to convince you that a climate jobs approach can bring almost 100% cuts in fossil fuels emissions. I cannot really convince you of this if I dodge the problems by assuming they will be solved in the future. So this is about what we can do with what we have.

However, where there are technologies that don't really work yet, but would make a big difference if they did work, I will alert you. And Chapter 10 will be devoted to one such technology: *Hydrogen*.

WIND POWER FOR THE PEOPLE

*South African climate jobs marcher
at the UN climate talks in Durban, 2011*

CHAPTER 5

WIND AND SOLAR POWER

Most of the renewable energy will come from wind turbines and Solar PV cells. The reason is simple. They are the cheapest form of renewable energy so we can build them faster – and we have to build an enormous amount.

Wind turbines are built in three parts. The “tower” is the tall base. On top of the tower sits the aluminum “nacelle”. It looks like a large oval submarine. Two or three large blades are attached to the front of the nacelle. The blades turn in the wind, and their turning drives a generator in the nacelle.²⁹

The three components – the tower, the nacelles and the blades – are usually made in separate factories. They are taken to the site on trucks or boats, assembled there, and then all the necessary cables are attached. Sometimes there are just one or two big wind turbines on a site. But it is more efficient to build wind farms of many turbines in rows.

Technically, there are three kinds of solar power – Solar PV, Concentrated Solar Power and Solar Thermal. Solar PV, though, is much the most important. When people refer simply to solar power, PV is what they mean. It’s what I mean, too.

The PV is short for “Photovoltaic”. “Photo” is from the Greek word for light, and “volt” stands for electricity. Solar PV works in the following way. Sunlight contains particles called photons. When those photons hit a wafer of silicon, they knock loose electrons. Electrical current is always an oversupply of free-floating electrons trying to reach a place that does not have enough electrons. Solar PV electricity comes from “solar cells”.

These are thin slivers of silicon inside a plastic or glass cell that allows the light through. Those cells are placed so that they face the sun. The electrons are knocked loose and flow down a wire that leaves the cell and connects to the local electricity grid or a battery.

Silicon is not the only substance that can be used in solar cells. Many engineers are busy experimenting with alternatives. But for the moment, more than 90% of solar cells are made with silicon.

Wind turbines and solar arrays are two of the key building blocks of 100% renewables. The third is building new grids. The reason is that no one kind of renewable energy provides a steady supply of electricity. There is less solar power when it's cloudy, and no solar power at night. When the wind blows hard, turbines produce a lot of electricity. When it dies down, they do not.

But grids can combine different forms of energy over great distances. When the wind is not blowing in one place, it is blowing in other places five hundred or a thousand miles away. At night, when the sun is not shining, the wind is blowing somewhere. High voltage cables allow the people running grids to mix the energy supply over very long distances, and so smooth out the supply. This makes very large-scale grids essential to 100% renewable energy systems. As I will explain, there is basically no way to make a profit from these grids. They are basic infrastructure projects on which other aspects of any climate transition depend.

Large scale grids also need other forms of renewable energy beyond just wind and solar. These include concentrated solar, wave, tidal and geothermal power. All of these are much more expensive than wind and solar energy. Producing them for sale into the market does not make sense. But the grid will not balance without them. So these forms of power all require large subsidies.

100% renewable electricity systems also require some form of storage for electricity. Usually, people think of this in terms of batteries. But there are serious problems with batteries, and in later chapters I explore some of the alternatives.

Controlling the market

There is another way to leave behind the rule of the market in order to make renewables work. We simply pass a law in each country saying that, with a few exceptions, it is illegal to burn fossil fuels to make energy for sale.

Without that law, we face all kinds of problems. With the law, renewables no longer have to compete with coal, oil and gas.

Almost all writers on renewable energy assume that competition between fuels will continue. But that competition constantly works to reduce the share of renewables in total energy.

Competition also means that renewable energy will only work as long as it is cheaper than coal, oil and gas. But the price of fossil fuel energy fell before the Covid 19 pandemic. It has fallen further during the pandemic. And the more renewables we use in future, the further the price of fossil fuels will fall, as demand falls even when supply stays the same

Moreover, if we don't ban fossil fuels, any increase in demand for energy will drive up the amount of fossil fuels burned. If there is a ban on almost all uses of fossil fuels, then energy use will only increase if renewables increase.

This may seem extreme. But we are trying to reduce global emissions across the board. There are some sectors where it may be possible to cut emissions by a third or a half, but it will be quite difficult to cut them further than that. These sectors include farming, aviation, shipping and sewage. Because those are going to be hard nuts to crack, we need to cut emissions from fossil fuels as deeply as possible.

Why many people think solar power is small scale and decentralized

I am arguing that the task of rewiring the world requires very large, centralized grids and enormous amounts of energy. But many environmentalists, anarchists and socialists believe that solar power is inherently small scale, decentralized and democratic. This belief is rooted in how solar power developed. It is not a silly belief, but it is out of date.

Silicon is the most common element in rocks and sand. But silicon in nature is always mixed with other elements. The technical challenge for fifty years has been to produce 99.9% pure silicon.

There is a common misconception that the development of any cheap production technology comes from research and development. Sometimes research helps. But for almost every technology, the key advances come from mass production. Engineers, technicians and workers learn by doing together.

Until recently Solar PV was far more expensive than using coal or gas to make electricity. Thirty years ago, environmentalists who wanted to stop climate change knew they had to find a way to reduce the cost of solar. The way they did that was the reason that we now think of solar as a small-scale, decentralized technology.

The environmentalists knew that the only way to make solar affordable on a large scale was to build large amounts of expensive solar PV over many years. At first this was done mainly by dedicated people who built their own solar power systems and installed them on their own roofs and properties. These solar arrays were “off grid” – not connected to the larger electrical network. This is one reason people still often think of solar as a decentralized form of energy.³⁰

These early pioneers were hippies, cranks and geeks, but also heroes. However, change really took off when some environmentalists persuaded local or national governments to give grants to homeowners who wanted to install their own solar PV, again usually on their rooftops. Even more important were government programs where people were able to feed their rooftop solar energy into the national grid at a guaranteed price. At first the largest programs were in Japan and Germany.³¹

Although these programs relied on subsidies they would not have survived without early adopters, the environmentally concerned people with enough money to pay the costs up front to install solar PV on their roofs.

But the real breakthrough came when the Chinese government stepped in, and Chinese companies solved the problem of efficiently making wafers that were 99.9% pure silicon. Many of the technical problems were the same as in making silicon chips for computers and phones. Chinese industry does a lot of that too. The other reason the Chinese companies were so successful was that their government encouraged mass production.³²

The pioneers of wind power, like the pioneers of solar, built much smaller turbines than we have now. Many of them too were built off grid. The legendary Christian Risinger, an inspired artisan, built one of the first modern turbines in Denmark by himself in the 1970s, using “interchangeable parts from other equipment, such as bicycles.” But once Risinger finished his turbine, he connected it to the grid.

Why wind farms and solar arrays are big

Both wind power and solar power make sense as part of large grids. Large wind farms full of giant turbines also make sense. The reason is two mathematical facts about wind turbines that have important consequences.

The first fact is that the amount of electricity produced increases with the square of the length of the blade. That means if you double the length of the blade, you get four times as much electricity. And

if you triple the length of the blade, you get nine times as much electricity. This is why most wind turbines are so large.

The second mathematical fact is that the amount of electricity produced increases with the cube of the wind speed. So double the average wind speed, and you get eight times as much electricity ($2 \times 2 \times 2 = 8$). Triple the wind speed, and you get twenty-seven times as much electricity ($3 \times 3 \times 3 = 27$).

Double the length of the blade and triple the wind speed and you get 216 times as much electricity.

This is why turbines and wind farms are built in very windy places, like mountain passes and ridges. Steady, strong wind is also the appeal of offshore wind turbines. These are usually installed on the continental shelf, in relatively shallow water. The turbine is anchored to the seabed, and cables carry the electric current ashore.

Floating wind turbines are another option. So far only a few are actually working, off the coast of Scotland and Japan, and they are about twice as expensive as anchored offshore wind. But they hold out the prospect for the future of almost unlimited, relatively steady supplies of wind power.³³

There is presently a lot of rooftop solar all over the world. But there are now more efficient ways of using solar. One is in new buildings, where the solar panels can replace roof tiles. Installing arrays of PV on the roofs of public buildings and warehouses is also cheaper than putting panels on smaller domestic roofs. But the real economies come with the "industrial scale" solar farms that now cover many fields and deserts. In these, solar arrays can be mounted on pivots, so that they turn to follow the sun across the sky at the best angle. When you read about very cheap solar, this is what they mean.³⁴

Solar may have started "off-line", but it now makes sense as part of an integrated grid that connects hundreds of thousands of users. Solar power is, by its physical nature, a technology that works far more efficiently if it is shared.

An important exception

There is an important exception to this generalization about scale. Rooftop solar is particularly well suited to running domestic air conditioners. The sunnier it is on any given day, the more electricity is produced and the more it is needed. The same PV solar array works three times as well in Baghdad, where people need air conditioning desperately, as it does in Scotland, where they don't.

Moreover, many parts of the world, like southern Iraq, Iran and Pakistan are exposed to increasingly longer and more lethal heatwaves. In these conditions, air conditioning is a matter of life and death. Electricity grids commonly break down during heatwaves. This is partly because the grids are in poor shape anyway, partly because electricity demand surges, and partly because the heat causes technical problems for the grid and the power plants.

In these conditions what makes sense is rooftop solar, normally connected to the grid, but capable of working on its own and connected to at least one air conditioner.

Renewable energy jobs are mostly factory jobs

Many people assume that most renewable energy jobs involve work on maintaining wind farms and solar panels. It's a reasonable assumption. But in fact, the majority of renewable energy jobs are in factories. This has important implications. We said in the last chapter that we cannot win climate jobs without massive working class support. And those factory jobs will be crucial in winning that support. If we do everything right.

But not if we do it wrong. For example, most writers on the energy transition assume that most countries will import most of their wind turbines. They also assume that most solar panels will come from China, because they are so much cheaper there. Given the World Trade Organization (WTO) rules this is all you can do. And it will be by far the cheapest way to build renewables.

These assumptions are wrong. Consider how that sort of policy would look in the first few years of any climate jobs project.

There are basically three different kinds of jobs in wind power. There are the manufacturing jobs making the blades, the towers, the nacelles, the parts and the cables. There are the installation jobs assembling all the parts on site. And there are the operations and maintenance jobs looking after, cleaning and repairing the wind farm. At first the great majority of the jobs are in manufacturing. The number of operations jobs increases slowly.

Take, for example, the project of building enough renewable energy to supply all the electricity needs in the United States. The numbers involved at the end of the first year would be something like:

Manufacturing	614,000 jobs
Installation	154,000 jobs
Operations	41,000 jobs ³⁵

Basically, if you import the wind turbines, all the jobs will be somewhere else. Year by year, the number of jobs in operations will increase, as more and more wind farms are built. Here is what the split of jobs in the US would look like after five years:

Manufacturing	614,000 jobs
Installation	154,000 jobs
Operations	205,000 jobs

Without those manufacturing jobs, what you have instead is a massive government project that exports wind jobs and closes down coal and oil jobs. That would be a political problem, and just plain foolish.

To see why, let's look at what happened in the US presidential election in 2016. West Virginia has been the most militant labour union state in the US for a century. The reason was coal. But where there were 150,000 pick and shovel miners in 1955, there were only 12,000 mineworkers by 2015. And by then West Virginia was tied with Mississippi for poorest state in the US, struggling with opiate abuse and desperation.³⁶

Running for president in 2016, Hilary Clinton said during a speech on renewable energy in Ohio, "We're going to put a lot of coal miners and coal companies out of business."³⁷

Clinton's opponent was Donald Trump. He won 68% of the vote in West Virginia, his largest margin in any state. He had a majority in every one of West Virginia's 55 counties.

There is the same problem in South Africa. This time let's look at solar power, and imagine that the solar cells are imported from China. The split between manufacturing, installation and operations is a bit different for solar, but not that different. At the end of one year the jobs would divide as follows:

Manufacture	35,000 jobs
Installation	12,000
Operations	3,500 ³²

Here is the split in South African solar at the end of five years:

Manufacture	35,000 jobs
Installation	12,000
Operations	17,500

And vice versa: there is the same problem with wind in South Africa, and with solar in the United States.

From 2012 onwards, the South African government had a program of giving contracts to the private sector to supply renewable energy. Under those contracts, almost all the manufacturing jobs went to corporations in the global North. In one memorable instance, the Danish corporation Vestas made the wind turbines in Denmark. Then Vestas flew in white Danish workers, on Danish wages, to install the turbines as poor black rural South Africans watched. A few South Africans were then left with jobs in operating the wind farm. After those sorts of experiences, South African trade unionists were deeply skeptical about renewable energy jobs.

But you can stand the problem on its head, and the manufacturing jobs become a blessing. If a public sector Climate Service or Climate Corps owns and runs the manufacturing plants, very large numbers of jobs will be created within the country. Moreover, those factory jobs are the only climate jobs that can be put anywhere they are needed. There will be many public transport jobs in any climate service, but they will go where the passengers are. Jobs in construction and building conversions will go all over the country, everywhere the buildings are. Renewable energy operations jobs will be largely in rural areas. Renewable energy installation jobs will belong to gangs of workers moving from one rural site to another.

But wind and solar manufacturing plants can be built in the valleys and towns where coal mines and oil fields are closing down. This will protect not just jobs, but the fabric of those communities.

Think what a Green New Deal in the US could do with all those manufacturing jobs in wind and solar. The factories could replace the jobs lost in West Virginia and Kentucky mines. They could go to the oil fields of the Permian Basin in West Texas, to the refinery workers of Houston and the offshore oil workers based in Louisiana. Those factory jobs could be placed to begin to heal other devastated communities, like Baltimore, where the docks and factories closed, like Flint, where the auto plants closed, the inner city of St. Louis, and Gary, where the steel plants closed. That would be a Green New Deal that could carry every county in West Virginia.

**SAUVE
LA TERRE**

**MANGE UN
LOBBYISTE**

*"Save the Earth, Eat a Lobbyist"
Climate striker, Paris*

CHAPTER 6

BALANCING POWER AND BACKUP TECHNOLOGIES

Before we go any further, a few words are needed about costs, because the topic can be confusing. This is not about how we pay for green new deals. That is a key topic, and we tackle it in Part Six. This is about how we control the cost of each wind turbine, or solar panel.

Two principles are in tension in any climate jobs project. On the one hand, we want to keep down costs. On the other, we know we must spend whatever it takes. This needs some explanation.

Costs basically means jobs. This is the starting point if we are to understand the tension. Let's take the example of railways. Part of the cost of running a railroad is wages. But let's look at some of the other costs. The railway needs engines. The cost of those engines is made up of the wages paid to workers at the engine manufacturer, plus the costs of electricity, steel, etc. The cost of the electricity is made up of the wages paid to the power station workers, the people who built and maintain the grid, the miners and oil and gas workers and truck drivers and pipeline workers who supply the fuel, and the people who made the tools, machines, trucks and parts for all those workers.

Just as the proverb says that the universe is turtles all the way down, costs are jobs all the way down. But there is another part to costs. Companies take profits off the top for the bosses and the stockholders, lenders take interest on loans, landlords charge rent and governments tax.

A public sector project could avoid paying for profits. But even a public sector body would still be buying a lot of parts, supplies and

services. This is why I say that there would be eight million direct jobs in a US Climate Corps, but there would be another four million indirect jobs in the supply chain.

Now we can explain the tension. On the one hand, we need to do everything we can to reduce emissions. Some of the things we need to do will require fewer jobs for every million tons of emissions we can reduce. An example of this is building solar power and wind power to replace current electricity generation. Another example is running cars on electricity instead of oil.

But then there are things we have to do that will require many more jobs for every million tons of emissions we can reduce. Let's take the example of building wave power turbines. This requires a lot more jobs than wind power for every million kilowatts of electricity supplied. It's much more expensive. But we can't do without wave power, because some of it is essential to balance the irregular supply of cheaper wind and solar power to an all-renewable grid.

This is part of a more general imperative – we have to reduce emissions as close as we can to almost nothing, so we have to do the difficult and expensive things along with the cheap and easy.

This means we have to be prepared to spend money and meet the costs of creating jobs where we must. But it does not mean we can forget about costs. We want to do everything we can with as few workers as possible, as cheaply as possible, bearing in mind that we are also workers, and we want safe jobs and decent pay. But we don't want waste. If we have workers to spare, we can rewire the world more quickly. We are working against the clock here.

Intermittent Power

Almost all countries will need a balance of wind and solar power. Even if they receive an enormous amount of sunshine, they will still need wind at night.

A country with half solar and half wind will have three times as much electricity during the day as during the night. This is because they will use up all the solar power during the day. Half the wind power will be used during the day and half during the night.

At the moment there is more demand for electricity in the day and early evening. In the US, for example, the demand is twice as much in the day and the first three hours of the evening as it is in the rest of the night.³⁸ But we are planning to use much more electricity, and in new ways. It will make sense to recharge many vehicles at night,

and more heating of homes and of industrial materials will happen at night. The result is that even Egypt, where solar power is very efficient, will need substantial quantities of wind, so they have plenty of energy through the night.

By contrast, the UK has famously unpleasant weather and a northern latitude. But that same weather becomes a blessing because it creates enormous resources of offshore wind in the North Sea. So the UK would use much more wind than solar.³⁹

However, we will also need other forms of power beyond onshore wind and solar. Four kinds of power are likely to be useful: concentrated solar, tidal, wave and geothermal power. Three kinds of power are problematic, and not likely to be useful: hydropower, nuclear power, and fossil fuels with carbon capture and storage.

Concentrated solar, tidal and geothermal power all have three things in common. One is that they all help to balance the supplies of wind and solar. Without these technologies, we will be unable to make the grid work.

The second thing is that right now they all require a lot more investment of jobs and money than wind and solar for the same return. They require three, four or five times as much work.

The third thing is that with mass production some of these technologies will become far more efficient. That happened in past decades with coal, oil, wind and solar. It will happen with some of these technologies, but probably not with others. We do not yet know for sure which technology falls in which camp. That is another reason for serious investment by governments, with an understanding that some roads will end in dead ends, and that short-term profit cannot be the yardstick. This was, after all, the attitude governments took towards new technologies when they embarked on total war in the twentieth century.

I will describe each technology, trying to explain briefly how and why it can be useful.

Concentrated Solar Power

Concentrated Solar Power is a strange and miraculous technology. Each Concentrated Solar plant has arrays of hundreds, and sometimes even thousands, of mirrors. These mirrors reflect the light of the sun onto a tall tower in their midst. The angle of the mirrors is constantly adjusted during the day, so they are always concentrating the light of the sun on the tower. Inside that tower is a liquid that

can be heated to great temperatures, usually mercury or liquid salt. The energy from all those mirrors heats the mercury or salt to very high temperatures, at which point they turn into gases which can store a great deal of heat. That heat drives a steam turbine that creates electricity.

Sometimes, instead of a tower, a great pipe lies on the ground amid the mirrors. The pipe works in the same way as a tower.

Concentrated Solar certainly works. But it only makes sense where there is a great deal of sunlight year-round. Most existing Concentrated Solar has been built in places like southern Spain, Morocco and Arizona. Even there, concentrated solar requires about three times the expense, and three times the numbers of workers, compared to ordinary solar power. So it makes no sense further north.

Concentrated solar has one great advantage, however. The mercury or salt in the pipe can stay hot for six or twelve hours, and then be released when needed to drive the turbine. This means concentrated solar can cover the evening, the period of highest demand in many countries.⁴⁰

Tidal and Wave Power

Tidal power uses the force of the tides to turn generators. This can be done by vertical or horizontal turbines under the sea in shallow waters. Tidal power can also be concentrated by using barrages to funnel the water through a narrow passage. Many environmental organizations are concerned that such barriers could have serious consequences for marine life. If this turns out to be an overwhelming obstacle, we can still use ordinary tidal turbines.⁴¹

The great advantage is that tidal power provides regular, predictable power around the clock. Yet tidal power is an immature technology, and still very expensive. Most projects are really pilot projects, and typically cost five or more times as much as wind power. So tidal power only makes sense in places where there are exceptional tides. And even in those places, it requires large subsidies.

The highest tides in the world are in the Bay of Fundy in Canada. The largest tidal power turbine in the world was built there by Open Hydro. That company went bankrupt in July 2018, and the turbine was closed down. The CEO of the French parent company of Open Hydro said at the time that even in such favorable

circumstances electricity from tidal power sold at three times the price of solar and wind powered electricity. "However, what we have experienced in the Philippines, Chile and Canada, the UK, Japan, Indonesia and France, is that the public authority is not prepared to pay the cost of the energy. So we have made the decision to stop investment in this technology."⁴²

In contrast with tidal power, wave power makes sense in many more places. It usually takes the form of small turbines that bob near the surface, and are anchored to the seabed. These turbines are usually linked in lines. The South African engineers Stoffel Fourie and David Johnson have suggested that wave power is particularly likely to work well in their country. South Africa has 2,800 km of coastline. The country juts out into the Southern Ocean, where the wind blows around the globe all year, unobstructed by any land. The result is an enormous resource of strong, steady waves all year round.⁴³

But for the moment wave power, like tidal power, is basically in an experimental stage.

Geothermal

Geothermal is particularly useful for balancing wind and solar because it is such a steady power source night and day. Iceland is a prime example. It's a volcanic island sitting on a sea of lava. The lucky Icelanders have long used geothermal energy for most of their heating and all their electricity. This is not an immature technology.⁴⁴

Iceland is exceptional. But there are substantial reserves of geothermal all along the volcanic "Ring of Fire" that runs along the Pacific Rim. Philippines, for example, already has the third largest installed capacity of geothermal in the world. So there are already experienced geothermal engineers and skilled workers. The government currently plans a doubling of geothermal power by 2030. This figure is probably something of a guess about what is possible. A determined attempt to see if much more geothermal energy could be captured would make sense for the Philippines and would benefit many parts of the world.⁴⁵

Concentrated solar, wave, tidal and geothermal will allow us to smooth out the ups and downs of electricity demand around the clock. Luckily, they all work on different time scales, so they can balance each other to a certain extent. We need these technologies to make the grid work.

However, right now all these technologies require a lot more investment of jobs and money than wind and solar for the same return.

The Mix

The mix of renewables would differ from country to country. For example, for South Africa it would be something like 50% wind, 40% solar and 10% other. But for the Philippines it would be more like 50% solar, 30% wind and 20% geothermal.⁴⁶

Hydropower

So far we have been discussing renewable energy technologies that look useful but need a lot of development. Hydropower is a mature form of renewable energy, but with some problems.

The force of gravity provides energy to water falling down from a dam and down through a generator to produce electricity. Norway already gets 96% of its electricity from hydro, Costa Rica 80%, Venezuela 68%, Brazil 63% and Canada 58%. More representative, though, are countries like China (19%), Russia (17%) and USA (7%).

The regulated flow of water is steady from day to day, and can be turned on and off to meet demand. That makes hydro a blessing in Norway and Costa Rica.

In China, India and many other countries it has been a curse. One reason is that big dams almost always go with the eviction of very large numbers of people. The other problem is that big dams destroy the agriculture downstream. In Egypt, for example, the wildly popular Nasser government built a massive dam in the 1950s on the Nile at Aswan. For thousands of years, the Egyptian farmers of lower Egypt and the Nile Delta had depended on the replenishment of the soil by the Nile. But the new dam cut off the supply of silt that the river had brought down to the flooded fields. The result has been an agricultural disaster.⁴⁷

Those are reasons not to build more big dams. But there are other reasons, specific to climate, against building more dams. One is that in most countries, most of the possible big dams have already been built. The larger problem, though, is that even where new dams are possible, they will be very expensive and take a long time to build. In 2014 an excellent long report by Atif Ansar and colleagues at Oxford University examined both the promised and the actual costs of 254 large hydropower projects across the world. They found massive cost overruns were the rule, not the exception. The average time to completion was more than eight years, but many dams took much longer than that. Costs and delays on this scale rule out new dams as a backup technology.

Moreover, hydropower is a mature technology. Mass production is not going to bring down costs in any significant way. Established hydropower dams are reliable, useful and will last for decades. But Ansar and colleagues particularly advise any governments in poorer countries against trusting the promises of large dams.⁴⁸

Small scale hydro projects do not have these problems, but they make only a small difference. And we will return to dams in the next chapter, when we look at the possibilities of using them for storing energy with “pumped hydro”.

Biofuels and Biomass

Hydropower, we have argued, is a mixed blessing. To round out our survey of alternative energy, we will look at three technologies that do not work, but are often proposed and may well be in readers’ minds.

Many countries currently use large amounts of biogas, like ethanol for cars from corn in the United States and from sugar cane in Brazil. Many also use large amounts of biomass, like wood and manure for heating. These often pass for “natural solutions”. But they all do exactly the same thing fossil fuels do – they burn carbon and put CO₂ into the air. The manufacture of gas from corn and sugar cane burns a lot of fossil fuels too. Moreover, as we will show in Part Four, as climate change gathers force, we are going to need every bit of farm land we can save. And where we do not grow crops we will plant trees to take CO₂ out of the air. Biofuels set the hunger of engines in competition with the hunger of children, and the engines always win. Biomass devours the grazing of animals and the green cover that renews the field. We will have to reforest every bit of the land on earth we can, and leave those trees to grow, to fix carbon in the wood and the soil. Every field planted to be cut down to run cars is one less permanent stand of trees.⁴⁹

Nuclear Power

Nuclear power will not help. Much of the controversy around nuclear power focuses on the danger of accidents. These are real and serious dangers.⁵⁰

Our concern here, though, is with climate change. To halt climate change, we need swift and large scale deployment of renewable energy. Here, there are several problems with nuclear.

First, there is not enough uranium to make nuclear reactors more than a small part of the global response. Indeed, there are only very limited plans for new nuclear power anywhere.

Moreover, nuclear power would tie up a great deal of money and workers which could be used far more efficiently elsewhere. That cost is why there are no private companies anywhere in the world building nuclear power stations without a guaranteed subsidized energy price from a government.

Expense is of course also a problem with concentrated solar and wave power. The difference, though, is that nuclear power is a mature technology. It is not going to get any more efficient. A recent study by Joana Portugal-Pereira and colleagues looked at the construction costs of all commercial light water reactors – the most common kind – from 1955 to 2016. They found that costs, adjusted for inflation, are 50% higher now than they were in the 1980s. More important were the delays. Ten years from planning to completion is swift for a nuclear project. Much longer delays were common, meaning that the whole project often took twenty or thirty years. Wind and solar can be built now, and far more cheaply.⁵¹

None of this is a climate argument for closing existing nuclear power stations. Keeping them open makes sense in climate terms. They are still dangerous, of course, and that is no small thing. And there is real support for nuclear power within some unions, some communities and some countries, because people depend on those jobs. The way to deal with that is to give nuclear workers the same promise as coal miners – a permanent climate job.

Carbon Capture and Storage

Many people, especially in trade unions, are attracted to carbon capture and storage. Unfortunately, it too is not going to work.

In capture and storage, chemical “scrubbers” in coal and gas fired power stations take the carbon dioxide out of the exhaust. This CO₂ is then transported in pipelines and sealed into caverns or empty oil and gas fields. This technology has been tried in several different places, and it seems to work.

However, very large amounts of energy are needed to extract the CO₂, pressurize it into liquid form, and then transport it through the pipelines. There are also doubts about whether the CO₂ will stay underground. It could leak upwards into the air, or downwards and sideways into the water table. Even very small leaks, on the order of one half of one percent a year, would mean that over a century half of the recovered CO₂ would make its way into the air.

That is a hostage to fortune. And it is impossible to ignore the fact that hardly any commercial power stations use capture and storage, and governments are very reluctant to subsidize it. This may be simply because of the expense, but it may be because of worries about leaks.⁵² It has never been proven to work at a large scale, the sort of scale that would be needed to make any difference.

Moreover, it is sort of mad to first burn the fossil fuel to create energy and then use much of that energy to extract the carbon. The same investment can move directly, and more cheaply, to making renewable energy without the carbon.⁵³

However, there is a different form of carbon capture that may be useful in the long run. This is the direct extraction of carbon from the air using renewable electricity. This is perfectly feasible now, although it is very expensive.

The expense means that now it makes far more sense to switch to build renewables and cut emissions in every way we can now. But once that work is done, it may be worth directly extracting the carbon from the air. If, and this a big if, we can work out a reliable way to store the carbon.

**I AM THE
LORAX
AND I SPEAK
FOR THE
TREES**

*Primary school climate striker
London*

CHAPTER 7

SUPERGRIDS

A rewired world does not mean that all energy will come from renewables. But it does mean that most energy will come from electricity, and all that electricity will come from renewables. That will not be an easy thing to construct. We will need new national and international supergrids to integrate all these new kinds of power into new electrical supply systems. These will be qualitatively new undertakings. The challenge of mixing together power from renewable energy is different in kind from mixing together energy from fossil fuels – and far more complex.⁵⁴

These technological differences make it almost possible – probably completely impossible – to build the grids while depending on private corporations trying to make a profit. We need some detail here to explain why.⁵⁵

The place to start is with what electric grids do now in countries that don't have much renewable energy. For the moment we will only be talking about grids in rich countries. Grids in poor countries are usually different, because they don't have enough investment and so they crash a lot.

Let's take the simplest, old fashioned model first. No grid is actually run quite like this now, but the model is good for thinking with.

In this model an electric utility supplies electricity to all the homes, businesses and industry in a particular area. That utility can be a private company or one owned by a city or state. The utility has perhaps a few million users. The electricity supply comes from a small number

of power plants. Some of those plants burn coal to make electricity, some burn gas, some use oil, some use nuclear power, and some are hydropower dams that use falling water to generate electricity.

There are a small number of big power lines coming into a central place. From there, medium size power lines run all over the region to substations. At substations the electricity is transferred into smaller power lines that carry electricity to homes, businesses and industry.

The engineers who run this grid have a problem. Electricity is not a liquid or a gas. It's a field. Electrical charge flows from areas where there is an excess of free electrons to areas where there are not enough electrons. For example, electrical current moves from a power plant to homes where people need light.

Although no one electron moves immensely fast, the cascading wave of power is very fast indeed. But the power does not flow downhill, like water. It can flow to any place in a vast interconnected system where there is a shortage of electrons, through any pathway. The power can double back, flow down another channel, around and sideways. All this can happen far faster than any human monitor can follow.

If the supply of electrons does not balance with the need for electrons, the current ceases to move at a steady wavelength. When that happens, the system burns out – physically, the wires burn and melt their coatings. To stop that happening, the people who build any circuit, from the ones in your house to the National Grid in Britain, build in fuses that break the electrical flow.

But at the level of the grid, here's the rub. There has to be redundancy in the grid – extra pathways in case one path closes. This is because there are constant faults on the line. In the US, as in many other countries, the main problem is trees falling on the line. This is most serious when a tree falls on a main power line. That happened on an ordinary day in April 2018 in Puerto Rico, and more than two million people lost electricity.⁵⁶

The second biggest problem in the US is squirrels eating the insulation on lines, particularly at sub-stations, and shorting the circuit. Then there are truck accidents, something odd in a nuclear reactor, ice on the lines, late deliveries, old wiring and a hundred other possible glitches. There are also the effects of heatwaves, storms and floods, and all of these are getting worse with climate change.⁵⁷

If the whole system were to stop every time there was an interruption, the system would not work. That is why designers build redundancy – more pathways – into the system. But those pathways make the system

more complex. For example, a grid failure in the northeastern US and eastern Canada in 2003 deprived 50 million people of power. It started when one tree fell on a line in Ohio. The power automatically rerouted onto other lines, where three more trees fell. More power surged into fewer pathways, crashing those pathways, and pushing more current into other pathways, and the whole system crashed.⁵⁸

These are the problems that face grid engineers when almost all power comes from coal fired plants, gas fired plants, big dams and nuclear. However, all these sources of electricity can be turned on and off quite easily. Now let's add renewable energy into the mix. You can do this on a small scale, reasonably easily, and it has been done in many places. But the problems multiply when you want to have all electricity from renewables.

In the older systems you had at most a few hundred power plants supplying the grid. Each of these power plants could break down, but usually they did not, and they supplied a reasonably steady amount of energy. The engineers and operators running the grid could turn hydroelectricity and gas fired electricity plants on and off quickly. Coal plants took longer. Nuclear plants took days, because they might explode if you went too fast. But the system was manageable.

But with all renewable electricity you have tens of thousands of rooftop solar arrays. They are feeding electrical current into the same tens of thousands of wires that bring current into the house. You have thousands of wind farms and industrial scale solar farms. All those sources are providing amounts of current that can vary from minute to minute. The wind falls a bit at one wind farm, and seventeen minutes later rises a bit at another wind farm forty miles away. Clouds pass over a solar array on a rooftop, reducing the power by half for a few minutes, but not over the roofs across the street. These variations are happening all through the system, all the time, in places next door and a thousand miles apart.

That's why we will need big grids. The more places are connected in one network, the more the variations smooth out. And the more different kinds of renewable energy are included in the grid, the more the differences smooth out.

Storage

Big grids need a lot of storage. Storage is an alternative to finding new forms of renewable energy to balance wind and solar. It solves the same problem – how to keep a steady supply of electricity that matches the demand for electricity.

Batteries are machines for storing electricity. The difficulty at the moment is the size and expense. Think of the size of a flashlight battery. Now think of the size of a car battery. That battery does not run the engine, it just runs the car electrics. Now imagine the size of a battery that would be necessary to store all the electricity used over twelve hours in a forty-story office building. Now imagine the battery that could store enough electricity to operate a steel blast furnace in a steel mill for twelve hours. Now scale up for an industrialised country of 330 million people.

This is the problem currently confronting engineers. They have not solved it, although they are trying.

There is also the possibility of linking car batteries into a grid and using them at moments of need – we will come back to this when we look at electric cars in the next chapter.⁵⁹

However, there are also problems of supply with batteries. Since the 1990s most batteries have used lithium, the lightest of all the metals, because it is an excellent electrical conductor. There are two problems here. One is that there may not be enough lithium. There are only a limited number of places where lithium is found in sufficient concentrations to be easily mined – Australia, China, and especially the triangle where Chile, Argentina and Bolivia come together. The second problem is that the methods currently used to mine lithium are highly toxic. Understandably, there is considerable resistance from indigenous people in the triangle to the devastation of their environment.⁶⁰

I will write a good deal about batteries and lithium in the chapter on *Extractive Industries*. The dilemmas, and answers, are complex. But there is one point that should be made now. Until 1992 there were no batteries in the world made with lithium. Now lithium is standard because it is the lightest and cheapest way to make a battery. But it is perfectly possible to fill the world with batteries, none of them made with lithium.

Dams and Pumped Storage

Dams offer the possibility of pumped storage. This would mainly mean using dams which are already providing electricity.

When there was too much electricity in the system, some of it would be routed to dams. The electricity would be used there to pump water up from below the dam back into the reservoir behind the dam.

At some point in the future, when there was not enough electricity, this stored pumped water would flow back down over the dam and through the generators to make electricity.

This method has been tried in many countries, and it works. It can also be used to balance grids over very long distances. Norway, for example, runs almost all its current electricity grid with hydropower – it's a country of mountains and fiords. Norwegian climate campaigners have suggested that they could store and discharge large amounts of electricity for other countries.

Engineers are also doing work with compressed air storage. At times of surplus electricity, air is compressed into storage holes, and then released as needed.

Headroom

The best alternative to batteries, however, is probably headroom. Headroom does the same job as storage. It means building enough solar and wind to provide electricity for even the worst days. On normal days, the grid turns off the connections to perhaps a quarter of the solar and wind available. This works – obviously. Instead of storing electricity for the days when we need more, we just always have enough. But most accounts of renewable futures say that headroom would simply be too expensive.

Maybe that's true. But almost all the potential players in our energy markets have vested interests in dismissing the headroom option. At the moment developers of wind and solar can sell almost all the electricity they produce. In a max-headroom scenario, at least a quarter of the total wind and solar capacity would be idle on most days. That would break their business model for wind and solar.

The fossil fuel companies and the nuclear industry are currently arguing that we have to keep some gas and nuclear in the mix to supply a steady balance. They too do not want to hear about using headroom instead. The startups and engineers in love with concentrated solar or marine power do not want to talk about headroom either. Indeed, for anyone technologically inclined, there is something troubling about just doing more of something basic.

This means that there is little or no constituency for the headroom option. However, every time I do the back of the envelope calculations for the different options at current costs, headroom comes out looking pretty good. Careful recent work by Mar Perez and colleagues has confirmed this.⁶¹

But headroom will only work if the public company that runs the grid is the same as the public company that runs the wind farms and solar farms. Then the incentive for the company will be not to make a profit, but to supply reliable, steady power. It is one of the very best reasons for liking a National Climate Service.

Headroom could also provide an opportunity for unprecedented innovation. The public company could provide massive amounts of free energy to scientific and research bodies. We could use headroom energy to strip carbon out of the atmosphere. We could send rockets into space using spare energy, using vast amounts of energy for non-essential projects would no longer be a massive waste, but a deliberate part of ensuring we had renewable power everywhere all of the time.

The bottom line, though, is that we could rewire the world with only solar and wind power, using only the kinds of turbines and solar cells already developed. All the other backup technologies may well be ways of building the grid we need more quickly and smoothly. But if batteries, storage, concentrated solar, geothermal, wave and tidal power never work out properly, we can still rewire the world.

Smart Grids

The big new grids will have to be “smart”. That means they run on complex computer monitoring programs which constantly turn many small parts of the system on and off. There is no way any human being could keep track. Electricity moves too fast, and there are too many inputs and outputs. Of course humans will still monitor the system, panic when necessary, then scream and hit switches.

The grids will also be smart in another sense. “Smart meters” in each home and building will monitor electricity use. The residents will be able to set timers to use some electricity at a time of night when it is cheaper, because wind energy is going to waste in the small hours.

But the computers and people operating the grid will also be able to reach into the house and turn the air conditioning up a couple of degrees, or the heating down a couple of degrees. Recharging electric cars, and a boost to the water heater, can be set for times of spare electricity. And at moments of unexpected surges of demand, the level of use can be nudged downward. All this will make it much easier to balance the grid, and distribute the flow of electricity around the clock.

There's a problem here. Who in their right mind wants to allow a private corporation, or an arm of the government, to know all that information about you? It would include who was using which bedroom when, and who was home when they said they were out. Of course the phone companies and Alexa are already busy collecting that information, and turning it over to advertisers and the police.

Moreover, there is an enormous temptation for the electricity companies to raise the effective charges while they make the system too complicated to understand. American consumers have rebelled in many cities in response to smart meters. The successful rebellion in Boulder, Colorado speaks volumes. Boulder has basically two sources of employment. One is the outdoor recreation towns in the mountains around. The other is the famously liberal and environmentalist students and faculty at the University of Colorado. Boulder organised and rejected smart meters in the home because they were being screwed. If they can't get it through in Boulder, they can't get it through anywhere.⁶²

The only solution I can see, as radical as it sounds, is an electricity company that doesn't screw the customers. Perhaps this needs to be an electricity company that is owned by the customers and the workers who create the electricity.

All this technology will mean an enormous amount of wiring, pylons and connections, millions of holes dug, and tens of thousands of miles of cable laid. But it will also mean an enormous amount of intellectual work developing the programs and systems. Many of you know how often quite simple computer systems fail at work, and how maddening it is when that happens. These new grids will be far more complex, and need redundancy built in because they cannot fail in that way.

The new grids will have to be able to carry far more current than the ones we use now. They have to connect sources of supply in different places from where the plants are now. It will be building a new system on entirely new principles, and yet there will be no point when we can shut down the old grid and fire up the new one. We have to keep the whole system running all the time.

Again, this is a project on a scale that will require planning, central organisation and maintenance. It will require a National Climate Service. The pressure of profits will lead to cutting costs and cutting corners. This will be disastrous. If you want to see what happens when private

corporations cut corners on major contracts for computer systems for the public sector, talk to any public sector worker in Europe or North America. And we don't have to imagine what would happen with an underfunded grid, where not enough time and money had been spent on building electricity generation and a grid. All you have to do is go to Nigeria, Pakistan, Iraq or any of many other countries where underfunding has produced chronic blackouts and crashing grids.⁶³

In these countries, as elsewhere, electricity supply systems were originally built to supply factories, mines and the homes of the rich. The poor were not connected. You can see this in the coal field in Mpumulanga, in the east of South Africa. A massive power plant dominates the skyline, its great chimneys belching smoke high into the air. Giant pylons carry heavy cables away from the plant. In the shadow of the plant, 800 meters away, sits a village of single-story shacks. That village has no electricity.

This is the legacy of apartheid. But there are many other countries with even more ramshackle electricity supplies, like India and Nigeria. Blackouts are common. So is "load shedding", in effect a rolling blackout controlled by the people managing the grid. In many places, residential neighbourhoods commonly make do with four or six hours of electricity a day.

This is part of the reason why a low carbon world will need so much more electricity, so that everyone can have steady access to electricity. Moreover, blackouts and crashes will have far worse consequences than now in a world where almost all the energy comes from electricity. The grid will then be supplying far more than it does now. A crash will not just turn out the lights, the TVs and the appliances. It will turn off the heating, the air conditioning, all the transport and all the industry.

If that happens, it will happen in a situation where the forces of carbon capital are locked in struggle with environmentalists. The enemies of the Earth will seize on any such massive failure of the new grid, and argue for fossil fuels forever. We cannot cut corners on this one.

That means massive government spending. If the work is contracted out to private companies, they will cut those corners in most countries as they build the system. And then it will crash after everyone is dependent on it.

In most small and medium sized countries, we will need grids that cross national boundaries. North America, for example, now has four

grids. One is in the vast northern plains and forests of Quebec, full of hydropower and wind. One, in the east, links parts of the US and Canada. Another, in the west, links Canada, the US and northern Mexico. The fourth and final covers only the state of Texas, and is by general agreement too small. That's now – those grids will probably have to amalgamate.

In Europe, perhaps only Russia, Turkey and Kazakhstan have the renewable resources to run a separate grid. It is also more than likely that Europe will seek to import electricity from North Africa.⁶⁴

The Philippines, an archipelago of thousands of islands, has only three grids at present, on the three largest islands. It is certainly possible to link the islands with underwater cables, but they will need proportionately more workers, and more backup electricity.

In every country, though, building a grid is a staggering task. My estimate is that in the US, for example, it will require perhaps one million workers a year for twenty years, just to build the grid. That's one million jobs on top of the jobs needed to build the wind and solar power.

However, that figure of one million jobs a year for 20 years is one of the least precise estimates in this book. Frankly, it's a guess. I have found no source with a clear idea of how many workers will be required, because no one has done such a thing before.⁶⁵ As academics like to say, more research is required.

Financial meltdowns

A government can build enough solar and wind power and get the money back over the years in electricity bills. There is no way electricity bills will ever be able to cover the one-off cost of building a new grid. That will have to be government money.

Then there are the financial pressures once large amounts of renewables are fed into the grid. That creates what is called in the United States the "utility death spiral". In the US, utility companies each work a part of the grid. The fossil fuel power stations and the renewable producers supply electricity to the grid, and the grid pays them. Some of this electricity is supplied on long term contracts. But when demand peaks, or there is a sudden break in supply, the utilities who share the grid have to buy more power. They look for the cheapest supplier.

That cheapest supplier is usually a wind or solar supplier. One reason is economic. The great majority of the expense of running a wind farm, or a solar farm, is the capital investment in the first place. The wind is

effectively free. That means the wind farm can sell electricity at a very low price and still make money. Eventually they have to make back the capital cost of building the turbines. But they can keep charging a low price for years at a time.

By contrast, a gas fired power plant has to pay for the gas every day. Their price for electricity cannot fall below the amount they need to buy the gas, or they go broke fast. So the renewable supplier tends to get the contracts.

There's another snag for the utility company in the US. There the companies usually had to lend money to the renewables companies to get them started. Then the fossil fuel plants started to lose money. The utility loaned money to them too. Soon the utility companies were up their ears in debts that the fossil fuel suppliers could not repay.

Once a country embarks on a plan for all renewable electricity, the financial problems of the fossil fuel power plants will rapidly become even worse. The companies that own the coal and gas power stations will go broke very quickly.

This is because the executives and share owners know that their assets are going to become "stranded". Share owners will try to get their money out. The companies will be unable to pay off loans and begin to go broke. But the grid will collapse if those power plants simply shut down. It will take at least 15 years to close down all the fossil fuel plants. This means the grid – in effect, the government – will have to take over the fossil fuel plants and close them down slowly, one by one. Doing that in an orderly fashion will also mean a climate jobs project can give every worker in those plants another job, with the same pay, near where they already live.

In sum, there is no way to build the renewable energy and the smart grids we need except with public ownership and government money. This means ownership of the new renewable power grid, but also taking the legacy fossil fuel power plants and utility companies into public ownership. Otherwise, the scale of the problems and the technical and financial complexities will make the project impossible.

However, there is a more positive way of thinking about that complexity. The energy expert Gretchen Bakke says that the engineers who work on them believe that grids are the most complex machines humans have ever built. They would say that, of course, because they're fans. But they're probably right. And the supergrids will certainly be the most complex and beautiful machines in history.⁶⁶

**MATKĘ
ZIEMIĘ
MAMY
TYLKO
JEDNA**

*"We only have one mother earth"
Climate striker, Warsaw, Poland*

CHAPTER 8

RENEWABLES AND THE MARKET

The falls in the price of solar and wind power have been dramatic. Does this mean that the market will now produce enough renewable energy?

Unfortunately, no.

We have been told for two decades that the proportion of renewable energy in total global energy has been continually rising. And yet, in 2019 wind and solar produced less than 2% of the total energy used globally. Less than 2%.

And that proportion has not been growing. For the last four years, the amount of new wind and solar each year has been flat, and not increasing. That means that total investment has actually been falling. (If solar is cheaper, lower investment can still produce the same amount of solar.) On the face of it, this makes no sense. Surely, if the price of wind and solar is falling, they should be replacing fossil fuels. And the cheaper they get, the more corporations should be investing. In fact, the opposite is happening. The market is failing. This chapter explains why, and what we can do about it.⁶⁷

The Statistics

The statistics on renewable energy are usually presented in ways that are confusing. Let me show you how that works, and how to think clearly about the numbers.

I start with the statistics for renewable energy in the European Union. The statistics for renewable energy are usually presented as a percentage of capacity. In 2018, for example, 17% of installed capacity for electricity generation in the EU came from wind power. And 11% of installed capacity came from solar PV. That's a total of 28% from wind and solar. That's pretty good.

But that is a measure of "installed capacity". Capacity means the amount of electricity a wind turbine is capable of producing if the wind blows at maximum speed 24 hours a day every day. For solar PV, capacity means the amount of electricity a solar array can produce if the sun shines without clouds 24 hours a day every day of the year.

But most of the time the wind does not blow at the highest speed the turbine can handle. And the sun does not shine at night.

In practice, a wind turbine is doing well if it provides 35% of its maximum capacity over the whole year. A solar PV array is doing well if it provides 20% of its maximum capacity over one year.

By contrast, natural gas usually achieves about 60% of capacity. Coal achieves almost 80%.

What this means is, we should never pay attention to statistics about capacity. The statistics you want are the ones for electricity production – the amount of electricity actually generated over a year. If you look at those statistics for the EU in 2019, wind accounted for 11% of electricity generation, and solar accounted for 4%. So that's a total of 15% of electricity generation. That's about half of the figure for capacity.

However, these are statistics for electricity generation. Sometimes it is called energy generation. Sometimes it is called power. But it means electricity and only electricity. The statistics do not include the oil, coal and gas burned in transport, in industry, and in buildings. And only about 40% of total energy use in the EU goes into electricity. That means wind and solar account for about 6% of total energy in the EU. Not so good.

But the rest of the world is worse than the EU. The global figures for electricity production each year are measured in terawatt hours. One terawatt hour is a total of one billion kilowatt hours over one year. As you will see, world-wide total energy use is 159 thousand terawatt hours a year. Wind and solar combined produce 2 thousand terawatt hours, less than 2% of total energy use. See the following table:

Global energy in 2018 in 1,000 terawatt hours

Oil	54
Coal	44
Gas	39
Traditional biomass	11
Hydropower	4
Nuclear	3
Biofuels	2
Wind	1.4
Solar	0.7
TOTAL	159 thousand terrawatt hours

“Traditional biomass” mostly means burning wood, but also includes burning leaves, crop residue and cow dung.⁶⁸

But it is very rare that you see the statistics that show wind and solar combined produce less than 2% of global energy. What you will see instead is a statistic for “renewables”. You might think that renewables means wind and solar. It does not. It usually includes biomass, hydropower, nuclear power and biofuels. Let’s look at those numbers again:

“Renewables” in 2018 in thousands of terawatt hours

Traditional biomass	11
Hydropower	4
Nuclear	3
Biofuels	2
Wind	1.4
Solar	0.7
TOTAL	22

In that calculation, half of the renewables are from burning wood and other traditional biomass. About 10% are from wind and solar combined.

Let's look at those statistics again:

Global Energy Use

Coal, oil and gas	137
Other Renewables	20
Wind and solar	2

Moreover, as we have seen, there will not be large increases in biomass, biofuels, hydropower or nuclear. The two energy sources that are really capable of expanding are wind and solar. They will be the workforces of the transition to renewables.

You may be thinking, "Wait a minute. What about all those times when the news says that on such and such a day 100% of energy in Germany came from renewables?"

Such statements are misleading for three reasons. The first is that they do not mean just wind and solar. Second, they don't actually mean 100% of energy. They mean 100% of electricity. Third, this particular day was probably the sunniest and windiest in the last few months. They don't mention the very much larger number of days when less than half of energy for electricity came from renewables.

In other words, the statistics are presented in ways that mislead you. I'll explain why shortly.

It should not be really surprising that there is so little wind and solar energy in the world. After all, CO₂ emissions are going up globally. If we had really gone from tiny amounts of renewables to very large amounts of renewables, CO₂ emissions would be going down.

Again, maybe you are thinking. "Hang on. In Europe there has been a real growth in renewables, and there have been real falls in emissions. The same is true in the United States."

And you're right. But most of the falls in emissions are coming from a switch from burning coal in electrical power stations to burning natural gas. Coal has about twice the emissions compared to gas for the same quantity of electricity. That shift has been marked in the European Union and North America, and it has had a much larger effect than the growth in renewables.

I can hear some of you thinking, "this is weird. This is beginning to sound like a conspiracy theory about the lizard people trying to kill Donald Trump. Why is Jonathan saying one thing, and almost all the sources I read are saying the opposite?"

There is more than one answer, because more than one group of people have good reason to exaggerate the amount of wind and solar. The oil and gas companies have obvious reasons. Just look at the ads they do on television and social media about how much renewable energy they are building. They want us to believe they are solving the problem.

The politicians and governments want the same thing. They do not want us to believe they are failing.

The people who work in the renewable industry, and the people who own it, want everyone to know the industry is doing well. And many of the rest of us desperately want to see more renewable energy to save the planet, so we want to believe what they are telling us.

But the figures are clear enough. So what's gone wrong? And how can we fix it?

What Went Wrong

Sean Sweeney and John Treat at Trade Unions for Energy Democracy (TUED) have explained what's gone wrong in a series of brilliant reports. Sweeney is a professor at the City University of New York, and TUED is an alliance of trade unions from all over the world concerned with climate change and public sector energy industries.⁶⁹

Sweeney and Treat's explanation for what has happened is convincing. It goes like this:

Until 2016, the amount of wind and solar power globally was steadily increasing. But that amount started from a very low base. At the same time, the global demand for energy was increasing rapidly. As more wind and solar was coming onstream, so were large amounts of fossil fuels. In particular, there have been large rises in the amount of fracked gas in North America. So while wind and solar have indeed increased, they remain a small proportion of the total because fossil fuels are increasing too.

Net capacity added in main generation technologies, 2009-2019 in GWs

Coal	529
Gas	438
Hydro	283
Wind	487
Solar	638 ⁷⁰

There was almost no net change in oil and nuclear for electricity generation.

But notice that these are figures for capacity added. Because wind and solar give you far less power for your capacity, these figures in fact show that the share of fossil fuels in electricity generated increased over the last decade.

And these are only the figures for electricity generation. The rise in use of oil in transport and gas in industry mean that the share of wind and solar in total energy use has fallen even more.

Then, starting in 2016, the amount of private investment in wind and solar began to decline. This was, oddly enough, a result of the falling price of wind, and in particular the falling price of solar. This seems strange, but Sweeney and Treat explain why that happened.

Until 2016, almost all wind and solar investment happened because of subsidies. Most of the subsidies were in the European Union, and most of them took the form of "feed-in tariffs." This meant that people or companies with wind or solar were promised a guaranteed high price by the electricity company for the power they provided. This subsidy was not paid by the government. Instead, the electricity company raised money for the subsidy by charging more to customers without wind or solar power. This was a political bomb waiting to go off. It was also a system that could only be tolerated as long as wind and solar were a small part of total supply.

Then the price of wind, and particularly, solar fell. The renewables industry began to say that solar was as cheap as coal, and maybe even cheaper. Wind, they said, was cheaper than gas. They were probably exaggerating a bit, but not by much. At that point the governments in Europe abolished the feed-in tariffs. Reasonably enough, they said there was no point in other customers subsidizing something that was already cheap. Instead, renewable companies had to bid for contracts to supply electricity to the grid. The renewable company that put in the lowest bid would bet the contract in each case.

The result was a deep cut in profits for the renewables corporations. They had been having fat contracts with guaranteed profit margins. And those margins could only get better as the technology got cheaper. Now they had to put in the lowest bid, which shaved their profit to the bone.

Companies had enjoyed guaranteed healthy profits. Now they faced narrow margins and low profits. Not surprisingly, many companies stopped investing.

The subsidies were cut first in the European Union. Quite quickly, they were cut in the United States as well. The same process is being repeated in China. In 2018 China had a reputation for massive development of renewables. In fact, wind accounted for 5.2% of electricity generation that year, and solar for 2.6%. That is a total of 7.8%, and that is only for electricity.

But then the Chinese government began withdrawing support for wind and solar. Michael Standaert, a knowledgeable journalist covering Chinese tech and energy, wrote in *Yale Environment 360* in September, 2019:

Important roadblocks have recently slowed the nation's green energy transition, following several years when emissions had plateaued. Although major solar and wind power installations in China's more far-flung provinces can produce large amounts of renewable energy, a lack of high-voltage transmission infrastructure means that a sizeable percentage of the green energy goes unused.

In addition, as renewable energy prices have fallen and the central government has grown increasingly concerned about the impact of the U.S.-China trade war on China's economy, renewable subsidies are being phased out. Wind and solar facilities must now compete directly at auction with other forms of power generation...

While curtailing subsidies for wind and solar power, the central government has sharply increased financial support for what it calls "new energy" extraction, which includes fracking of shale gas and separating methane from coal. Those subsidies are an important reason behind China's rising CO2 emissions...

While new solar photovoltaic installations hit an all-time high of 53 gigawatts (GW) in 2017, they slipped to around 41 GW [in 2018]... Projections are for about 25 GW of solar power to be installed this year and in succeeding years through 2025, an amount that would not sharply curtail fossil fuel use.⁷¹

Which is an understatement.

The same thing has been happening in India. During the 2015 Paris climate talks, India's government stated that it would install 175 Gigawatts of renewable energy by 2022. However, India is not expected to reach more than 69 GW by 2022, and renewable energy capacity fell to just 8 GW during the 2018-2019 financial year.⁷²

The problem is global. The rate of installation of new solar and wind has gone flat. That means that actual levels of investment must have declined.

Maybe this is a temporary stall in the market. Maybe it will right itself in five or ten years. I have my doubts, but it could happen. But the larger and more important fact is not the stalling of wind and solar. It is that headline number: After 30 years of effort all over the world, wind and solar provide less than 2% of global energy.

So, do we despair?

No.

All these problems with the market just mean that the market has not worked. We have given the market in renewables decades to work, and it has not. And indeed, why should it? Why should the market be the solution to the most acute problem humanity has ever faced?

This is another obvious reason we must have public sector, government run climate jobs programs producing renewable energy. Then those workers and those governments will not have to worry about profit margins. They can get on with the job that needs doing.

It's an example of a more general point. When things go wrong, don't despair. Fix the problem by doing something different.

Total Emission Reductions

I have now outlined measures which could reduce emissions from burning fossil fuels to generate electricity from 15 billion tons a year to 0.5 billion tons. That's not perfect, but it is a 97% cut in those emissions.

At the same time we could generate three times as much electricity as now, so we could convert heating, transport and industry to renewable electricity. And we could create millions of well paid, secure, productive jobs – transforming our economies, our societies and our local communities.

PART THREE

**TRANSPORT,
INDUSTRY
AND
BUILDINGS**

RESPECT THE SACRED

*Banner at the front of a march of indigenous
protesters against the Dakota Access Pipeline,
Standing Rock, 2016*

CHAPTER 9

TRANSPORT

This chapter is about emissions from transportation. The message is that we can make massive cuts in emissions and still give people in most of the world more transport and better lives. To do that we need a comprehensive switch to electric vehicles and public transport. That will require extensive regulation.⁷³

Here are the current emissions:

CO2 emissions from transport in 2018

Cars	4 billion tons of CO2
Planes	3
Trucks	2
Shipping	1
Buses, trains, minibuses	1
TOTAL	10 billion tons of CO2 ⁷⁴

Careful readers will have noticed that the numbers above add up to 11 billion tons, not 10. That is because almost all the individual numbers have been rounded up slightly. Some readers will also have noticed that the figure for airplanes, 3 billion tons, seems high. We will explain why later in this chapter.

There are three things we need to do to cut these emissions. One is to run all cars, trucks, buses and trains on electricity from renewable

sources. That will get rid of almost all emissions from those sectors. The second is to get many people out of cars and onto buses and trains. That will save energy, which reduces the amount of renewable electricity we will have to produce. The third, and most difficult, is to do something about planes and ships, which cannot run on electricity. I will take all three things in order.

First, we electrify all cars, trucks, buses and trains. This is straightforward. A government simply passes a law saying after three years all new vehicles have to be wholly electric. Each year after that, the number of petrol and gas burning vehicles on the road will go down. After twenty years there will be hardly any. If the people wish, governments can also speed up the process by paying "cash for clunkers" – buying old vehicles and recycling the metal.

There are a couple of problems. One is that large electric trucks do not have the same power as diesel trucks. They cannot accelerate as quickly and are very slow uphill. The immediate solution would be smaller electric trucks. That would create many more jobs for truck drivers. Putting more containers of railways would be a longer term solution.

In many countries, like the UK and South Africa, the current networks are working near capacity. In both countries we will need a new rail network double the size of the present one. Rail networks take years to build. So for the moment, smaller electric trucks and more drivers are probably the answer. In the longer term, railways could take far more freight traffic, or we may find technological breakthroughs with electric trucks.

There may be a better alternative already. It is possible to build overhead power lines on the major four and six lane roads that truckers use. This has already been done for one stretch of road in Germany, and it works. The technology for building and running overhead electrical lines has been used on railroads for decades. They are not hard to build, they are safe, and they can connect easily to the roof of the truck, as with railway locomotives.⁷⁵

The trucks would have hybrid engines, but not ones that use petrol. Instead, the engine would use electricity from the line on the motorway. But when it left the motorway, it would run on a battery for shorter distances to its destination. That battery would use the same motor technology as hybrid cars to store and reuse the energy from braking.

Short demonstration projects of 6 to 10 kilometers have been built in Germany on the A5 near Frankfurt, the BAB1 near Lubeck, and the

B62 near Baden-Württemberg. They work. Which is not that surprising, because there is no new technology involved.⁷⁶

Another advantage to overhead power lines for trucks is that they could also deliver power to charging stations for cars along the motorway. How to get large amounts of power to these stations is a problem for any plans for large scale electrification of cars. To coin a proverb, this can save two polar bears with one raft.

The other problem is that the electric cars of today are not able to store enough electricity to go more than 200 miles or 300 kilometers without recharging. However, most car journeys in all countries are over much smaller distances. Where distance is needed, people can imitate what many do in the US and Canada now for longer trips – fly and hire a car at the destination. They could also take trains.

It would also be possible to build a network of rapid charging stations. At each one, a battery could be lifted out of a car and a new one put in, which would take a couple of minutes. The charging stations would own the batteries, and rent them to car owners.

Another way of extending car journeys is for the car to use less energy. Fast acceleration is a large energy drain for all cars. So is driving over 50 mph (80 kph).

There is an important point of physics here. Much of the energy used to move a car forward goes into displacing the air in front of the vehicle. It's the same reason that runners in a race try to bunch behind the pacemaker who is cleaving the air in front of her. Cyclists in a race do the same. Crucially, the amount of energy needed to displace the air is determined by the square of the speed of the vehicle. So a vehicle going 70 miles per hour requires almost twice the energy of a vehicle going 50 miles per hour to make a path through the air ($70 \times 70 / 50 \times 50 = 49 / 25$).

In other words, electric cars which accelerate more slowly and have a lower top speed could drive much longer distances without recharging. Until now electric cars have been built to sell to a niche market of affluent people, and the manufacturers believe that those people want a high-end vehicle that can do everything a petrol powered car can do. But with mass production there will open up a space for cars that sell to the same market as the old Volkswagen beetle, Morris Mini, De Cheviot and Model T – a cheap, reliable car that goes a long way on little energy.⁷⁷

In addition to electric cars, we also need to get large numbers of people out of cars and into buses and trains. This saves energy and

fuel because most cars have only one or two passengers. Buses use between a half and a quarter of the energy per passenger compared to cars, depending on how full the buses are.

Trains use even less energy. Again, this is for reasons of physics. One advantage is that the train is long and thin. Remember, past a certain speed most of the energy goes to divide the air in front of the vehicle. In a train of twelve cars, the front car does that work for the rest. The other advantage trains have is that both the wheels and the track are made of steel. This means that there is much less friction as the train moves, compared to a bus where the rubber of the tires drags across the asphalt of the road.

However, train tracks and electrification cost a great deal more, and require many more jobs, than putting a new bus on the road. And it takes much longer to build a new railway. So the choice between rail and bus lines is always a trade-off between time, the number of jobs needed, and energy saving.

One great advantage to buses is that they can go into operation as fast as the factories can make them. Buses also clear roads and create jobs. If thirty people are driving to work, each in their own individual car, all thirty are doing real work driving. But it is not a paid job. If all thirty get onto a bus, one person drives that bus, and she is doing a paid job.

Buses are another case where regulation will make all the difference. Cities can reserve certain lanes for buses, either during rush hour or all day. This happens in many places already. Cities can also reserve whole streets for buses, either during rush hour or all day long. Then you get the real benefit of moving people out of cars, because the traffic zips along. You can see the effect this would have if you take a night bus in London in the early hours of the morning. The bus does a 60-minute commute in 20 minutes. But where this system would really come into its own is in the great and utterly clogged cities of the world, like Lagos, Mumbai, Kinshasa and the LA freeways.

The key here is not to just encourage people to take public transport and leave their cars behind. That will always leave the roads clogged and bus passengers as second class citizens. The key is regulations to ensure that at certain times, in certain places, people must use buses and not cars.

Several other things can speed up buses even more. One is to eliminate the time the driver spends taking fares. This can be done by employing conductors who take the money. This used to be the case in most countries, and still happens in many. And it creates more jobs.

Another way is simply to make buses free. This increases the appeal and efficiency of buses. The buses are still paid for, of course, but from taxes, which means the burden falls more on the rich than the poor.

Express buses can also work well. Imagine a street four lanes wide, with parking on both sides. When it becomes an all bus street, there is no need for parking. Then express buses can pass easily and quickly on the outside lane, avoiding the constant delay of stopping every two blocks.

Many cities have already installed "Bus Rapid Transit" systems. These have reserved lanes for buses, with fixed platforms where people pay before boarding. The experience is mixed.⁷⁸

But then what happens to existing taxi and minibus drivers? In many cities today, the taxis are allowed into the reserved bus lanes, slowing them down. More important, taxis have the same problem as private cars – they require a lot of energy just to get one or two people somewhere.

Remember, we have to build the support of majorities to change the world, and part of that is not dumping workers on the scrap heap. There is an obvious alternative which makes climate and human sense. In Istanbul it's called the *dolmuş*, and millions use them every day. In English the phrase is shared taxi, and they are found in many countries around the world.

Shared taxis work like this. As long as the driver has a spare seat, she picks up anyone who sticks their hand out. Much of the time, the taxi is running with four or five passengers, and using about a quarter of the energy per passenger of a single person car. Sometimes a taxi follows the route of an established bus line. Sometimes they can function as express buses. Sometimes they run routes at right angles to the main bus lines, which mostly run in and out of the city, thus giving bus passengers more choices.

In the United States, Uber and Lyft have recently introduced shared ride schemes which work in a similar way. But the taxi does not start out full, or with a fixed route. Instead, the driver starts with one passenger and then picks up others, and computer control of flexible routes makes this possible.

The disadvantage of shared taxis is that the rich have to sit next to the poor, a white person next to a black person, and the twice born next to the Dalits. This is also the advantage of shared taxis – they can begin to create another kind of society, where those people talk to each other.

Taxi drivers can also scale up to minibuses. They can do this either

by being owner operators, and getting government loans, or by going to work for a public minibus service. Minibuses are already a crucial part of transport provision in South Africa, Turkey and many other countries in the global south. They use less energy per passenger than taxis do. But because they are smaller than other buses, they retain the speed and flexibility. Like taxis, they can line up and wait at the start of the run until they are full, and thus more fuel efficient.

A combination of shared taxis, minibuses and buses can provide fast, efficient, clean services that come every few minutes all day long and run all night – what people want from their transport.

Putting people in buses and mini-buses can also free up a lot of space on roads and streets. Some of that space can go to cyclists. Two different patterns of urban cycling are common now. In one pattern, strong, agile and daring young men and women weave through traffic. Their health improves because they are so fit, and their health is damaged because they have so many accidents and breathe so much pollution. On balance, it is better for those young adults to cycle. But the calculation feels different to children and older people.

The other pattern happens when the city provides cycle-only lanes. Then cycling is suddenly safe, and the less fit, the older and the younger fill those lanes. For this, a bus lane that is painted on the road is not enough. Curbs between lanes are needed so that cars, vans or mini-buses cannot simply crowd into the cycle lane. And the cycle lanes have to last for most of the journey, with perhaps short and unavoidable interruptions where the rider has to get off and walk.

With all this in place, many cities can become like Amsterdam or Copenhagen, where half the workforce cycles to work. The reduction in energy use is important. So are the health benefits for the cyclists, and the increased safety and freedom for children. Cyclists, moreover, do not take up a lot of space on the road. It should be said, however, that Amsterdam and Copenhagen are flat.⁷⁹

Two other groups of vehicles could be included in the cycle lanes. One is battery driven electric cycles. Some of these simply supply extra power on hills, and in some the battery powers the whole journey. They use small amounts of energy, and have already transformed traffic in Chinese cities and leisure in Austria.

Wheelchairs driven by electric motors are also important to equality. All transport systems discriminate against the disabled, some more and some less. But safe and navigable routes for wheelchairs can make an enormous difference to quality of life.

Reducing the number of cars on the road frees up a great deal of space, and creates many possibilities. We can reserve city centers for walkers, cyclists and buses, or even make them fully pedestrian. This has been done in parts of many cities already, and you know what? They never go back. It's the remaking of the city centres, which become vibrant and alive again.

Putting people on buses also opens up enormous amounts of space in the rest of the city. With fewer parked cars, you have enormously more space. A large proportion of the streets across the city can become car free. This provides space for tree planting, small allotments to plant food and flowers, and splash pools for children in summer. These open spaces can transform the lives of old people, children, the overcrowded, the disabled, the lonely, parents of toddlers, and dogs.

This is not simply a matter of more space. It is shared space. I used to visit a friend in London who lived in one of the blocks where everyone's back garden opened onto everyone else's. The sense of space, and of community, was striking. Shared space in front of the flats and houses will be just as important in creating a sense of community. It will provide places where old people can watch children play, and know them by name. It can create far safer communities, because people collectively own and watch that space.

The transport changes do need regulations. These are imperative if we are to reduce emissions by requiring electric vehicles and reserved lanes. But pedestrian only spaces do not require some top-down authority. All that is needed is for one city to vote democratically to experiment with becoming largely pedestrian. Then people will visit from all over the world, and far more will see reports on television. That one example will spread around the world.

The Global South

The measures we are describing will work in both rich countries and poor. But they will be more important in the global South.

In some rich, very car dependent, countries, like Canada or the United States, buses and trains would save a great deal of energy. Indeed, they would do so in China and Germany as well. But public transport is even more important for the future in poorer countries. In these countries, more than half of people already take the bus or train, or walk or cycle to work and school. As these countries get richer, the roads have begun to fill with cars. The air becomes poisonous and

roads become grid locked. If most people in India and Nigeria drove a car to work, the demand for energy would be enormous. The gridlock would also be unbearable. Indeed, it often is already.

But public transport that does not overload the roads, that comes quickly day and night, and runs swift and clean provides an alternative vision of a low carbon future for developing countries. It is what I mean when I say that we want carbon-free growth to improve the standard of living for poor people in poor countries. It is also a vision of equality.

This future will not work if the same system is not implemented in rich countries as well as poor. The bus will continue to be a sign of backwardness, until cinema goers in Kathmandu see actors in Hollywood and Bollywood movies talking to each other on the bus, and flirting with strangers in minibuses.

Another consideration is important in many poorer countries. Large numbers of taxi and minibus drivers and owners are already in place. Kenya, Tanzania and South Africa provide examples, but there are many more. These drivers and owners have long provided a transport service, and met a need that the state and the municipalities have ignored.

There are also more than ten million motor rickshaw three wheelers (tuktuks) in southeast Asia, and another ten million in India alone. These people deserve a living, and the chance to drive an electric vehicle. However, this is an area where a lot of unfeeling mistakes have already been made. In many cases top down government measures have slashed living standards in the name of green transport. In 2019 the Egyptian government began to ban three wheelers in Cairo. In South Africa, the government tried to replace the minibuses which had run right through apartheid from Soweto to Johannesburg. The ensuing "taxi wars" were brutal and bloody, and the government retreated.⁸⁰

These are not simple tales of good workers and evil planners. Relationships between owners and drivers are complex, and redolent with class conflict. But a climate jobs transport approach could remake transport by giving every taxi, minibus and tuktuk driver an electric vehicle and a secure job.

In many parts of the world taxi and bus workers in the informal sector have been able to organize themselves in unions. It's difficult, but it's not impossible. And if humanly possible it works best to decarbonize a transport system by organizing the existing workers first.⁸¹

Why public transport?

We have suggested a two-fold approach to road transport. On the one hand, a switch to public transport can improve the quality of urban life, while also reducing the amount of energy needed for transport. At the same time, the government can require that all new vehicles built or sold must run on electricity. But why do both? Why not simply switch to electric vehicles, without all the public transport? Wouldn't it be easier, and save jobs in car factories?⁸²

There are four answers to this question. First, the transition to using renewable electricity for almost all energy needs is going to be a massive project. The more we can reduce energy demand, the easier it will be to achieve the transition. And the faster we will get there, which is important to halting climate change.

Second, the route I have outlined has the advantage of making people's lives better. It is important for building support that green new deals provide something that is not just different, or less, but palpably better.

Third, there are enormous numbers of jobs in public transport. People need those jobs.

Fourth, jobs will be lost in car factories if there is a massive switch to public transport. This will not happen at first, because there will be many new electric buses, electric cars and electric trucks to build. Those vehicles will be more expensive at first, which is to say more jobs will be needed to build them. But in the longer term, after the frenzy of the first decade, there will probably be fewer jobs.

We have to recognize where car workers find themselves now. All over the world, large numbers of jobs have been lost to robots and automation. And all over the world, many more jobs will be lost as these technologies are refined. A climate jobs approach will give car workers a guaranteed working future, and it is the only approach on offer which will do that.

Aviation and Trains

So far we have been talking mostly about transport on the ground, and in towns and cities. Now we turn to transport between cities, and to aviation and trains.

It is perfectly possible to cut all CO₂ emissions from cars, vans, buses and trucks. Aviation is another matter, because there is no way to replace the aviation fuel, made from oil, with electricity. One could

argue that global emissions from aviation are comparatively small. The official figure is one billion tons of CO₂ a year, about 2% of total global emissions.

However, there is considerable evidence that some of the other gases produced by planes have a greater impact because they are released so high in the atmosphere. The most important of these gases is water, and the most important impact is to change the nature and density of cirrus clouds. In 2020 an impressive study by David Lee of Manchester Metropolitan University and colleagues across the world came to the conclusion that the heating impact of all these emissions together was roughly three times the impact of the CO₂ alone.⁸³

To make the argument easier to follow, I have done the calculations here as if total aviation emissions were 3 billion tons of CO₂. This is about 5% of total global emissions, a substantial amount. Moreover, before the Covid 19 pandemic emissions from planes were increasing faster than from any other source. The reason is there is so much unmet need for fast national and international travel. The problem is not just emissions now, but finding a different way of meeting that need going forward.

Some improvements in fuel efficiency are possible, although there are definite limits. Planes are already very efficient and aerodynamic, because fuel is already a considerable part of the costs to an airline. And only limited economies are possible by filling the planes more fully, because in most countries they already run at 80% of capacity or more. But banning private planes would help.⁸⁴

What can make the most difference, however, is a switch from planes to trains. It is perfectly possible, for example, to stop all domestic flights in the continental United States, or all flights within Europe. Stopping these shorter flights would make a great deal of difference because so much of the fuel use in any flight comes at take-off and landing. On a short haul flight, that is more than half the fuel use, and so more than half the emissions.

Rail connections could be built to replace any flights within Europe or the United States. Let's consider journeys of less than 3,000 miles or 5,000 kilometers. The replacements would not have to be "high-speed" rail. That term usually refers to the state of the art fast rail services that have been built in China, Japan, France, Spain and Germany. Most of those services go at least 200 mph, or 300 kph. But that would not be necessary. Something like the ordinary UK intercity services, which at their best go 125 mph (200 kph), would be adequate.

Having somewhat slower services, on this scale, would be useful for two reasons. One is that less electrical power is required. This is because, again, the amount of energy needed to part the air is determined by the square of the speed. The second reason is that the track has to meet higher standards, and be more firmly bedded, to go very fast. Train tracks designed for speeds of 125 or 150 miles per hour can be built much more cheaply, and with much less delay.

But a train that can average 125 mph can cover 3,000 miles, or 5,000 kms, in 24 hours. Journeys that long or shorter include London to Moscow, Oslo to Istanbul, Istanbul to Casablanca, Istanbul to Kabul, Kabul to Ho Chi Minh City, Cairo to Nairobi, Nairobi to Joburg, Kampala to Lagos, New York to Los Angeles, Mexico City to New York, Montreal to Vancouver, Caracas to Lima and Lima to Buenos Aires.

These journeys could be comfortable. People could move about and chat, and go to restaurant cars. They could also sleep in what are called couchettes in French. These are compartments where six people sit in two rows of three during the day. During the night two upper beds fold down on each side, so six can sleep. People can arrive at their destination a day after boarding the train. And most train journeys would be much shorter than that.

I have done long railway journeys with a good sleep overnight, and I have done long flights across Europe and the US. I emerge from the rail journeys calm and rested, and from the airport shattered.

Making this switch will require building new railway lines. This is true even if they are not high speed, because most of the railway lines in the world are already close to full capacity with passengers and freight.

There has been a lot of coverage in Britain and the US of the difficulty of building high speed lines. The attempted line between San Francisco and Los Angeles is sometimes presented as proof that these lines cannot be built, or would take forever to build.⁸⁵

In fact, there are high speed networks already in several countries. China built a dedicated high-speed only network of 29,000 kms in six years, start to finish. That's longer than the regular rail network of all but eight countries in the world.⁸⁶

So what's the problem in California? One answer is property. More than half the expense, and much of the delay on high speed lines in many countries comes from buying out the thousands of property holders along the lines. Much of the rest goes in building bridges, overpasses and tunnels. In addition, many countries also have traditions of long delays and large cost overruns on large infrastructure projects.

In some cases, perhaps most, I suspect that corruption is also salient.

Moreover, the model for building high-speed rail in North America and Europe now assumes Public-Private Partnerships. These are deals for large construction projects in which the government assumes all the risk and loss, and private companies are charged with management and reaping the profit. That is a recipe for cost overruns and failure to deliver a service. This is what has happened across a range of industries in the United States and Britain, the two countries which have pioneered these partnerships. To coin a phrase, it's no way to run a railroad.⁸⁷

A partial solution to the overruns and corruption is to make building new rail a public project, with engineers and workers hired directly.

A deeper problem in both Britain and California, as well as other countries, is the business model for high-speed rail. This model assumes that rail will have to compete for passengers with air travel over medium distances. That means rail will have to be very fast, and deliver profits, which means large costs to build, expensive tickets, and large passenger numbers. There are too many contradictions in that business model. The solution is to gradually close short-haul flights, so the need to compete with planes is no longer relevant.

Another way to save a lot of money is not to run the railway lines from city center to city center. Many countries already do this with buses. In Finland and Venezuela, for example, the inter-city buses stop outside the city, and passengers transfer to local transport. Most countries in the world do something similar with air travel. The planes land well outside the city center at something called an airport, and then taxis, private cars, trains and buses then take passengers on into the different parts of the city.

At the moment railways run from center to center because when they were built, mostly more than a century ago, urban land was easier to obtain and the business people badly wanted a modern railway station as a mark of civic pride and status. But if railway lines ran around cities there would be far less need of expensive tunnels, and far less expensive property to buy.

In some cases, it would also be worth converting existing roads into railway lines, with an immense savings in construction and property costs. And there are many cases where it would also make sense to use part of the existing airport as a railway station, already connected to good transport links.

In the long run, all flights of 5,000 kms or less could be transferred to rail, and many flights of 10,000 kms could be transferred too. But the long run will take time. I mentioned the Chinese network built in six years, but that is unusually fast for a whole network. Building a new rail network in most countries will be an immense project, and could take ten years or more to finish. We would need true consultation and real democratic processes engaging the local communities. This all means it will take time to wind down flights too. During that time we can begin with shorter flights, and ramp up long distance bus services with – wait for it – reserved lanes.

There will also be a reduction in business travel after the pandemic. Learning has taken place. But over the long term more people are going to migrate from one country to another – particularly with the impact of climate change. Migration increases the demand for visits home to friends and family. Demand for travel to see the world also continues to grow. I think that these are very good trends. The more people know of the world, and the more people travel around the world, the easier global solidarity becomes. When you have visited a place, you can more easily picture what is happening there. Empathy becomes easier.

But we will also need some form of rationing. Perhaps the easiest would be that anyone who takes a long-distance flight has to stay in their destination country for a month, and that holiday entitlements agreed with employers are adjusted for this.

Still, there is a choice to be made. One possibility is that short haul flights come to an end, but long haul flights slowly increase. There would be more room for migrants and people who wanted to see the world on those long flights, but less for business people who could work virtually. Employment levels would remain much the same. Emissions would probably fall by at least a quarter, through technical changes.

The second choice would be to end short flights and keep long flights at current levels. One thing that would make this much easier is a tunnel between Siberia and Alaska across the Bering Strait. The Strait is only 53 miles wide at the narrowest point, and the sea is mostly about 30 to 50 meters deep. The weather, and the seas, are terrible much of the year. But a tunnel would be easy enough to build. More difficult technically would be building considerable rail and road links across tundra, snow and steadily melting permafrost. In all, it would be a project on the scale of the Suez Canal, the Panama Canal and the Channel Tunnel – all of which have been built. ⁸⁸

Over the last thirty years there have been plans in Alaska, and by the governments of China and Russia, to build such a tunnel. The benefit would be that this would provide a bus and train link between Africa, Europe, Asia, North America and South America. Travel between most countries would then be possible using only renewable electricity.

So what happens to the people who work in aviation if aviation emissions have to decline by a third or a half?

Many people in aviation work in catering, baggage, ticketing, cleaning and other jobs where they may not always be dedicated to working for that employer. These would be easily transferred to our new trains. But lots of people also work in jobs where the travel and excitement of the job are specific to aviation.

There are several things to say to those people. First, there are massive layoffs and bankruptcies, right now, in the aviation industry. Those are going to continue. Aviation workers need a Green New Deal right now, on a massive scale.

In the longer run, half the jobs would go in twenty years. But without any changes to the aviation industry, half of current workers will retire or leave the industry over twenty years anyway. With business as usual that will not be a smooth, planned, process. Many airlines and airports will go broke. So we will need a public body that keeps a register of workers in the industry, and makes sure that workers laid off are offered first crack at any jobs that open up elsewhere.

Shipping

Shipping is the other area of transport that's hard to electrify. Electric ferries work well over short distances, but most shipping is long haul. And there is a surprising amount of it. The majority of international freight, and the great majority of intercontinental freight, moves by sea. Shipping is also far and away the most efficient way of moving weight. This is partly because ships float. It also takes less energy to part the waves. Cargo ships are also relatively long and thin, so they have to part less water. The result is that shipping now accounts for slightly less than 1 billion tons of CO₂ emissions a year. There are ways of reducing those emissions by changing ship design and engines, but they will not make much difference.⁸⁹

There is one way that emissions from shipping can be reduced a good deal. Once a ship reaches a certain speed, the amount of fuel needed to power a ship is a function of the cube of the speed of the

ship. The calculations are complicated, and differ for different kinds of ships. But basically, a 30% cut in the speed of the ship can reduce total fuel use during the voyage by a third. A cut in speed of 50% can probably reduce total fuel use by half.⁹⁰

Shipping firms know this. It's why oil tankers move at such a slow and stately pace. So do other bulk carriers of commodities like coal. The big problem is with container ships. The invention of the standard container transformed global shipping over the last fifty years. It was central to the rise of China as a manufacturing power, and to the destruction of union organization in many ports around the world. Containers also reduced costs a great deal.

But they also developed at the same time as the shift to "just in time" production and inventory methods across global industry. Just in time provided more flexibility to industry. And it reduced financial and borrowing costs by moving products more quickly. But it meant that ships with manufactured goods and parts had to move quickly.

Simple rules can change all that, by setting maximum average speeds. These rules do not need to be global. Any receiving port can simply require that ships which might want to dock report their positions via satellite at weekly intervals.

Maersk, the world's largest fleet owner, is already experimenting with reducing speeds. The reduction in emissions could be massive.

The number of seafaring jobs and ship building jobs available would also increase. If ships take twice as long to get somewhere, the total number of ships has to double. And the number of seafarers working has to double too.

Sails could also make a difference if ships were already going slowly. Slow moving ships also provide a more low carbon way than planes to get people across the Atlantic, the Pacific and the Indian Ocean. The problem with passenger sea voyages now is that they are wasteful. Large numbers of crew, and a lot of space and expense, is devoted to giving passengers a luxury experience. But young people, in particular, might find low carbon slow moving sea voyages an attractive alternative. People could sleep four to a cabin, taking three or four weeks to cross the Atlantic. The passengers could do the cooking, cleaning and washing collectively. They could produce their own entertainment. And a ship full of two thousand young people for a month could create a lifetime of memories.

Military emissions

We have not yet considered emissions from military transport – planes, missiles, tanks, trucks and so on. These are small. The only military I have been able to find accurate estimates for is the United States. Its emissions from fuel use were 59 million tons in 2017. That is sometimes quoted as being more than the emissions of some countries, like Sweden, or Norway or Switzerland. And that is entirely true. But total US CO₂ emissions from civilian transport were 30 times that number. Total US emissions were 80 times as high, and global emissions were 500 times as high. In those terms, US military emissions are unimportant.⁹¹

There is another side to those emissions, however. Oil is absolutely essential to the operations of the US military, and to every other military on the planet. A very low carbon transport system would be threatening to the US and other military machines. For one thing, it would be extremely difficult to operate tanks and trucks in countries without an infrastructure for fuel. This would apply both to the military's home country, and worse, to any country they might want to invade. If some planes are still running, it might be possible to piggy back military aviation and missile fuel on top of that. But the supply lines would be exposed, and the military use of oil would be widely sneered at.

For these reasons, it is likely that US, Chinese, Indian and other armed forces are quite likely to prove hostile to zero carbon road transport, in particular.

In short, military emissions are not in and of themselves a major problem, but the politics will be.

Total cuts in emissions

It depends on what the people of the world decide we want to do, but very large cuts in emissions from transport are possible. We can, without much technical difficulty, reduce emissions from all ground transport from 6 billion tons to almost nothing. We can reduce aviation emissions from 3 to 1.5 billion tons. With shipping, we can reduce emissions from 1 to 0.5 billion tons and still allow far more freight and passenger transport.

That would be a total reduction from 10 billion to 2 billion tons of CO₂.

FIGHT THE FIRE

WIR HABEN ES VERGEIGT, DER MEERESSPIEGEL STEIGT!

"We blew it, the sea level rises"

A chant on German climate demonstrations. This uses the wonderful German term "vergeigt" that literally means "mis-fiddled" as in played the fiddle wrongly, as in, one totally "fucked up". This has the connotation that you can't go back once you played your fiddle wrongly in a concert. You won't be able to turn back the time and correct your mistake. You messed up the concert for everyone, and destroyed your whole fiddle career. That's it. Go home.

CHAPTER 10

INDUSTRY

We start our consideration of industry by clearing up something that can be very confusing. There are two possible ways of counting emissions. One is to count the emissions which are produced on site in industry. The other way is to count in terms of “end-users”. In this second way of counting, you add together the emissions produced on site and the emissions produced in the making of the electricity which is eventually used in industry.

The trouble with end-user calculations, though, is that it can easily lead to double counting. I have already counted the emissions from electricity currently used in industry in the earlier chapters on renewable energy and electricity. Here I am just going to talk about, and count, emissions on site.

There are two main sources of emissions on site in industry. One source comes from burning coal or gas to heat materials like steel in blast furnaces. The other comes from greenhouse gas emissions as byproducts of the chemical reactions in the industrial processes, like the CO₂ that escapes in the making of cement.

The emissions from industry on site in 2018 were:

Burning fossil fuels for heat	5 billion tons
Byproduct emissions	3 billion tons
TOTAL	8 billion tons ⁹²

These emissions from burning fossil fuels and industrial byproducts come overwhelmingly from three industries:

Emissions in billion tons of CO₂ from industry in 2016

Cement	2.5
Steel	2.5
Chemicals	1.5
Other	1.5 ⁹³

Cement, steel and chemicals industries account for 6.5 billion of the 8 billion tons emitted. The remaining 1.5 billion tons come mainly from pulp and paper, aluminum and the food industry.

Costs and International Competition

There is a special tyranny of costs in industry. You can see it in what engineers write about possible emissions cuts in industry. There is an enormous range of material in the published research, and much of it is very good.⁹⁴ But almost all of it is produced under a particular constraint. The researchers are looking for ways of reducing emissions that industry can *afford* to implement.

This is entirely sensible. Why should they be looking for solutions that no one is going to use? Why, indeed, should anyone fund them to do such research?

I can imagine expensive ways of creating a very low emissions renewable electricity economy. So can lots of other people. They, and I, can also imagine a way of running a public transport system that reduces emissions. In both cases, we are imagining that people like us are in charge of a national public electricity grid, or a national public transport system.

Industries, though, are often producing their products for an international market. They are competing with similar companies in other countries. If their costs rise a great deal because they are implementing very low emissions technologies, those competing companies can and will hammer them. The innovating company will go bust.

The result is that almost all studies on the decarbonizing of industry are phrased in terms of looking for options that are “affordable”, or economically “sensible”. It is not easy to see beyond this to what might be possible. And there is an understandable tendency to look more at changes in process rather than at simply not manufacturing that particular thing any more.

But it is still possible to see the broad contours of possible changes in the four main sources of industrial emissions: cement, steel, fertilizers and plastics.

Reducing Industrial Emissions

It is not easy to cut emissions from heating materials in industry. Cutting emissions from electricity production is reasonably straightforward: switch all production from fossil fuels to renewables and emissions are almost nothing. Cutting emissions from ground transport is straightforward too: reduce the energy required by using more public transport, and switch all vehicles to renewable electricity.

Burning fossil fuels to heat limestone accounts for about 40% of the emissions from making cement. But 60% come from the process. The whole point of heating limestone is to get rid of the carbon, which escapes from the limestone and joins with oxygen to make CO₂ in the air. It is possible to heat the limestone with renewable electricity, but there is no way round the CO₂ from the carbon.

There are some ways of reducing emissions from making cement. They include more efficient kilns, recycling of concrete, and using higher strength concrete.

The real solution, though, is using little or no concrete. Almost all cement is used in concrete for buildings and infrastructure like roads and bridges. The next chapter, on buildings, will explore the implications of construction without concrete.

Again, this solution involves simple regulation. This does not mean that all emissions would be avoided. There may still be situations in which cement or concrete is absolutely necessary. And there will be some emissions from alternative materials, such as making lime for mortar or asphalt for roads. But very substantial reductions in emissions would be possible.

Moreover, there has been some research into alternative materials. A ban on concrete would send the search to find alternatives into hyper-drive, and perhaps equally useful, if more expensive, solutions would emerge.

Steel

This industry is often called iron and steel, but the end product is steel. Unlike cement, most of the CO₂ emissions come from heating materials, and only about 10% are byproducts of the process. About

30% of new steel is made from recycled steel, and almost all of the heat can be done with electric arc technology. This uses an electric beam passing from one electrode to another, rather like directed lightning, to heat the furnace up to 1,600C. That electric arc can be powered by renewable electricity.

The problem is the other 70% of steel, which is made from processing iron. Steel is basically iron with the impurities removed, and the main impurity that has to be removed is oxygen. The iron is usually heated in a blast furnace by burning coal or coke. Both of these are mostly carbon. Burning the carbon heats the iron. Some of the burning carbon combines with the oxygen in the air to produce CO₂. And some of the carbon combines with the oxygen in the iron to produce more CO₂. You see the problem.

There is a possible solution. Iron can be heated by burning hydrogen gas. Then the hydrogen combines with the oxygen in the iron to produce H₂O – water vapour, and there are no CO₂ emissions. The problem at the moment is where that hydrogen comes from. The usual way of producing hydrogen gas is to make it from natural gas, which is methane. That creates CO₂. However, it is perfectly possible to make hydrogen out of water, using renewable electricity. The water splits into hydrogen and oxygen.

Swedish steel makers are experimenting with producing steel with hydrogen from renewables. The problem they confront now, however, is that it takes a great deal of electricity to make the hydrogen. There is a general agreement that we will have to wait at least ten years, and maybe longer, before hydrogen can be anything like economically competitive.⁹⁵

The solution here, of course, is to step outside the constraints of “economically competitive.”

If governments decide that all steel production has to be done with hydrogen, then it will be done. Again, though, this is a task for a climate service making renewable energy. No manufacturer, private or state owned, will want to compete with steel plants in other countries using cheaper fuels. But a combination of subsidized hydrogen and import taxes on non-hydrogen steel will solve the problem. And it is entirely reasonable to hope that in time mass production will lead to innovations that bring down the cost of hydrogen.

It will also be possible to reduce some of the uses of steel by switching to other materials. Most steel is used in buildings,

infrastructure and vehicles. A building of ten stories or more requires a great deal of steel. A building of three or four stories does not. If we stop building tall buildings, we can drastically reduce the use of steel in construction. We will say more about this in the chapter on buildings.

The other main use of steel is in vehicles. The usual material here is steel, but many manufacturers use aluminum for parts of the vehicle. Cars and pickups are sometimes made almost completely from aluminum. The aluminum panels are weaker, so auto manufacturers have to use two or three layers for full strength. Many heavy truck manufacturers also use aluminum for much of the cab and body, because the lighter weight helps to save fuel.⁹⁶

The good news here is that almost all aluminum could be produced using electricity. Very large amounts of energy are needed to heat the raw bauxite into aluminum. Globally, 60% of this is now done using fossil fuels. But 40% is done with electricity. This is usually in places with large amounts of very cheap electricity, like the hydroelectricity from dams in Norway and geothermal energy in Iceland. There is no technical reason, however, why all aluminum cannot be produced using renewable energy.

However, there is a limit to how much aluminum can be produced. There are sufficient known reserves of bauxite to supply 100 years of aluminum production at current levels. But if all steel was replaced, which is not going to happen, those reserves would be used up in about ten years. So a switch from steel to aluminum cannot solve the problem. It may serve as a partial solution until a way of using electrolysis on iron ore becomes workable.

It is not easy to estimate how much steel emissions could be reduced by a combination of using hydrogen, switching to aluminum, and using less steel in construction. But it seems reasonable to estimate at least 80%, from 2.5 to 0.5 billion tons.

Chemicals

The chemical industry is responsible for 1.5 billion tons of emissions. The two main sources are the production of plastics and of ammonia for fertilizers.

What fertilizers contribute to the land is nitrogen. In synthetic fertilizers, the first stage of the process is to use heat to combine natural gas (CH₄) and nitrogen (N) from the air to create ammonia (NH₃). In the process, some CO₂ and nitrous oxide escape into the air as industrial byproducts. But about two thirds of the total

emissions come from the fossil fuels used to heat the natural gas to make ammonia.⁹⁷

Changes to the production process, the use of alternative fertilizers, and chemical scrubbers to catch the nitrous oxide can reduce these emissions by at least a third, and perhaps more.

A larger problem remains. CO₂ emissions from fertilizer manufacture are only 0.5 billion tons a year. But the nitrous oxide emissions from fertilizer use on the land are almost 3 billion tons a year. In the chapter on farming we will describe how we can reduce those emissions by cutting fertilizer use by at least half. And that would mean we can cut fertilizer manufacture by at least half as well.

The other important sector in chemicals is plastics, with emissions of about 0.7 billion tons. Again, there is now wide awareness that we manufacture and use far more plastic than is good for the planet. The most important problem is single use plastics, especially in packing and packaging. The alternative is often paper, which has its own emissions. The other single use of plastic is in bottles. All those uses can be replaced by glass and aluminum, which can easily be recycled. So again, there are cuts possible in emissions from plastics, and larger cuts from using other materials.⁹⁸

Total Emissions Reductions

I have outlined the major problems in industry, and the most important solutions. My estimate is that the following reductions in current emissions would be possible with technologies we have today:

Possible reductions in industrial emissions, in billion tons

Cement	2.5 to 0.5
Steel	2.5 to 0.5
Chemicals	1.5 to 0.5
Others	1.5 to 0.5
TOTAL	8 to 2 billion tons

Further cuts in emissions could be made if it proves possible to use electricity for heating all materials.

These cuts in emissions lean, to some extent, on technological solutions. But bans, switches and substitutions will be more important. Again, that means government regulations: to ban concrete for most

purposes, to insist on more aluminum in vehicles, to limit the use of steel in construction, and to restrict the use of fertilizers in agriculture.

Here again, help from the state will be essential to the reduction of industrial emissions.

人からどう思われようが、
私たちは声を上げる！

**climate
justice**

*"No matter what people think,
we will continue to raise our voices. Climate Justice."
Climate striker, Japan.*

CHAPTER 11

BUILDINGS

This chapter is about emissions from buildings. In developed economies about two thirds of these emissions come from people's homes, and a third come from public buildings and businesses.

There are three ways of thinking about emissions from buildings. One way is to think about the emissions from the electricity used for lighting and machines. We have covered this in the chapter on electricity.

The second way is to think about emissions from the materials used in buildings. As we saw in the chapter on industry, the important materials are concrete and steel. We will not be counting emissions cuts in making materials here, as we have already counted them. But we will be thinking about different ways of building houses that can reduce the use of those materials.

The third way is to think about emissions from cooking and heating in buildings. Those are the emissions we are actually counting in this chapter. Today there are about 3 billion tons of those emissions a year, globally, which is a lot less than industry or transport. But we will go into some detail, because we are also talking about saving on materials, and because we want massive house building programs in poorer countries.

This chapter comes in three sections. In the first we look at ways to cut emissions from existing buildings. The second section looks at how to regulate new buildings, and the third is about new public housing. Then we will say some things about air conditioning, often a controversial topic.

Conversion of existing buildings

People in buildings use wood, coal, oil and gas mainly for heating, but also some wood and gas for cooking. The reason is the same as the problem we saw with heating industrial materials. Electricity is a good way of producing motion, and an inefficient way of heating. This is a good reason for reducing total energy use in buildings as well as switching to electricity.

The UK provides a good example of how to do both. The British weather is cold, and damp, and the houses leak a great deal of heat. About a third of the population live in some form of public housing, and most people live in towns and cities in buildings of six stories or fewer. The climate jobs campaign in Britain proposes that teams of municipal building workers would refit block by block. They would put up scaffolding and work their way down the street, doing all the necessary work house by house, or flat by flat.

The two fixes with the most impact would usually be insulating the attic and switching to a much more efficient modern boiler. The teams would also insulate some side walls, double glaze the windows where appropriate, and insulate around the windows.

At the same time, they would switch the home over from fossil fuel heating to electric. Where possible, this would be a heat exchanger, which is basically a backwards air conditioner. An air conditioner pumps the air from the outside into a house, extracting the heat as it does so, and pumps the heat in the inside air back out at the same time. A heat exchanger takes hot air from outside the house and pumps cold air out at the same time.

The other common change in heating would be that all house heating would be powered by an electric boiler. Of course different houses would need different fixes. And it would be politically unwise to force people to renovate. But you can offer it to them for free, and in most cases people would save a good deal on their heating bills in the long run.

This would also be good work. There would be a lot of electricians, plumbers and plasterers. It would also be good work for apprentices. And it would solve some of the difficulties most building workers face. Mostly they work on short jobs, sometimes on windblown sites, often far from anywhere, with long hours and a lot of rain. Other times they work on small jobs, with few other people, and little security. Or you do private jobs, often for customers who look down on you and are cranky about your work.

Renovation work would allow teams to work near home, for months and years, alongside each other, and let friendships build. It would also allow you to work in the homes of people from all walks of life, most of whom would treat you decently. You could build a culture of safety. And you would have the satisfaction of knowing that your work was saving the world.

This kind of renovation, with electrification, could eliminate almost all emissions from homes.

Public buildings and businesses would be a bit different. But again, it would make sense to offer the conversions to organisations and owners for free.

New Build

In Britain the average life of a house standing now will be eighty years, and the average life of a public building forty years. In most countries the turnover is faster. Luckily, reducing emissions from new builds is easier. The key is what are called building regulations in the UK, or code in the US. These are the detailed rules construction companies must already abide by. These make it possible to make sure that all new buildings will be heated by renewable electricity, and that they will conserve energy.

Architects in Germany have already designed and built tens of thousands of “passive houses”, which are insulated, well ventilated and use very small amounts of energy.

Indeed, in many different parts of the world there are traditional methods of house building which are beautiful. In hot places houses are built to be cool, and in cold climates they are built to be warm. One thinks of the old adobe houses of Mexico and Texas, and the thick mud walls in many parts of the world. Or the open but shaded interior courtyards with ponds, and the high narrow stone houses of Yemen and Tibet. Africa and India were once full of homes made of earth, clay or natural materials that worked thermodynamically, and were often beautiful. And there is much that is thrilling, and solid, and unexpected, that can be done with stone.

The use of many of these materials has become a matter of cultural shame, and the endless similar ugliness of concrete is the face of snobbish modernity in much of the global South now.

One key to all this, though, would be simply to ban tall buildings. They do not make climate sense. The elevators moving people up and down in a twenty-story building use a large amount of

electricity. To build tall you need large amounts of steel for the frames and usually large amounts of concrete as well. There is no other way to gain the necessary strength.⁹⁹

Think about modern office buildings, built of metal and glass. You may remember that a decade ago climate change was commonly referred to as the “greenhouse effect”, by analogy with the way that the glass in a greenhouse traps heat. Those tall glass buildings work like greenhouses. If you have worked in one, you know that you always have to keep the windows closed. You cannot open them on hot days for air. The glass is there to let the sunlight in, but that’s bad for the computer screens. And the air is endlessly recycled through the whole building. At the worst that produces sick building syndrome. At best it is a colossal waste of energy and an unpleasant use of space, and a sign that our world now worships lawyers, bankers and their large erections.

But human beings have lived in beauty and comfort without those tall glass building for thousand of years. Regulations that said we had to build lower would unleash inventiveness, creativity, whimsy and fun in architects and workers. Cities might be built to celebrate beauty, not expense, height and power.

It is reasonable to ask if new building regulations might substantially increase the price of new houses. The answer is yes. The architects of passive houses say the increase is 20% or less. But there is a quirk of the market that will balance this. There are two parts to the price of most homes – the price of the land, and the price of the actual building, the house or flat. The total price of homes in the market, though, is largely determined by how much money people are able to spend on housing, which in turn is a function of how much they are paid and can therefore borrow. These relationships between prices mean that, in towns and cities, if the average cost of building a house goes up, the average price of the land goes down. People already pay the highest price they can afford, so if more of that cash goes to building a home there is less left over to pay to the person selling you the land on which the home is built.

That also means that more of your money will go to the building workers who will have more work, and a great deal more fun and satisfaction in working within the new regulations.

Air Conditioning

House conversions, and new housing, will also need air conditioning in most parts of the world. There is controversy about this. Pope Francis, for example, questioned the spread of air conditioning as a

form of luxury consumption of resources in his 2014 encyclical *Laudato Si*. This is understandable in our current world, where the better off have excessive cooling and the poor are left to sweat. And there is a long tradition in environmentally sensitive architecture of insisting that thermal comfort levels differ from place to place, and that building cooling and well-ventilated buildings is more important.¹⁰⁰

All that has long been true. But we are entering into a new, and worse, world. Air conditioning has been a privilege. But the people who will suffer most in a much hotter world are the working poor in cities in the hottest places. They are already enduring great heat in summer in the cities along the Persian Gulf and in South Asia. Baghdad is experiencing temperatures higher than at any time in history, temperatures that breach the levels that humans can survive. In more and more places, we are approaching the point where air conditioning is not a luxury but a necessity.¹⁰¹

Government programs to supply air conditioners to poor and middle income people in those countries will save many lives, and build support for climate jobs. The air conditioning can be run on local solar energy. People only need the cooling when the sun is shining, and local solar will be much more reliable than aging and underfunded grids.

Limited resources will not be a problem. There is enough sunlight, and storage will not be needed. However, air conditioners that use F-gases do produce serious global warming emissions. Luckily, we can simply ban them. (See the chapter on *Leaks, Waste and Refrigeration*.)

Public Housing

In many countries there is a pressing need for public housing. This is most acute in countries like India, Pakistan and South Africa, where the Covid 19 pandemic has shown everyone the public health dangers of large numbers of people packed together. But those dangers did not begin with the latest pandemic, and they are not limited to those countries.

This is why the climate jobs campaign in South Africa has always included decent new public housing among their necessary projects. There are countries where that housing will fit best in climate jobs. In other countries it will make more sense as part of the larger Green New Deal. In either case, it is a good example of carbon-free development. Homes can be built with solar PV air conditioning, with space to breathe, with safe, clean water and sanitation, and using natural materials instead of concrete.

**MAD MAX
WASN'T
MEANT
TO BE A
DOCUMENTARY**

*Climate striker
Melbourne, Australia*

HYDROGEN?

For some years there has been a considerable swell of support for hydrogen. It always seems to be the fuel of the future. The problem, though, is that hydrogen from methane is a high-CO₂ fuel. And low carbon hydrogen from electrolysis is an expensive fuel, in most cases a waste of energy right now.¹⁰²

Many future scenarios for renewable energy depend heavily on uses of hydrogen that do not now make sense. The assumption is that in future hydrogen will be produced much more cheaply, and this is indeed possible. But as we have said before, in this book we will restrict ourselves to the solutions that work now. Otherwise it is too easy to slip into imagining that we are certain to solve problems we may fail to solve.

But it's important to have a look at hydrogen here, for it could deliver some emission reductions we could not get in any other way.

Hydrogen is not found free-floating in nature. It is always in combination with other elements. To produce hydrogen fuel, manufacturers have to separate the hydrogen from the other element. The usual way of doing this now is to start with methane – natural gas. Methane is CH₄, one carbon atom and four hydrogen atoms. The methane is heated and the hydrogen siphoned off. The carbon atoms go into the air as CO₂. So hydrogen – allegedly a “clean” fuel – is made by emitting CO₂.

Moreover, the methane is usually heated by steam, which is made by burning coal or methane. The overwhelming majority of the hydrogen used in the world today is manufactured in this way. It is a fossil fuel.

You need to be careful in reading about hydrogen. Many of the scenarios for “green” hydrogen assume that it will be possible to heat methane and then capture and store all the escaping CO₂. This is a variation on the more general scenarios for capture and storage. And as we saw in an earlier chapter, those scenarios do not work.

There is a green way of producing hydrogen – electrolysis. This involves running an electrical current through water. The electricity breaks the bonds between the Hydrogen and the Oxygen in the H₂O. The hydrogen can be stored, and the oxygen escapes into the air. If the electricity comes from renewable electricity, this is renewable energy.

The trouble is, green hydrogen from electrolysis is expensive. The best recent estimate is that green hydrogen from onshore wind is about three times as expensive as hydrogen from methane. Solar PV is between three and eight times as expensive.¹⁰³

It may be possible with future developments in engineering to bring down the price considerably. But one physical limit remains. It takes much less energy to split the bond in methane than the bond in water.

However, hydrogen from electrolysis may be much cheaper than it appears at first sight. This is because making hydrogen can serve as a form of storage on the grid. When there is an over-supply of renewable electricity, that over-supply can be used to make hydrogen. If that over-supply would otherwise be wasted, the hydrogen is effectively without cost.¹⁰⁴

Where could this hydrogen best be used? One common suggestion is hydrogen fuel cells instead of batteries in cars. The car or truck carries tanks of liquid hydrogen and oxygen. These are injected, bit by bit, into a fuel cell. This creates a chemical reaction in the fuel cell. That reaction produces two things. One is electricity. The other is water, as the hydrogen combines with the oxygen to make H₂O.

Remember, the hydrogen was produced in the first place by splitting the bond in the H₂O molecule, and that took a lot of energy. When the H₂O bonds again, that releases the energy in the form of electricity. And the only exhaust is water vapour.

In effect, a fuel cell is working like a battery to produce electricity for an electric vehicle. The difference, though, is that you have to keep recharging the battery. But a fuel cell will run for much longer before you have to fill up the tank.

There are only a small number of hydrogen fuel cell cars on the road in the world. But we know the technology works, because there are 230,000 hydrogen buses on the roads. So far 99% of them are in China, but other engineers in other countries can do the same.

One limit, though, is that it will always be more efficient to use the electricity directly in the vehicle. With electrolysis, you have to use energy to break the bonds in the water, energy to compress and transport and store the hydrogen, and then energy to turn the hydrogen back into electricity. It will always be a great deal cheaper, and more efficient, to cut out the middle man, the hydrogen, and just use the electricity in the vehicle.

However, hydrogen fuel cell cars may be the solution to problems with the supply of lithium for batteries. As we saw, mining lithium is polluting, and it may be very difficult to mine enough of the metal to supply all the car batteries we are going to need. I will say more on this in the chapter on *Extractive Industries*.

Some researchers have suggested that hydrogen might be particularly useful in heavy trucks. These trucks require large amounts of power, and they travel long distances. Batteries, even in the medium term, are unlikely to deliver that much power for long journeys. Hydrogen may be the answer – but as we saw in the chapter on *Transport*, overhead power lines may work even better.¹⁰⁵

It has been suggested that we can run planes and ships on hydrogen. If we can do that, it would be fantastic. But most estimates of when this will be possible tend to say 2040 or 2050, which means maybe never. It also means that for the job we have to do now, hydrogen for planes will not work. That is an enormous pity.

As we saw in the earlier chapter on *Industry*, the one place where hydrogen from electrolysis is likely to make a considerable difference is in the manufacture of steel.

There are also plans in Britain to use hydrogen as a “green” fuel to heat homes. In these plans, the hydrogen is transported down the pipes that already carry natural gas to homes. Then it can replace the natural gas in heating and cooking.

This is a con. These are not proposals to use green hydrogen. They are proposals to use the energy from natural gas in a more expensive form. These plans come from the existing companies that sell gas, who want to extract the last possible drop of profit from their existing infrastructure and reserves of gas. Moreover, these plans propose that houses and buildings will be converted to use

hydrogen boilers. In practice, this would be done instead of the conversions to insulations and electric heating I wrote about in the last chapter.¹⁰⁶

The takeaway on hydrogen is this. It may be very useful for cars, buses and trucks. It may not. It is very unclear whether it will be a useful fuel for planes and ships. If so, it will be many years before that is possible. Hydrogen may make a real difference in the manufacture of steel. Heating homes with hydrogen is a con and would crowd out better forms of heating.

In every case, it would be a serious mistake to proceed with any project that used hydrogen made with methane. Only green hydrogen from renewable electricity makes sense, and then only in limited uses. But at the same time, climate jobs projects should put serious work into seeing, in practice, where hydrogen could work.

**STOP
BLOCKING
OFFSHORE
WIND**

**CLIMATE
JOBS NOW**

*Maritime Union of Australia climate striker
Sydney, Australia*

CHAPTER 13

LEAKS, WASTE AND F-GASES

I have now outlined measures which could reduce emissions from burning fossil fuels and industrial processes by 88% in fifteen to twenty years. That would require state funding, widespread regulation and the work of tens of millions of people across the world. This is what could be achieved, in billion tons of CO₂ equivalent:

Reductions in CO₂ Fossil Fuel Emissions

Producing electricity	15 to 0.5 billion tons
Industry	8 to 2
Transport	10 to 2
Heating buildings	3 to 0
TOTAL	36 to 4.5 billion tons a year

These are reductions in emissions of CO₂ from fossil fuels. But there is a bonus reduction in methane emissions. This happens because fossil fuel leaks of methane account for 4 billion tons of CO₂ equivalent a year. If we stop using fossil fuels, we won't have any leaks of methane from fossil fuels.

Some of these leaks come from coal mines. Methane is often found in coal seams, and is the "firedamp" responsible for most of the explosions in the mines. But smaller quantities of methane leak out of active coal mines all the time. Very small amounts also leak from mines that are no longer being worked.

The second source of leaks is oil wells. Natural gas is more than 90% methane, and the gas often lies on top of the oil deposit. When oil companies drill, that gas comes up first. Traditionally oil drillers just let that methane escape into the air. Now the best practice is to burn the gas as it escapes, turning it from methane to the less powerful greenhouse gas CO₂. But best practice costs money, and when the drillers can get away with it, they just let the gas vanish into the air.

The third source of methane leaks is, not surprisingly, natural gas itself. Some of these leaks happen at the wells, and some come from pipelines and pipes at every stage of the distribution process.

No one knows for sure what proportion of these leaks come from each of these different fossil fuel sources. Until recently the working assumption was that they were roughly equal. But there has been a worrying and steady rise in total methane levels in the global atmosphere since 2008. An interesting recent study by Robert Howarth at Cornell University argues that part, and perhaps most, of this rise comes from increased fracking for oil and shale gas in the United States. The timing fits, and the chemical signatures in the atmospheric methane seem to fit too.¹⁰⁷

The good news is that almost all of these leaks can be eliminated if we take the measures outlined in the previous chapters. Those measures will cut human use of coal, oil and natural gas by more than 90%. And in doing that we will at the same time cut methane leaks by more than 90%. We can say, with some confidence, this would reduce global methane leaks from about 4 billion tons to about 0.25 billion tons.

That means a total reduction in fossil fuel emissions from 38 billion tons of CO₂e to 4.75 billion tons.

Reductions in emissions from burning fossil fuels, in billion tons of CO₂e

	Before	After
CO ₂	36	4.5
Methane leaks	4	0.25
TOTAL	40	4.75

Before we finish this part, there are two miscellaneous sources of emissions we need to explore: waste and F-gases.

Waste

Methane from waste totals 1.5 billion tons a year. About half of that comes from landfills, and half from wastewater (sewage).

Methane comes from landfills because organic matter is part of the waste that is dumped into landfills and covered over with earth. The organic matter decays without oxygen, and so produces methane. But a system of drainage channels and pipes can transport this methane to the surface. As the gas comes out of the pipe, it is burned and thus turned into CO₂, which has only 4% of the warming impact of the methane.

This is reasonably easy to do with new landfills, and has been widely done for more than a decade in many countries. It is more expensive, but perfectly possible, to do as a retrofit. All that is needed is an extension of these methods to all landfills. There is work and expense here, but the landfill operator does get a source of energy as a result.

Sewage systems, or wastewater, account for the other half of waste emissions. The source here is human excrement, and other organic material like toilet paper, that decay under water in the sewage system. There are several partial solutions, including various ways of exposing the sewage to more air.

But the best way of cutting wastewater emissions is anaerobic digestion. Anaerobic digester toilets can work in houses. The excrement from the toilet goes into a closed bucket in the house, and inside that bacteria digest the sewage. The eventual products are methane and sterilized solid fertilizer. The methane can then be burned as a fuel, which at least converts it from powerful methane to much weaker CO₂.

Anaerobic digesters can also be used on a much larger scale in sewage plants. The methane collected can be stored and burned later for energy or heat. As with landfill, there are still CO₂ emissions, but they have only 4% of the impact of methane emissions. It is also possible to process the methane further to produce fertilizer without emissions.¹⁰⁸

Using all these methods, it is ambitious, but probably possible, to reduce global methane emissions from waste from 1.5 billion tons to 0.5 billion tons of CO₂e.

F-gases

It is easy to do something about F-gases. We can ban them.

F-gases are "hydrofluorocarbons," made up of hydrogen, fluoride and carbons. They are also called HCFs, and are

widely used in refrigeration of all kinds. This is new. Previously refrigerators used CFCs. But in the 1980s scientists discovered that the escape of CFCs into the atmosphere was destroying the ozone in the high atmosphere, creating a spreading ozone hole over Antarctica. High altitude ozone was protecting humanity, and life, from dangerous radiation.

So the governments of the world came together to agree in the Montreal Protocol of 1989 to ban CFCs all over the world. That took time, but by 2010 there were very few CFCs manufactured in the world, all clandestinely. This shows that it is possible for all the governments of the world to act together for the sake of the global environment. But one difference from the situation with climate change is that the global refrigeration industry did not have the power of the coal, oil and gas industries. The other difference is that the corporations were able to switch easily to use F-gases in refrigeration.

It was rapidly discovered, however, that the new F-gases were powerful greenhouse gases. The most commonly used has 23,000 times the warming impact of a similar amount of CO₂. So escapes of even tiny amounts of F-gases could have serious consequences. There was swift agreement at subsequent meetings of the Montreal process to phase out all F-gases in developed countries by 2020, and developing countries by 2030. This has not happened. Instead, emissions are rising.¹⁰⁹

At the moment escaping F-gases account for almost 2 billion tons of CO₂ equivalent, just over 3% of global emissions. Bans on the manufacture, transport and sale of F-gases would bring that down to nothing. Different F-gases persist in the atmosphere for between a few days and 50 years. As with methane, banning them would lead to sharp falls, in some cases over days and in other cases over decades.

Technically, the ban would be easy. Alternatives exist for use in every kind of refrigeration. The most common is using various hydrocarbons, like propane, to replace the F-gases as refrigerants. But these alternatives are more expensive, and demand for air conditioning is increasing. That is why emissions are rising.¹¹⁰

Total Emissions

Now we can add together all the emissions reductions we have outlined so far.

Reductions in emissions in billion tons of CO₂e

	<i>Before</i>	<i>After</i>
Fossil Fuels	40	4.75
Landfill and sewage	1.5	0.5
F-gases	1.5	0
TOTAL	43	5.25

If we can do that, it will be an enormous achievement. It won't be perfect – 5.25 billion tons a year is not zero. But a deep reduction in emissions from fossil fuels is the most important thing we have to do. It will not be easy, but it will be possible.

That still leaves 12 billion tons of emissions from farming, herding and forestry. The chapters in Part Four are about how to reduce those emissions.

PART FOUR

**FORESTS
AND
FARMS**

**DON'T
KILL
AFRICA**

*Photocopied pieces of paper held up by delegates to
the Durban COP in 2012, defying security to protest
inside the talks*

CHAPTER 14

FERTILIZER, MANURE AND RICE

Parts Two and Three were about how climate jobs can cut emissions from burning fossil fuels, waste and F-gases. Part Four is about the remaining emissions, from agriculture and forestry. They are:

Methane

Cattle, and goats

3 billion tons a year of CO₂e

Rice

1 billion tons

Nitrous Oxide

Fertilizer and manure

3 billion tons

CO₂

Cutting down trees

5 billion tons

On top of that, we can probably plant enough new forests to offset the effect of another 370 billion tons of CO₂ over a period of about fifty years. And we can probably store a total of about 100 billion tons of CO₂ in the soil. Here is how that compares to emissions from fossil fuels:

Comparison of emissions, in billion tons of CO₂ equivalent

Fossil Fuels	40
Agriculture	7
Deforestation	5
Reforestation	-5

Fossil fuel emissions are four times those from forestry, and six times as large as emissions from agriculture.

On the other hand, forestry and agriculture together have almost a third of the impact that comes from emissions from fossil fuels. So fossil fuels are much more important, but forestry and agriculture are still important.

Farming the Soil

This chapter is about emissions from farming the soil. The next is about emissions from raising livestock. In both chapters, however, we are mostly not talking about creating new jobs, but about trying to influence the people who are already doing the work. That means our climate jobs approach to the people who work the land is different from our approach to other workers. And we always have to remember the enormous amount of stupidity and suffering that governments with political agendas have inflicted on farmers and herders all over the world. Enthusiastic consent, step by gradual step, is essential here.

Climate jobs is a method for getting the necessary work done, but it is also a method for building a mass movement. This is obvious enough when thinking about jobs in renewables, transport and construction. But it is equally true in agriculture. Much discussion of food and agriculture proceeds as if the two main players in the discussion are agribusiness and the consumers. Here I put the people who actually work the land and pastures front and center.

Another way that farmers and herders are different is that, for many of them, climate change will quite simply destroy their way of making a living. What to do about that will also be central to this discussion of agriculture. But first, let's talk about emissions.

Global emissions from growing crops each year

Nitrous oxide from fertilizer and manure	3 billion tons
Methane from rice paddies	1 billion tons
TOTAL	4 billion tons of CO₂e

We can see that nitrous oxide from farming and methane from rice paddies creates four billion tons of CO₂e emissions. Or slightly more than half the 7 billion tons of emissions from agriculture.

The Food and Agriculture Organization of the UN, and some other researchers, often lump emissions at farms together with the emissions from food processing, transport, distribution, supermarkets and sales. This gives larger estimates for the emissions from agriculture. But it is a form of double counting.

Let me explain. These estimates of emissions from the wider food industry take four forms. One is that they count the emissions from burning oil to transport crops and animals to market, and distribute food around the country. But we have already explained in the chapter on *Transport* how we can reduce those emissions to nothing. We do not want to count them again here.

Secondly, some researchers count the emissions released when fossil fuels are burned to make the electricity that is used in slaughterhouses, grain mills, food processing plants, supermarkets and stores. Again, I have already accounted for all those emissions in my chapters on electricity. We do not want to count them again here.

Thirdly, some researchers count the emissions from the oil used in farm machinery and the electricity used in farm buildings. However, these emissions are small, and it will not be hard to eliminate all of them.

Finally, there are the emissions from the manufacture of synthetic fertilizers. These are not trivial. The total is about 0.6 billion tons. We discussed them, and counted them, in the chapter on *Industry*.

Nitrogen and Fertilizers

Crops need nitrogen to grow. Up to a certain point, the more nitrogen they get, the more they grow. Farmers have three ways of putting more nitrogen into the soil for plants to use. They can add man-made fertilizers which contain nitrogen to the soil. They can add animal manure, which

contains nitrogen, to the soil. Or they can grow crops like clover and alfalfa, which extract nitrogen from the air and fix it in the soil.

All three methods, but especially fertilizers and manure, create nitrous oxide as a byproduct. The amounts of nitrous oxide are tiny, but nitrous oxide is a very powerful greenhouse gas. Recall that one kilo of nitrous oxide has the same effect as 300 kilos of CO₂. Like carbon dioxide, and unlike methane, nitrous oxide stays in the air for 100 years or more.

Nitrous oxide emissions each year have the same total effect as a bit less than 3 billion tons of carbon dioxide emissions a year. That's 6% of total annual global greenhouse gas emissions.

Nitrogen is the main active ingredient in man-made fertilizers. Most farmers spread too much nitrogen on the soil. On average the crops take up about half that nitrogen. The other half remains on the surface of the soil or is washed away. In either case, some of the nitrogen eventually bonds with the oxygen in the air to make nitrous oxide.

Animal manure creates the same problem. So do compost and organic fertilizers. In all cases, the active ingredient is nitrogen. If farmers use too much of these, a good portion of the runoff becomes nitrous oxide.

In the United States, and some other countries, farmers use more fertilizer than manure. Globally, farmers use more manure, though fertilizer use is increasing steadily. There is evidence that farmers tend to overuse fertilizer more, but at least as much nitrous oxide comes from manure. There is also evidence that past a certain point, adding more fertilizer leads to sharply increased emissions of nitrous oxide. This means that cutting the amount of fertilizer used by half, for example, will cut the emissions by far more than half.¹¹¹

Crops that fix nitrogen in the soil, like clover and alfalfa, also pose a problem. That nitrogen too mixes with air to produce nitrous oxide. But total emissions from cover crops are less than a tenth of nitrous oxide emissions. Nitrous oxide is also produced in the manufacture of fertilizer and nylon, but again this is only about a tenth of total nitrous oxide emissions.¹¹²

The problem is how to use less fertilizer and manure and still grow crops. There are several solutions. One is to use broadly similar amounts of fertilizer and manure, but in different ways. Careful monitoring, backed by software, can show farmers where more fertilizer will make little difference to the crop but a lot to the runoff. Using some of the fertilizers later in the season, and putting it in

different places, can also reduce emissions. Different kinds of man-made fertilizer also have different levels of emissions. Chemicals can also be added to the fertilizer to prevent nitrification. Put all of these strategies together, and it may be possible to reduce emissions by up to a third, though these changes are easier to manage with fertilizers than with manure.¹¹³

The more radical, and probably better, solution is “conservation agriculture”. This is not quite the same thing as “organic farming”. Organic farming means farming without using man made pesticides and fertilizers. Conservation farming often uses some pesticides and fertilizers, but much less.

Conservation farming has three main pillars. The first is “no-till farming”. Much conventional farming is now done by tractors or ploughs turning over the soil, after which seed is broadcast. With no-till farming, there is targeted planting of the seeds instead. Typically, a machine makes a hole of the correct depth in the soil and then pops in seeds. A small amount of fertilizer or manure is popped into the hole at the same time, so that it is directly available to the seed below the surface of the soil. From the point of view of climate change, this has two advantages. First, much smaller amounts of fertilizer can be used, and then there are even smaller amounts lost as run-off.¹¹⁴

But no-till farming on its own is not enough. The yields are simply too low. So the second pillar of conservation agriculture is crop rotation. This has long been standard practice across much of the world. One year in two, or one year in three, a field that usually grows wheat, maize or other grains is planted with another crop that restores nutrients to the soil. Clover and alfalfa are common choices, but there is evidence that planting a large variety of crops, all mingled together, works best.

The third pillar is leaving organic cover on top of the field. The farmer can simply cut down the clover or alfalfa when grown and leave it there. Or the farmer can harvest the maize, or whatever, but leave the stalks and other organic matter on the field. Either way the nutrients can sink down, and the carbon and other nutrients in the soil are shielded from light and heat.

Combined, all three methods allow the soil to gradually regenerate. In much of the world, soil that has been farmed with fertilizers and pesticides has become degraded. The topsoil layer is thin. The soil that does remain is weak and crumbles easily in your hand. In a sense, the remaining soil has become a platform for irrigation, pesticides and fertilizer to grow crops.

If you stop putting the fertilizer into the field, and just do no-till, you will have low yields. It takes time for conservation agriculture to restore the soil. There are conflicting claims about how long, but a reasonable estimate would be five to ten years. This means that if a farmer wants to switch to conservation agriculture, she has to be able to sit out years of bad harvests. Few farmers anywhere in the world can do this. It is especially hard for small farmers, who have small margins on which they have to survive. And it is equally hard for farmers who are already facing falling yields because of degraded soils.

Larger farmers, or more financially secure ones (not the same thing), can and do find a partial solution to this by changing their methods in some of their fields at first, and when that works changing more.

But a more general solution is possible. Governments in many parts of the world have given many kinds of subsidies and support payments to farmers. These subsidies could be extended to tide farmers over in the transition to conservation agriculture.

Even without such subsidies, a surprising number of small and medium farmers have already made the transition. One estimate is that one farmer in eight globally has done so, which is an enormous number of people. However, this estimate relies on official reporting, which probably inflates the numbers by including all the farmers who make only small changes on a bit of their land. Still, the extent of adoption is stunning.¹¹⁵

One reason is debt. Fertilizer-based farming requires considerable cash outlay. The farmer has to pay for the fertilizer, but also for the tractors that will plough the soil. Some farmers own the machines, some rent them and some employ other people to do the ploughing. But however you do it, there is a considerable outlay. With that usually goes substantial expenditure on pesticides as well, and often on irrigation and sprayers. All this investment has two consequences.

The first is that many farmers can switch to conservation agriculture and have smaller yields at first, but still be better off, because they are spending less cash. This can shorten the number of years needed to break even. It also means that some farmers who switch have simply reached the financial point where because of their debts they have no alternative.

No-till conservation agriculture can also free large numbers of small farmers from a debt trap that produces chronic anxiety. This is

a problem not just in the US, but around the world, and particularly in India. In the last twenty years a quarter of a million Indian farmers have committed suicide, most because they fear losing their land through debt. The most common method is drinking pesticide, which is easily available and symbolically powerful, but a slow and hideously painful way to die.

In India, the US and elsewhere, what has happened is that over the last forty years the methods of industrial agriculture have brought massively increased yields. These increases have relied on tractors, harvesters, fertilizers, pesticides and irrigation. Small farmers have to invest and spend large sums of money on all of these, or they will not get the yields. Yet it is easier for the big farmers to do that. The small farmers fall behind, get into a cycle of debt and eventually have to sell to larger farmers.¹¹⁶

The methods of industrial agriculture increase yields a great deal at first. Over time, however, they exhaust the soil. At that point, small farmers who are already in debt are very vulnerable. A new deal project that is ready to step in and tide them over will win the support not just of the most vulnerable farmers, but of whole communities.

A few caveats are in order. To repeat, no-till conservation agriculture is not the same as organic farming. There are debates about exactly what counts as organic farming, and some dodgy labelling. But the usual definition is that organic farming uses no artificial pesticides or manufactured fertilizer, only manure and compost. In conservation agriculture, farmers use smaller amounts of fertilizer, and moderate amounts of pesticides. The point is not that it is all natural, but that emissions are much less.

The key to reducing emissions is not the difference between using animal manure and fertilizer. Both are heavy in nitrogen. The difference is in the amount of nitrogen used and where it is placed.

Second, it is important not to be seduced by claims that conservation agriculture will have higher yields than fertilizer agriculture. The evidence is mixed, because no two fields, no two crops and no two regions are the same. But in general, conservation agriculture does as well as fertilizer agriculture. Not better, and not worse, on average, once the soil has time to grow richer. There have been many studies of this, and the evidence is robust.

Organic agriculture, properly practiced, has somewhat lower yields. That's why food usually costs more in the organic section of a supermarket. This is worth mentioning because of a common claim

that small scale “agroecology” could produce far more food than industrial agriculture. For this, there is no evidence base, but nor does there have to be. Yields are not the point. The human dignity of small farmers and the avoidance of greenhouse gas emissions are the point.

In short, do not get lost in arguments about yields. Conservation agriculture does not have to deliver fantastic yields. But it does have to deliver reasonable yields, or farmers will not do it. Nor, in a democracy, would it be easy to force them to do so.

Force would also be morally wrong. And foolish. The evidence is reasonably good that the approach I am suggesting would work. But governments around the world have imposed foolish agendas on farmers, with great cruelty, much killing and eventually resulting in low yields. And after all, if the people who know the land cannot be convinced, they are probably right.

To sum up, conservation agriculture will require many good examples, and a process of learning and gradual persuasion. It will require subsidies so farmers have time to make the transition. But in time, it should be possible to reduce fertilizer use by two thirds to three quarters. Moreover, the fertilizer that is used would be much less likely to escape as nitrous oxide.

Reducing fertilizer use would also reduce fertilizer manufacture. That manufacture is responsible for nitrous oxide leaks of 0.1 billion tons of CO₂e, and CO₂ from burning fossil fuels of 0.5 billion tons. Reducing fertilizer use by two thirds would reduce manufacturing emissions to 0.2 billion tons.

The other main source of nitrous oxide from factories comes from the manufacture of nylon, at about 0.2 billion tons of CO₂ equivalent. It looks possible to reduce that by about half, partly by using less nylon and partly by changes to the production process.

Overall, it might be possible to reduce nitrous oxide emissions from 3 to 1 billion tons. This will probably be tight, though. That’s a best estimate, and it may take longer than 20 years. It might be more reasonable to think in terms of reducing emissions to 1.5 billion tons. Remember, we have said we will persuade the small farmers, not force them.

Storing Carbon in the Soil

Now we approach a thorny question – how much extra carbon can conservation agriculture store in the soil, and what difference will this make to climate change?

There is a good deal of controversy around this question, and often strong feelings. Some things are not at issue. Agricultural soils contain a great deal of carbon, and so do grassland soils. But much of the soil has lost a great deal of that carbon as a result of intensive agriculture and overgrazing. There is also agreement that conservation agriculture and careful grazing management can restore at least some of that carbon. That is to say, thin “mineral” soils can return to looking more like dark, thick “organic” soils. And carbon cannot simply be buried in the soil. It has to be absorbed by plants through photosynthesis, and by microorganisms in the soil digesting plant matter.

Where the controversy starts is over how much of this is possible. I find it difficult to make a solid estimate. And I’m not the only one. In 2019 the IPCC published an authoritative 864-page report on *Climate Change and Land*. That report was written by all the leading scientists in all the relevant fields, and is extremely useful. They say they have “high confidence” that the “global mitigation potential for increasing soil organic stocks in mineral soil is estimated to be in the range of 0.4-8.64 GtCO₂ per year.” That means a range of between 0.4 and 8.64 billion tons. The high estimate there is more than 21 times the low estimate. In other words, they have high confidence in their total disagreement.¹¹⁷

This is not their fault. It is the state of the field. I suspect there are two reasons. One is that everything to do with our knowledge of soil is polarized between a research community closely linked to fertilizer manufacturers and industrial agriculture, on the one hand, and researchers loyal to a vision of organic, natural and ecological agriculture on the other.

I think the other reason for the scale of the disagreement is that there simply has not been enough systematic research. The IPCC scientists, for example, point out that there is not even agreement of whether ploughing or no-till is better at storing carbon. In this connection, they say “the lack of robust comparisons of soils on an equivalent mass basis continues to be a problem for credible estimates.” That is a polite, but firm, way of saying that the necessary research work has not been done.¹¹⁸

For example, Bronson Griscom and thirty one colleagues from around the world came together in 2017 to publish a review of the literature on “Natural Climate Solutions.” This is the most authoritative review we have so far, and it is published, appropriately, in the *Proceedings of the National Academy of*

Sciences. The reviewers are enthusiastic about many solutions, particularly forestry. But they estimate that conservation agriculture and grazing management will make at best only a very small contribution to carbon storage in soil.¹¹⁹

There is a more sympathetic review of soil storage of carbon, however, published in *Frontiers in Climate* in 2019, by five professors from Colorado State, Princeton and Idaho universities. Their work seems solid to me, and the lead author, Keith Paustian, is a distinguished climate scientist. They estimate that agricultural soils and grazing land together, with very widespread adaptation of best practices, could store the equivalent of 4 to 5 billion tons of CO₂ a year globally.¹²⁰

However, there are three important limits on this estimate. The first is, as they point out, it will not be possible to store more carbon in the soil than it held at its best. Like the IPCC, they also say that the capacity for soil storage will be full after two to three decades. That would be after between 80 and 150 billion tons of CO₂ had been taken from the air.

The third limit they point out is that carbon will only stay in the soil if that soil also contains enough nitrogen. Storing 4 to 5 tons of CO₂ equivalent each year would require an amount of nitrogen each year equal to three-quarters of all current global fertilizer use. Earlier in this chapter I explained the importance of reducing the amount of fertilizer used. Without the extensive use of nitrogen fertilizer, some, but by no means all, of the shortfall could be made up by planting legumes and other rotation crops that fix nitrogen in the soil.

A reasonable estimate, I think, is that widespread conservation agriculture and good grazing management could make it possible to store 100 billion tons of CO₂ over twenty to thirty years. That is equivalent to all current emissions of greenhouse gases for two years. It is not a trivial amount. But overall it will not make a great difference. As we shall see, there are much larger reductions in CO₂ possible with forestry. Still, conservation agriculture will be important in reducing emissions from fertilizers and freeing many farmers from a cycle of debt.

Rice

The other source of emissions from growing crops is methane from rice, which accounts for one billion tons of CO₂e, one-seventh of the total from agriculture. This methane is emitted because

rice is mainly grown in paddy fields which are flooded with water. Any dead organic material in the field decays underwater and produces methane.

A bad solution would be to ban rice, the staple food of more than half the people in the world, and the work of hundreds of millions of farmers. In fact, no one is seriously advocating that position.

However, several measures can reduce methane emissions from rice paddies. One is clearing out the dead organic matter from the fields. Another is periodically draining the field, and then reflooding it. There are also varieties of rice that can thrive with less time underwater. A variety of other measures will help as well. All this means that technically it should be possible to cut emissions from rice paddies by half. But that means persuading all rice farmers to take all these measures. And there is the strong possibility that as the human population increases, so will consumption of rice. Given those problems as well, my estimate is that we can cut methane emissions from rice by a quarter, from 1.0 to 0.75 billion tons a year.¹²¹

Total Emissions

Our estimate of total reductions in emissions from growing crops is:

Reductions in emissions from crops in billion tons of CO₂e each year

	Before	After
Nitrous Oxide	3.0	1.5
Rice methane	1.0	0.75
TOTAL	4.0	2.25

Now let's look at the total possible methane reductions so far:

Possible reductions in methane in billion tons of CO₂e

	Before	After
Natural gas leaks	4	0.25
Landfill and sewage	1.5	0.50
Rice	1	0.75
TOTAL SO FAR	6.5	1.5 billion tons

And here are the possible reductions so far in emissions of CO₂ and other long-lasting gases:

Reductions in long-lasting gases in billion tons of CO₂e

CO₂ from fossil fuels and industrial byproducts

Before	36
After	4.5

Nitrous oxide from fertilizers and manure

Before	3
After	1.5

F-gases

Before	1.5
After	0

TOTAL SO FAR

Before	40.5 billion tons
After	6 billion tons

**BLA BLA
BLA**

**¡ACIÓN
YA!**

*"Blah, Blah, Blah.
Action, Already!"*

Protester, Madrid UN climate talks, 2019

LIVESTOCK AND METHANE

For some readers, this will be the most controversial chapter in the book, and the hardest to read. That's because it deals with meat. For some people, many of them in India and Europe, both vegetarianism and kindness to animals are central values. Other people, many of them in Africa, the Americas and the Middle East, are deeply suspicious of any attempt by people in rich countries to stop poor people eating meat. What makes this more contentious is that the global trade in meat is dominated by large corporations, but the majority of people who raise livestock are small farmers and herders in Africa, the Middle East and South Asia.

So feelings run high. But if we are going to build a movement with the support of majorities, nationally and globally, we will need the support of both meat eaters and vegetarians.

This chapter, therefore, does four things. First, I look at the evidence for the contribution of livestock to global emissions. Second, I look at what can be done to reduce those emissions. Third, I keep an eye out for solutions which will reduce cruelty to animals. Fourth I look for ways of freeing up some land now used for growing crops or pasture so that we can plant more forests.

The headline figure in 2019 is that cattle, sheep and goats emit 3 billion tons of CO₂e a year. That's 3/7 of emissions from agriculture, 30% of total methane emissions, and 5% of total greenhouse emissions.

Other writers on climate and livestock sometimes quote much higher figures for the emissions from meat animals. One reason is that they

often ignore that chicken and pigs have far smaller methane emissions per kilo of meat than cattle do. Another reason is that they assume all meat animals must be fed grain and soya crops from industrial agriculture. In this chapter I explain how we can change livestock raising so that cattle are fed on grazing land, pigs are fed mainly on waste, and chickens are fed on a mixture of waste and grains. If we do this, we can reduce livestock emissions from 3.0 to 1.5 billion tons a year of CO₂e, and people will still be able to eat meat.

Chewing the Cud

Almost all greenhouse gas emissions from livestock are methane from cattle, buffalos, sheep and goats. This is because all these animals are ruminants. That means they have a second stomach, called a rumen. When they eat, first they digest the grass or other food in the rumen. Then they “chew the cud” in their mouths, and then digest it again. Ruminants spend much more time on digestion than other animals. That’s an advantage, in that they can get more nourishment from a wider variety of plants and grasses than other animals. But it also means that their food spends much more time in their stomachs, without oxygen present. So as they digest the carbon in the grass in their guts, it cannot turn into CO₂. Instead, it turns into methane.

This methane comes out of cattle, sheep and goats as burps and farts – mostly burps. It is the same gas that comes out of us when we burp and fart, though we produce far less.

Globally, about one third of the nourishment people get from livestock comes from cattle, buffalos, sheep and goats. Two thirds of the meat humans eat comes from pigs and poultry, which have very small methane emissions. Pigs and poultry are not a climate change problem. Here are the figures on consumption:

Global consumption of meat in million tons in 2017

Poultry	123
Pigs	120
Cattle and buffalo	70
Dairy	25
Sheep and goats	15
Other	11
TOTAL	339 million tons

The figure for dairy is for the protein and fat from milk and other dairy products equivalent to 25 tons of meat.¹²²

[“Other” includes ducks (4 million tons of meat), geese (3), wild game (2), horses (1) and camels (1).]

Cattle, sheep and goats account for most of the emissions from livestock. Measurements of methane emissions from different herds in different countries vary widely. But let’s take the standard tables provided by the Food and Agriculture Organisation, which bring together a wide range of studies. What they show is that beef has about six times the emissions of methane from pigs per kilo of protein. Beef also has about 100 times the methane emissions of chickens.¹²³

Another way of saying the same thing is that cattle now account for methane emissions of about 3 billion tons of CO₂ equivalent a year. If all the beef eaters switched to pork, that would reduce the total to about 0.5 billion tons of CO₂e. That would be a reduction in emissions of about 83%, which is good.

If all beef eaters switched to chicken, that would reduce methane emissions from about 3 billion tons of CO₂ to 30 million tons. That’s a reduction in emissions of 99%.

Emissions of methane in CO₂e kilos per kilo of protein

Cattle	100
Pigs	17
Chicken	1

How do other possible meat animals compare? Buffalo, sheep, goats and deer have about the same emissions as cattle. Camels, llamas and kangaroos have about half the methane emissions per kilo of cattle. And horses have about a quarter of the methane emissions of cattle. I have been unable to find estimates for turkeys and ducks, but suspect they are not that different from chickens.¹²⁴

You may be surprised by these figures. In the debates over meat and climate, many people leave out the comparisons with pigs and chickens. Where there is a comparison, most authorities compare the total emissions in CO₂e for one kilo cattle meat with the total emissions for one kilo of pig meat. However, the way the FAO makes these calculations is to include the CO₂ emissions from

the transport and energy needed in getting the animal from the farm to the plate, and the nitrogen and other emissions from the crops grown to feed the animal. Those emissions make up about 50% of the total emissions for cattle, and about 70% for the total emissions of pigs.

I have already proposed ways of reducing all the transport and energy emissions to almost nothing by using renewable electricity. And the last chapter suggested ways of cutting nitrous oxide emissions from fertilizer use by two thirds. So here we can focus just on the reduction of methane emissions from livestock.

At first sight, a switch from beef, sheep and dairy to pigs, chickens and eggs would keep people supplied with meat and animal protein while reducing livestock emissions to almost nothing. But it's not quite that simple.

The Pattern of Livestock Raising

To understand the choices facing people, we need a bit of background on the patterns of animal farming around the world. Let's start with land use. The land surface of the Earth is 149 million sq. kms. Take away the glaciers, deserts, arid lands and fresh water and we are down to 104 million sq. kms.

Before human agriculture began some 12,000 years ago, that land was divided as follows:

Division of land before agriculture

Forests	63%
Grasslands	25%
Shrubland	12% ¹²⁵

Then people began to cut down the forests to make fields and pasture. They also converted most of the existing grassland to feed their cattle, sheep and goats – all of which ate grass. And they ran a lot of sheep, goats and camels on the shrubland.

In all, people cut down about one third of the existing forests. Most of this deforestation has happened since 1900. Land use is now divided:

Division of land now

Forests	40%
Grazing	32%
Cropland	16%
Shrubland	12% ¹²⁶

A tiny proportion of the land, equivalent to about 1.5%, is used for all human cities, towns, villages, buildings and structures. The 16% of good land used for crops is divided as follows:

Uses of crop land

Growing food for people	10%
Growing food to feed animals	5%
Biofuels	1%

The invention of agriculture created an important shift in human diet. Before that, we were mainly people who lived on the plains. Unlike ruminants, we did not eat grasses, but we followed the herds of ruminants and ate them.

Our ancient diet is reasonably clear from new research archaeologists have been doing. We are omnivorous and eat everything, but the staples were meat and tubers. The meat came mainly from hunting medium and large grass eaters. The tubers were a staple because unlike the species around us, we had invented the digging stick. But we also ate a wide variety of fruits, nuts, berries, seeds, shellfish, insects, birds, small animals, mushrooms, honey and whatever came to hand. We had a varied and nutritious diet.¹²⁷

Then came agriculture and the domestication of animals. Agriculture developed independently in several parts of the world. That changed the human diet. Most people now eat grains – in other words, grass seeds. Even today, three grains account for the majority of the calories humans eat. They are rice, wheat and maize (called corn in the US.) These days we eat them in about equal proportions, though rice is the staple in much of Asia and wheat in Europe. Africa and the Americas are more mix-and-match, and there is much more millet and sorghum in Africa.

Grains on their own were much less nourishing than the diet that earlier humans enjoyed. In agricultural societies, the rich, the

landlords and the city elite ate a good deal of meat and fruit. The mass of people got little meat or fruit, and often not enough grain. They were exploited, and the central fact of their exploitation was that they did not eat well.

None of this means that people cannot be well-nourished vegetarians. We are omnivorous, and a very adaptable species. Clearly, vegetarians all over the world live long and healthy lives. But those who do are well-to-do compared to the poor of the world. They round out their diet with nuts, fruits, vegetables, oils, soya, beans and pulses, and often with dairy, eggs and even fish. Those dietary supplements cost money.

A billion people in the world now are malnourished. Billions more do not eat well.

Cattle, Pigs and Poultry

The different kinds of animals use land in different ways, because they use food in different ways. Ruminants basically eat grasses. They evolved to be able to live on the plains.

Globally, sheep and goats still get almost all their nourishment from pastures. This is because they are so well adapted to living on the less lush pastures of mountain uplands, moors and shrublands.

These days, globally, cattle and buffalo get about half of their food from grass pastures, and about half from crops grown for animal feed. (The buffalo here are the water buffalo, common domestic animals in South and Southeast Asia, used for ploughing, milk and meat.)

Pigs and chickens can't eat grass. They depend on richer foods with more nourishment, and they too are omnivores. For many centuries domestic pigs have eaten whatever slops humans have left over. But they are adapted to eat acorns, other nuts, roots, tubers, worms, truffles, insects, dead animals, fungi, fish, eggs and meat of any kind. Like us, they also dig for food.

Chickens fly and peck. They too eat worms, insects, seeds, small dead animals, and whatever they find.

The majority of pigs and chickens are now raised in factory farms. They are fed some waste, but mostly chickens are fed maize and other rough grains, and pigs are fed maize, oil seed cake and soya.

These global patterns conceal considerable differences. The United States is at one end of a continuum. In the US 40% of crops are fed to people, and 60% are used for animal feed or biofuels. There people eat a great deal of meat – about 120 kilos per person per year. Farms

– even small family farms – are very large. Pigs and chickens are produced almost exclusively in factory farms, and cattle spend part of their lives in the euphemistically named “feed lots”.¹²⁸

The best estimate we have is that there are about 570 million farms in the world and most sit at the other extreme. More than 90% of those are “family-owned” farms, and they produce about 75% of the world’s food.

We need to be careful with this statistic though. It is also true that more than 80% of the world’s farms are less than 2 hectares (5 acres) in size. Those very small farms – the great majority of all farms – occupy only 12% of the global farmland. Farms of more than 200 hectares (500 acres) own half of the global farmland.

However, those small farms are concentrated in poorer countries. In East Asia and sub-Saharan Africa, they occupy 30% to 40% of the land, and may produce almost half the food. But when you read statistics that say most food comes from family farms, you need to remember that much of the food from those farms is coming from larger family farms in Europe and North America.¹²⁹

More than half the people raising livestock have incomes of less than \$2 a day per person, less than the price of a small packet of sausages in the UK. Something in the region of 600 million poor people live this way. Most of those poor herders live in Africa and Asia. In Africa and the Middle East, they often graze their animals on marginal pastures, much of which would be better described as shrubland. The majority of these herders also grow some crops. Estimates of the number of nomads who live mainly by herding vary widely, and are unreliable. My estimate would be between 100 million and 200 million people.¹³⁰

The global average of meat consumption is about 40 kilos per person, which is 110 grams, or 4 ounces, a day. This is about two sausages in the UK. But that global average conceals large parts of the world where the local average is between 25 grams – half a sausage – and 50 grams of meat and dairy a day. Most poor herders eat very little meat – they sell it, mainly for consumption in the cities, and then buy grain to live.¹³¹

There have been two main changes in the last twenty years. One is that meat consumption in Asia has been rising steeply. This is most notable in China, where it is a central part of the economic miracle since 1980. At the same time, factory farming of both pigs and chickens has become the dominant form of rearing livestock across most of China and Southeast Asia.¹³²

There are three main objections to factory farms. One is the cruelty to the animals. I will not go into the details of that cruelty here, but it is horrific. Just to say, pigs are kept in barns of 500 or more, so tightly packed that they stand forever crammed shoulder to shoulder, unable to turn around, bored, stressed, biting each other. Laying hens too are kept all their lives in such small cages that they are unable to turn around.

The second objection is that it is a perversion of human nature for the people who work in factory farms, and industrial slaughterhouses, to have to do the work they do.

The third objection is that animals in factory farms are fed antibiotics every day of their lives. As with people, it is crowding that creates epidemics among animals. The kind of crowding in factory farming means that one sick animal can infect thousands.

The use of antibiotics on this scale, however, is also very dangerous for people. Two main kinds of organisms cause infectious diseases – bacteria and viruses. Let's take bacteria first. Antibiotics work on bacteria, but not on viruses. For infections from bacteria, antibiotics are usually cures. The development of antibiotics transformed medicine in the 1940s, and has led to dramatically lower rates of death, especially in children and infants.

Bacteria develop resistance to particular antibiotics, however. No one bacteria becomes resistant. What happens is that perhaps one in a million, or one in ten million of a particular kind of bacteria is born with a mutation that makes it resistant to an antibiotic. That resistant bacteria survives, and multiplies rapidly – it's competitors for resources have all been killed off. After a few years, there are many more of that resistant strain of bacteria, and they are not killed off by that antibiotic.

Scientists have found many different antibiotics since they discovered penicillin. It is always a race to discover more before resistance builds up from the bacteria that cause different diseases. In 2013 Dame Sally Davies, then the Chief Medical Officer for England, wrote in *The Drugs Don't Work: A Global Threat*: "Globally, the vast majority of antimicrobial drugs are given to farmed animals, including cattle, sheep, chickens and pigs." Davies also pointed out that twenty different classes of antibiotics were discovered between 1932 and 1987. Since 1987, no new classes have been discovered.¹³³

We are getting closer and closer to the point where there will be no treatment for at least one common infectious bacterial disease.

With Covid-19, we have just seen what one infectious disease can do. At some point, perhaps in only a few years, we will have several infectious diseases with no cure, including possibly drug-resistant strains of tuberculosis and syphilis.¹³⁴

Covid-19, however, is a virus, not a bacteria. We have vaccines for some viruses, and treatments that help. But viral epidemics are more difficult to contain. The emphasis in the media and on the internet has been on the dangers of virus infection because people are intruding on nature, and catching viruses from bats or pangolins. That is certainly a danger. But the larger danger is catching a virus that spreads like wildfire among hundreds of thousands of tightly confined animals. The names "swine flu" and "bird flu" exist for a reason. Moreover, factory farms are mostly unregulated, and almost completely hidden, because the cruelty could not continue if people saw it.

So, increased factory farming of pigs and chickens would solve one set of problems, and create another. Moreover, epidemics among populations weakened by climate change and food scarcity will not be fun.

The intensive farming of pigs as practiced widely in the US raises methane levels. This is not from digestion, but from the lakes of urine, pig manure and sludge that surround the huts of the overcrowded animals. The total methane levels are still much lower than from the stomachs of beef cattle. But they are considerable.

All the horrors of factory farming can be avoided. It is possible to raise livestock in ways that provide animals with decent lives, allow herders decent work, allow people a good deal of meat, reduce greenhouse gas emissions and free up some pasture for reforestation. Here's how.

Alternatives

The alternative starts with bringing to an end almost all rearing of cattle on animal feed and relying only on pasture. This is because beef cattle are a very inefficient way of turning crops into protein. The statistics here are pretty unreliable, and much fought over, but it takes something like 10 kilos of animal feed to produce 1 kilo of beef meat.¹³⁵

By contrast, it takes 5 kilos of animal feed to make a kilo of pork, and 2 or 3 kilos of animal feed to make a kilo of chicken. This is why chicken is the cheapest form of meat. So in terms of land use, it

makes sense to run cattle, buffalos, sheep and goats on grass pasture. This would, however, raise the price of beef and milk.

Second, neither pigs nor chickens need to be raised in factory farms. The reason for those cruelties is the pursuit of profit. Factory farms make profits because they employ so few workers. Everything in their operation works to reduce the amount of human labour needed. You can see the same forces at work in modern slaughterhouses. The workers in a meat packing plant are operating an assembly line, packed together like sardines, exposed to epidemics, as we have seen with Covid-19, and driven by the relentless pace of the line. In the same way, workers in factory farms become cogs in a machine.

Third, it is perfectly possible to design laws to ban the factory farms which are replacing small household farms. For example, in China, pig factories are replacing the traditional urban and rural pigsties, where two or five or ten pigs live off the waste and scraps of a household and their neighbours. Instead, governments could give out loans to kick start small scale pig and chicken farming.

Alan Fairlie is a respected permaculture expert in Britain, but he has also written a useful book titled *Meat: A Benign Extravagance*. It's a balanced book, wise and careful to pay attention to all the arguments, and it has been quite influential. The most useful part, probably, is his extensive discussion of the potential for small scale piggeries.¹³⁶

Fairlie argues that for centuries pigs have lived with people by eating what we will not eat:

*The food we choose not to eat consists mainly of (a) surplus and spoiled grains and roots (b) residues arising from food processing (c) kitchen waste, and (d) slaughterhouse waste. These usually contain high levels of nutrients and are better fed to pigs or to poultry whose gastric systems have evolved to digest highly concentrated food. Pigs, like humans, are omnivores who have difficulty digesting significant amounts of fibrous matter and require high concentrate foods to thrive.*¹³⁷

There is an enormous amount of this waste, especially in the rich countries of the world. Fairlie argues that all of it should be fed to pigs. That includes the fruit, vegetables and grains of the wrong shape and size which are left in the fields. This is the major form of

waste in the global South. It also includes the massive waste in food processing, supermarkets, and foods left uneaten or thrown away as leftovers – these are the major forms of waste in richer countries.

Fairlie's solution is simple. Feed all that waste to pigs. There are no precise estimates of how much food is wasted globally. But it is certainly more than the amount of feed in grains and soya currently grown and fed to pigs.

Two things are required, however, to make sure that waste gets to the pigs. One is strong government direction. The other is popular encouragement. The contempt for anyone who throws away food should be general, swift and withering, be it a slaughterhouse, a farmer, a supermarket, a restaurant or a potential lover. The other thing is that there need to be small pig sties everywhere, within a bucket carry or wheelbarrow walk of every house and restaurant. The child saying, "Please, mister, can I have those slops for my pig," should become a much loved meme. And as Fairlie points out, another advantage is that children in many lands will grow up learning much about the intelligence, sociability and charm of pigs.

None of this means that Muslims, Jews or Hindus will have to raise or eat pigs. Of course not. Vegetarians will be able to carry on as usual. We will still have some cattle, and roughly the same number of sheep and goats as we have now. And we will have chickens. It is not clear whether there will be enough edible waste for chickens. But there will be a good deal. And in any case, chickens are the meat animal where it makes the most sense to supply them with animal feed, because they are the best at turning it into protein. Nor is there any reason why corn-fed chickens need to be raised in endless rows of tiny prisons.

As with pigs, a switch to small scale chicken and egg units, often in the city, can create many more jobs, and supplement the income of large numbers of the urban poor. And if anyone thinks space is in short supply, there is no end to the shrublands and semi-arid lands of the Earth.

Even if we needed to feed half the free-range chickens and poultry on crops, that would still only use up 0.5% of the land area where plants and trees can grow, or 3% of our current cropland.

In other words, we could use most of the food that is wasted today, reduce livestock emissions from 3.0 to 1.5 billion tons a year, have about half the cattle we do now, and have roughly as many pigs, chickens, sheep and goats, end factory farming, and create

many more full-time and part-time opportunities in small-scale animal raising. Plus the meat would taste a lot better, and we would have enough antibiotics and fewer viral pandemics.

Ruminants, Grasslands and Soils

Cattle, buffalo and other large ruminants may actually be good for the soil, and increase the amount of carbon stored. The wildlife biologist Allan Savory has been arguing this for almost forty years. His starting point is that grasslands and ruminants evolved together. Ruminants grazed in large herds, as antelopes do now on the African plains and as buffalos once did in North America. Those herds were constantly on the move. Their hooves would open up the soil, and their manure would fertilize it. Then they would move on quickly, leaving the soil richer, and holding more carbon.¹³⁸

Modern livestock agriculture in many parts of the world has changed this process. Cattle and horses graze in meadows, chewing over the same grass month after month. That exhausts the soil without nourishing it.

Savory recommends another method. He urges the farmer or rancher to fence off small paddocks. Put the herd in that paddock for a short time, and then move them to another paddock, and so on, recreating the old symbiosis.

Some farmers and herders in many parts of the world, but particularly North America, have taken up Savory's ideas, and find that they work. Exhausted soil and pastures are regenerated. I have not found much scientific evidence that the methods work. But the anecdotal evidence is strong, and the argument from co-evolution is convincing.

What is less convincing is the claim that controlled grazing can store enormous amounts of carbon in the soil. There is little evidence for this. But well maintained pasture does store as much carbon in the soil as a rainforest does. That's about half the carbon found in the trees and soil of a forest. So it probably makes a great deal of climate sense to graze cattle and other ruminants on grasslands.

The Pressures on Land

So how much land will we be able to reforest? Opponents of meat often say that cropland could be reforested if it was not being used for growing animal feed. I have described ways of reducing crops

grown for animal feed, with some exceptions for chicken. That will free up land – if we are lucky 4 million of the 5 million square kilometers currently used to grow animal feed. But there will be many other pressures on that land.

For one thing, some people will be eating less meat. But when people stop eating meat, they don't eat less food. They eat other foods to make up the calories and nutrition. In particular, they need to eat foods rich in proteins and fat. If you are not eating dairy or meat, fat in particular is a problem. It's not that people cannot survive on a healthy vegetarian diet. Of course they can, and hundreds of millions do. But the cropland needs to be directed to richer foods like soya, nuts, sunflowers and other oil seed crops. Those richer foods require more land than simply growing sugar or grain to replace the calories.

Imagine an adult man who eats 2,400 calories a day, and of that, 600 calories come from protein and fat in meat. One quarter of his calories come from meat, and three quarters from other sources, mainly grains. If he stops eating meat, he has to increase his non-meat calorie intake by a third, and much of that has to come from sources high in fats and proteins.

The second pressure is that climate change will mean lower total crop yields. More land will turn into desert, and more regions will suffer chronic drought. And of the rainfall that does come, more will fall in the wrong season and more will fall in great bursts that the land cannot absorb. The increased heat will also reduce yields. Of course, some regions, and some fields, will do better. But overall we will need more cropland, not less. If the South Asian monsoon and the Himalayan watershed begin to fail, as is likely, we will need a lot more crop land to feed ourselves.

The third pressure is that total global human population is still increasing. There are now about 7.75 billion people. It seems that number will not increase by much more than 15%, to 9 billion people, before the total starts to decline. But a 15% increase is still a 15% increase.¹³⁹

Finally, there are the poor. For fifty years, the amount of meat that people eat has been increasing. Middle income, working class people in the rich countries started eating more meat first. After a time, that levelled out. Now meat consumption is not increasing among people in the rich countries of North America and Europe. But ordinary people in middle income countries have started

eating more meat. The driving force has been China. Twenty years ago meat eating was a measure of great global inequality. People in the rich countries ate four times as much as people in the global South. That gap is closing, and as people in the poorer countries reach a higher standard of living, some of them will want more meat.

Meat and Class

In 2017 Alexandria Ocasio-Cortez introduced her Green New Deal resolution in the US Congress. It was very carefully phrased, and said nothing about meat. There was one sentence about every American deserving a good diet. But people on the political right knew that some vegetarian environmentalists in the US were campaigning for an end to beef. You only had to listen to Leonardo di Caprio and the documentary he sponsored, *Cowspiracy*, to know that. Sebastian Gorka, a right-wing journalist, commented that the Green New Deal people “want to take away your hamburgers,” adding, “This is what Stalin dreamt about but never achieved.”¹⁴⁰

The jibe went viral, because it pointed to a weak point of the climate movement. The key word is “hamburger”. Working class Americans don’t get to eat all that much steak. They eat hamburger, which is minced beef mixed with all kinds of fat and the dross of slaughterhouses. It remains legal for producers to add something called “pink slime” to hamburgers. This is fattening junk food.

The affluent, the professionals, the people who went to good colleges, those are the people who eat steak or reject steak. In the United States I shop in Walmart for the same reason everyone else there does. It’s cheap. They sell everything, including food. You see some fit young people under 25 in the aisles. Over 25, almost no one seems very fit. We are all overweight. Obesity is marching through the working class. Last time I was in the Walmart in Eureka, Missouri, they piled the insulin for diabetics by the entrance eight feet high. In the US diabetics die every day because they have no health insurance and they cannot afford a full prescription of insulin, so they ration themselves.

Working class people in America wear their cheap food on their bodies. Sugar, pasta, bread and donuts are cheap. You can eat a good diet from an American supermarket, but every bit of it is expensive – fresh vegetables, fruit, steak, fish, and all the foods without added sugar. The affluent look down on working class

people, make fun of them for being fat. And the fat people feel their contempt and squirm. How many times have you seen a liberal or an environmentalist share a picture on social media of a fat Trump supporter with a jeer? That's class contempt, and it hurts. So, no. If we can't afford steak, don't you dare touch our hamburgers.

There's another problem too. If we do cut back on beef, the beef that remains will be more expensive, and taste better. I have learned a lot, for instance, from Nicolette Hahn Niman's excellent *Defending Beef: The Case for Sustainable Meat Production*. However, Niman is describing what she learned running a cattle ranch in California with her husband, and what they sold was luxury high end organic beef for expensive restaurants.¹⁴¹

We need to find a way to get good meat to poorer people who now have bad meat. One possibility is rationing. Every Kenyan and every American who wanted one could have a free, guaranteed, juicy free-range steak every week. Something you could really dine on, not chlorinated chicken, pink slime, dodgy sausage or hamburger helper. Something you could taste.

Not that everyone would have to eat meat. We are entering a world where everyone who becomes vegetarian is making a generous choice for the world and the climate. This too should be honoured as an act of social justice.

Emissions Reductions

If we stop feeding cattle on animal feed, and we return some of the pasture land to forest, we can reduce emissions from cattle, sheep and goats from 3.0 to 1.5 billion tons of CO₂e a year.

The totals for emission reductions are:

Methane reductions in billion tons of CO₂e a year

	Before	After
Natural Gas Leaks	4	0.25
Cattle, Sheep and Goats	3	1.5
Landfills and Sewage	1.5	0.75
Rice	1	0.75
TOTAL	9.5	3.25 billion tons

That's a reduction of two-thirds in total methane emissions.

We can also count the total reductions from agriculture, including both methane and nitrous oxide.

Emissions reductions from farming, in billion tons of CO₂e a year

	Before	After
Cattle, Sheep and Goats	3	1.5
Fertilizers and Manure	3	1.5
Rice	1	0.75
TOTAL	7	3.75 billion tons

That's a reduction of almost half in emissions from agriculture. It's not perfect, but given the difficulties, it's good.

MI CUERPO

MI

TERRITORIO

"My Body, My Land"

*Sign carried by Kofan leader Alexandra Narvaez
from Ecuador on a march in Brasilia of indigenous
women from Amazonia, 2020*

TEAR DOWN THE WALLS

I have been talking about farming in terms of, “how can we reduce emissions?” Now I want to turn this around, and talk about how farmers, and the rest of us, can change the world so they can cope with climate change.

I have resisted doing this for years. The reason is that about a decade ago some environmentalists began to talk about “adaptation”. This discourse was suddenly everywhere. What they said was that the climate is going to change. Indeed, it has already begun to change. And this is going to be catastrophic for people, particularly villagers, women and the poor in the global South. It is time to stop talking only about prevention. We need to think about how people might cope, and ways to make communities more resilient.

I thought then that this was an ideological attack to accustom everyone, even the climate campaigners, to giving up. It was coming from the top, and from those in the climate movement who had understood they could not persuade the people at the top of society.

It was also, transparently, an attempt to move the available funding to NGOs. The money for jobs to stop climate change would not go to NGOs. It would go to public bodies or private companies to convert buildings, run buses and build renewable energy. The money for resilient communities would not go to the governments of poor countries, or directly to the poor people, or to the elected local governments in those communities. Instead, it would go to unelected NGOs where the “international” (usually white) staff made five times

the salaries of the national staff, who made ten times the incomes of the landless villagers.

Everything I thought then has proven to be absolutely right. But I was wrong about the central issue. To explain why I was wrong, let me start with the thing that still enrages me most about the “adaptation” discourse – that word “resilience”.

I spent three months in 2008 in New Orleans, doing research on people’s experience of Hurricane Katrina in 2005. They were very angry. The one phrase that summed up that anger best was, “Don’t call me resilient. It just means you’re going to f*** me again.”

Talking about resilience in the face of climate change ignores a deep truth – people cannot farm without water. Without water, the grass dies, and then the animals.

Globally, drought will be concentrated in the warmer regions. Where there was some drought, there will be more. These are not just poor countries. Some of the worst droughts in the world in the last few years have been in Texas and Australia. The photos of dying cattle in Texas look no different from the photos of dying cattle in Africa. But the difference is that in the United States or Australia few people work in the fields or with animals. A disaster for agriculture is not a disaster for the country. In Sudan, it’s the other way round. And in Sudan, people start from a far poorer base. No one in Australia dies of hunger in a refugee camp.

Hundreds of millions of people will however lose their livelihoods, their homes, their communities and their way of life. This will produce desperation, and calls for help, and murderous rage. All of these reactions are sensible and appropriate.

That’s why I was wrong to say we should ignore “adaptation”. People, particularly rural people, are going to be enraged, and they also need help. Both are important. We have talked about reducing emissions in the countryside, largely in terms of what will work technically, and what farmers and herders can be persuaded to do. But let’s turn this round. Instead of regarding farmers as the objects of policy, let’s think of them as the agents of change. Let’s think of “them” as us.

What will farmers, herders and agricultural workers need in climate catastrophes?

First, they will need relief. The journey into drought is sometimes a permanent fall off a cliff. More often, it is a steady descent. There are bad years, and better years, and then worse years. In many years, and many places, the harvests are bad, but they are

still a third, or a half or two thirds of the usual harvest. In all those situations, people need money to get by. They don't need relief food. Giving hungry farmers food from abroad just depresses the price of the food those farmers are already growing and trying to sell. They need money to buy food, and school clothes and a bottle, a prayer shawl and everything else they need to be human. The best way to do that is basic income grants that carry farmers, herders and workers through both bad and good years.¹⁴²

Farmers and herders also need a moratorium on debts in the bad years. A cycle of debt is how farmers lose their land. So they need laws which say no bank, and no person, can repossess a farm, or farm machinery, for debt. But such a law would threaten to close down all credit. And all over the world, farmers who live from month to month depend on credit to buy food, seed, fertilizer and machines. So there has to be a government funded credit union, or credit service, that still makes loans to people to go forward.

Farmers and herders need expertise too, badly. They need it because the climate is changing. They need to know what farmers and herders in other, more arid, places know. They need different varieties of their staple crops, and different crops, and different kinds of sheep. But they also need advice on the details, when to plant, how much water, the angle of the slope, and so much more. They need people from other areas, twenty miles or two hundred miles away, to come and stay awhile and help. A climate jobs project could pay those visitors.

Farmers and herders need agricultural experts too, but of a new kind. The government agricultural agents who advise farmers I have known are decent folk, almost all with a love of the land and most with a deep respect for farmers. But they work under tight restrictions. The industrial agriculture corporations control and patrol the limits of their research. The governments which educate and employ them follow the technical lead of the Big Agriculture corporations. The governments also want the medium sized commercial farmers who can feed the cities and the export markets. They don't want small farmers. Those farmers need a new generation of scientific researchers who are prepared to answer different questions.

Farmers and herders also need work. The government of India guarantees a hundred days paid work each year to one member of any rural household who wants it. It is very little for a government to

offer, and a great deal for any household to receive. India is not a rich country. There is no reason every country in the world cannot do this. Almost all farm households can spare one person for a hundred days and still work the land.

But, more and better than work schemes and grants, rural people need climate jobs and green new deals. They need full time, well paid work that they can do and not be driven from home.

Farmers and herders will need more land than they have access to now. When the climate changes in many areas, harvests and grass will fall. This means that people will need more fields and pasture to produce the same amount. In many, many parts of the world that land is sitting right there. Much of it belongs to the agribusiness corporations, the big landlords, the hacienda owners, the commercial farmers and the white settlers. In countries where landholding is so unequal, what people need is land reform – taking the land from the rich and redistributing it to the poor.

This is not a strange idea. Revolutions made it happen in France, Russia, China, Vietnam, Mexico, Turkey and Algeria. Conservatives made it happen in Japan, and nationalists across most of India, Egypt, Syria and Iraq. The United States made the governments of South Korea, Taiwan and the Philippines do it lest they went communist.

But rural people facing climate change also need a place to go. Almost all the literature on climate change and resiliency assumes people should stay put where they are. This is partly because the governments of the rich countries do not want to allow people what they often obviously want – a better place to live than the one that has been destroyed.

People are on the move in many parts of the world, seeking a better life, going where the jobs are. This has often been exaggerated. Right now just 3% of the world's population live in a country other than the one they were born in. Those migrants are particularly concentrated in western Europe and North America. But as climate change bears down, more and more people will have to move, and want to move.

More and more, those people come up against walls. Or they risk their lives on overcrowded boats in the Mediterranean, and now in the English Channel. Trump tried to build a wall across the border with Mexico. But it's not just the rich countries where walls are being built. India is building a wall around Bangladesh, much of which will go underwater. In South Africa there have been bitter riots with local

FIGHT THE FIRE

people beating, killing and burning out Africans from other countries, many of whom have fled drought.

This is one reaction to migration. Another is possible. The poor and the refugees can be welcomed, wrapped in warm clothes, found a home and a climate job and a school for their children. Welcomed into safety. Because there but for the grace of God and the accident of birth go you, and we are all living through the trauma on this planet together.

Moreover, solidarity is a two-way street. If climate activists help desperate rural people defend themselves, those rural people will become climate activists. Farmers and herders can organise for their own survival, for compensation from the powers that have caused their problems, and to stop climate change.

**MORE
TREES,**

**LESS
ASSHOLES**

*Climate striker in Cape Town
protesting outside the South African parliament*

CHAPTER 17

FORESTS

The final ways to reduce greenhouse gas emissions are to stop cutting down trees and to replant vanished forests. But “sustainable forestry” will be of little use. We have to plant the forests and allow them to grow, and keep growing as long as they can.

When you cut down forests, the trees and other vegetation around the trees decay. As that happens, the carbon in the trees and plants mixes with the oxygen in the air. The result is that the carbon becomes CO₂ emissions into the atmosphere. The soil on the forest floor stores as much carbon as do the trees and plants. When the vegetation is cut down, and the earth exposed, much of the soil carbon becomes CO₂ emissions as well.

Cutting down trees and forests releases about 5 billion tons of CO₂ into the atmosphere each year. That is equivalent to about 9% of global greenhouse gas emissions. Most of this deforestation is done to create fields for crops and pasture for animals. We can reduce those emissions to almost nothing by not cutting down any more forests.

A warning is needed here. That figure of 5 billion tons is an estimate. There is a good deal of controversy, and this is not an easy thing to measure. It could be that the emissions are as low as 2.5 billion tons. These global figures, however, are more reliable than the national figures governments provide for emissions from deforestation. The polite way of saying this, often found in the literature, is that national totals are often unreliable. Another useful word is “lies”.¹⁴³

Not cutting down trees will have consequences for building materials, and for food, as I discuss in a moment. But first I need to address the related question of reforestation.

Just as cutting down forests releases CO₂, so growing new forests increases stores of CO₂ in trees and soil. And we can certainly plant new forests on a massive scale. However, reforestation is not the same thing as “sustainable forestry”. Reforestation to slow climate change means planting trees and leaving them alone. Sustainable forestry will do little or nothing to delay global warming.

Sustainable forestry has long been a popular idea. The idea is to plant trees on bare land, grow and harvest them for biofuels and building materials. Then you plant new trees, and the process begins again. The idea was that the CO₂ is fixed in the forest all the time.

This makes a kind of intuitive sense, and many decent and dedicated foresters have spent lifetimes trying to make the process work. After all, they say to themselves, this gives governments and landowners a commercial reason to plant the trees the planet needs. If we don't do sustainable forestry, they thought, we will have no forests at all.

But here are the problems. First, when the tree is used as biofuel or biomass in a vehicle or a factory, the carbon burns and goes back into the air as CO₂. For more than half the life cycle of the forest, more than half the CO₂ is in the air, not in the forest.

The concept here may be hard to grasp. So let me walk you through it. Visualise a fully grown mature forest. 100% of the carbon that is supposed to be in the trees and plants is actually in the trees and plants. Now visualize a forest cut down clear to the ground. None of the carbon is in the trees and plants. Most of it is CO₂ in the air. Wait forty or sixty years until a new forest has grown again. Now 100% of that carbon is back in the trees and plants. But during those forty years, the carbon in the forest is growing from 0% to 100%. On average, about 50% of the carbon is in the forest, and 50% is in the air.

If the wood is used as a building material, that does store the carbon for a time. But most unharvested trees last longer than most buildings. And in many countries, wood is used in construction in ways that make it difficult to recycle. Moreover, much of the tree, and all the surrounding vegetation, do not make planks or even particle board. Instead, they are burned and go straight into the atmosphere as CO₂.

Moreover, a mature forest can take eighty years to grow. The sustainable forests that are now being proposed for much of the

tropics are commercial plantations. They grow trees like eucalyptus and poplars, which can be harvested in ten or twenty years. Those plantations are “monocultures”, with only one kind of tree, and little vegetation under and around them. So the plantations hold only a small fraction of the biomass of a mature mixed forest.

Remember, half the carbon of a mature tropical forest is in the soil, not the trees. Harvesting the trees every ten or twenty years means that the soil is regularly disturbed and emptied of much of its accumulated carbon.¹⁴⁴

These plantations can be a good way to make money. But they squander the chance to slow climate change.

I am not saying that we should stop all commercial forestry. There is a large forest products industry already in operation. That supplies wood for building materials, furniture and the pulp and paper industry. Humans will continue to need those things. What I am suggesting is that “sustainable forestry” be limited to the forests that are currently being cut down and regrown. But no more forests will be thrown into the chipper.

I hope that at some point in the future, honest professionals not driven by corporate needs for profit can meet to discuss how to balance the use of wood in buildings against the use of stone, bricks or steel. But the time when that is possible is not now.

How much reforestation?

Several different teams of scientists have made estimates about how much of the pasture land we can reforest. We will not be able to reforest the fields that grow crops. We are going to need that food.

We will not be able to forest the shrubland, nor will it be easy to forest the less fertile grassland. Still, the general estimate is that we can reforest about 9 or 10 million square kilometers of pasture land. That would be just under a third of current pasture land.

Possible future use of land

	Before	After
Forests	40%	50%
Grasses	32%	22%
Shrubland	12%	12%
Cropland	16%	16%

The share of cropland, at 16%, would not change. Global forests would increase by a quarter. That would restore almost half of the forests that were here before humans began cutting them down.

We would have about two-thirds of the grassland pastures we have now. The shrubland and semi-arid would remain intact. That would help to protect small scale herders in Africa and the Middle East.

We will probably need to convert some pasture land into crops. The global population will increase from almost 8 to at least 9 billion before it begins to fall. Moreover, it looks very likely indeed that climate change will mean reduced yields on the land we already farm.

There are debates about how much pasture we can spare for planting trees. But the consensus is that we can turn about a third of all the land used for existing pasture back into forests. That will restore about 40% – almost half – of the land lost to deforestation since 1900. And it will increase the extent of global forests by about a quarter.¹⁴⁵ Reforestation on that scale will take about 370 billion tons of CO₂ out of the air, and put that carbon into growing trees and plants.

There is about as much carbon in the soil of good pasture land as there is in the soil of a mature forest. So the gain from reforestation is the gain from the trees, not from the soil. As we established, about half of the carbon in a mature forest is in the trees and plants, and about half is in the soil. The carbon in the trees and the carbon in the soil are both lost when you cut down a forest. But it does not work the other way round.

Some of the new forests would be tropical or semi-tropical, in countries like Brazil, Congo and Indonesia. Between a quarter and a third would be temperate forests in places like Germany, Chile and the United States. Some of the new trees might be in boreal forests, in places where temperatures dip below freezing for six to eight months of the year. These are all in the far north, in Russia, Canada, Scandinavia and Alaska. Some scientists, though, warn against planting new boreal forests. They say that dark boreal forests would absorb far more heat from the sun than the white, snow-covered tundra and plains they would replace. This would contribute to the albedo feedback, which we heard about in the chapter on *Science*. This is a serious consideration.¹⁴⁶

There is a general assumption in the literature that most of the new forests would be in the global South. This is partly because tropical forests grow more quickly, and partly because land is cheaper there. I think this is a mistake, though. Brazil and Indonesia

are the two countries on which the burden of reforestation would fall most heavily. There would be considerable economic costs to both national economies, in lost land and lost income from timber. Brazilians and Indonesians are perfectly capable of uniting to reforest out of love for their land. But they are unlikely to do far more than their share if the people in richer countries have decided those countries that had been colonized should once again suffer the burden. So, yes, lots of trees in Europe and the United States.

In all, reforestation on this scale would take large amounts of CO₂ out of the air. All told, it could take 370 billion tons of CO₂ out of the atmosphere. That would have exactly the same effect as 370 billion tons of CO₂ not put into the air. That 370 billion tons is about ten years of fossil fuel emissions at current rates.¹⁴⁷

Looking closely at the numbers

Ending deforestation and planting new trees can make an important difference to climate change. Put the two together, and that 10 billion tons of emissions from reforestation a year is a quarter of the 40 billion tons a year we can cut emissions from reforestation by not burning fossil fuels.

Five billion tons of emissions is a substantial amount, and several different studies have come up with similar figures. However, one study in *Science* in 2019 by Jean-Francois Bastin and colleagues came up with an estimate three times as big.¹⁴⁸

The press release for that study used a quote that social media took round the world. It said that reforesting was the single most important thing we could do to stop climate change.

That was something many people wanted to hear. For some, this was because they felt that reforesting would be a natural solution in a way that sun and wind power are not. Others felt that the fossil fuel corporations are simply too powerful, and will be able to block renewable energy. So they welcomed the prospect of a solution which meant we do not have to take on and beat the corporations and politicians.

Unfortunately, other scientists quickly pointed out several mistakes that Bastin and colleagues had made in their calculations. The main one was that Bastin counted all the carbon that would be stored in the newly planted trees. Fair enough. He also counted the equally large amount of carbon that would be stored in the forest soil. But he was talking about changing pasture and grasslands into forests. And pasture

and grasslands already have as much, or more, carbon stored in the soil as do forests. This mistake more than doubled his estimate.

The second important mistake was that Bastin made his calculations on the basis that a tree contained all the carbon it would hold when fully grown as already being in the sapling the year it was planted. In fact, a tropical forest takes at least forty years to reach maturity. A temperate rainforest takes eighty.

The third mistake was that Bastin forgot that when CO₂ was taken out of the air, part of the sinks that absorbed CO₂ would also disappear. That mistake also greatly increased his estimates.

There were several other, smaller, mistakes in the article. Several experts in the field wrote blogs, letters to journals and other articles pointing out the flaws in Bastin's work. A correction was published in *Science* ten months later, in which Bastin and his team acknowledged their key mistake about soil carbon, and admitted that reforestation was not the most important measure for fighting climate change.¹⁴⁹

You very probably did not see the critiques, nor the correction. But there is a lesson here. Because something is written on the internet, and because it is published in a scientific journal, does not make it true. In particular, be very careful of quoting numbers without reading the article, and without checking with the numbers in this book too. If there is a discrepancy, investigate further. Above all, be careful of numbers which reinforce what you already think, or want to believe. We need honest accounting.

Forest People and Jobs

I have not talked yet about forests and jobs. In fact, it is striking in the literature how seldom there is discussion of the people who will live in the forests and what they will do. But one of my mantras for this book has been to look for the working people who could organise for a Green New Deal.

With forests, there are two obvious groups of people. One is the people who already work in forestry, logging and timber mills. Most of them would continue to do the work they do now. But some would love to work in planting and tending forests. This is not just a matter of protecting jobs, but also protecting communities. I am thinking particularly of the towns I know in northern British Columbia, but similar logging communities are found across Canada, Russia and Scandinavia. The second, and larger, group is the people who used to live in the forests.

In most places in the world, and particularly in the tropics, you can see the people who once lived in the forests. Now they often live in shacks on the edges of a village, around a city in the shanty towns, favelas, bastis and slums. Often enough they can be found in the maids quarters. They are known as indigenous people, orang asli, burakumin, adivasis, or by more brutal terms. Sometimes their parents or grandparents were torn from the forest land. Sometimes they remember leaving it themselves.

Some of these people belong to ethnic groups associated with the forest, and sometimes they just lived there. The majority of them lived in tropical rainforests, but there are also many forests in the north and far south. Many of these people would gladly go back to live in the forest – if it were a safe and decent life.

There are two reasons hardly anyone mentions this in the literature on reforestation. One is that these people are widely regarded as of no importance. But the other is a fantasy about rewilding. In this fantasy, it is assumed that there were no people in the forest primeval. And it is assumed that the rainforest should be left untouched, except possibly for ecotourists and their smiling low paid native guides.

In fact, people lived in traditional forests alongside birds, animals, insects, fruits and herbs. New, replanted forests will also be full of meat and fish. If we take pasture away from the herds of domestic animals, many people will still need and want to eat meat. There is no special reason why it should all be eaten by wolves and jaguars. And no cruelty to animals is involved. An endless forest is utterly different from a factory farm.

Moreover, rewilding the grasslands would mean replacing ruminants like cattle with ruminants like deer, antelopes and musk oxen. In climate terms, it would make little difference.

Chickens and pigs began in the forests. As we have seen, pigs and chickens – unlike cattle, beef, deer and antelopes – produce hardly any greenhouse gas emissions if they are allowed free range.

If we turn over almost half the grassland of the world to forests, that land can still be home to large herds of pigs. There are places where you can see that already beginning to happen. In the United States there are now wild pigs, descended from escaped stock, in the forests in thirty states. The wildlife authorities say it's terrible, that the pigs seem to be taking over and driving out the deer, who are ruminants, burping methane. Deer also eat tree seedlings, preventing the forest from regenerating. Another way of thinking about that is

that pigs are thriving, and here is a massive new source of meat. Also, of course, it means a good, free range life for pigs.

If you want to walk in forests where the main form of wildlife is wild pigs and chickens, go to Tahiti. The thing that stays in my mind, oddly enough, is how noisy both the pigs and the chickens were.

The people who live in the forest could hunt and gather forest products, eat them and bring them out to sell. Crucially, they could also be paid a wage to be guardians of the forest. Because if they are not, who will stop the deer and the other ungulates from stripping the growing trees? Who will stop poachers, the gold miners and the timber rustlers?

Indeed, the forest people could also be the foresters. These too are climate jobs. Planting and managing forests on this global scale will require an enormous amount of work. And the people who planted and grew the trees are those most likely to defend the forest.

That wage would be important. So would large numbers of skilled nurse practitioners, teachers and educated foresters serving small communities. Partly their services would make life decent, but they would also provide a way to keep some of the daughters and sons of the community in the forest. Democratic control of the forest land by the forest people would be crucial, as would a pride in being the wardens of the Earth.

Without those protections, we are likely to see a continuation of what we see now all over the world. The forest people come up against barbed wire and armed wardens. They are treated as scum, and beaten and raped by the cops. They are also forced by poverty into illegal trade in hardwoods and endangered species. It's a vicious circle where blame is always centered on the indigenous people.

Of course, in some countries there are now not enough traditional forest people, or not enough would want to go back. But the life would suit some people from other backgrounds just fine. Some people would migrate, or marry in. But that point about democratic control and paid work is crucial. I am not proposing that forest people be allowed to live in "forest reserves". I am proposing that they should be the paid foresters, that they should decide how to manage the forests, and they should be the holders of democratic power.

**AFRICA IS
BURNING**

**1 MILLION
CLIMATE
JOBS NOW**

*Banner at march to UN climate talks in Durban,
South Africa, 2011*

THE MIRAGE OF NET ZERO

So have we got to 100% greenhouse gas reductions? Does this mean we have arrived at net zero? Well, no, not quite. And there are serious traps in thinking in terms of net zero. This chapter explains some of those traps, but also some of the problems that can be solved if we aim for 100% decarbonization.

I will start with some questions people ask when I give talks about climate jobs, and some questions that readers of this manuscript have raised. The answers to these questions are all related. People ask:

- After we have done all that you propose, won't there still be the disgusting waste of SUVs?
- Won't people still be eating meat?
- What's the point, if we still have economic growth?
- What about unintended consequences and the rebound effect?
- Renewables run on clean energy, but manufacturing them will still require fossil fuels. What do you do about that?
- Don't we have to abolish subsidies to fossil fuels?
- Won't carbon taxes help?
- What about congestion charges to control city driving?

Now let me try to show how the answers are related. The first point is that all the way through the book I have been talking about "100%"

renewable energy. I put 100% in quotation marks above because I have argued we cannot quite get there. There will still be some CO₂ from running airplanes and ships. There will be small amounts of CO₂ and methane as byproducts of industrial processes. There will have to be some backup generators for hospitals and other essential services during any temporary breakdown of the grid.

But there will be no emissions from burning coal, oil and gas to heat buildings, make electricity or run vehicles, and almost no emissions from heating materials in industry.

After that, there may well be a growth in production, but there will be two restrictions. One is that all further production will have to be done using renewable energy. The other is that there will be a global limit to the amount of fuel burned in airplanes and ships.

These blanket restrictions are essential. Without them, different companies and different countries will constantly compete to find new activities that must be powered by fossil fuels. But if we ban burning fossil fuels except in those very limited ways I have specified, then we can begin to answer the questions above.

Embodied Emissions

The first one is, “what do we do about the fact that building renewable energy will still require burning fossil fuel?”

The answer is that at first we will have to burn fossil fuel to mine the metals and materials for a wind turbine. As now, we will still have to burn fossil fuels to transport and process those materials, to build the wind turbines and to transport them to site.

Those “embodied emissions” in a wind turbine are real. They are not very large. Way back in 2010, L. D. Danny Harvey calculated the amount of embodied emissions in renewable energy, using the idea of “payback time”. This is the length of time the wind farm takes to produce an amount of energy equal to all the energy used in making the turbines, transporting them, making and transporting the materials, building the factories, and so on.¹⁵⁰

Harvey calculated that for wind farms the payback time varied from two to eight months. For solar PV cells, the usual payback time was two to four years. For concentrated solar, the estimates varied from six months to two and half years. Wind turbines, solar PV arrays and concentrated solar power last about 20 years. What these estimates said was that the embodied emissions in renewable energy were very small. And that was ten years ago. The payback times now are probably a good deal shorter.

The real pay-off, though, comes after 20 years. Then the mining machines and the mining vehicles run on renewable electricity. The processing of the metals and materials is done with electrical motors and electrical heat. The parts of the turbine are transported to the wind farm on vehicles run on renewable electricity, and so on. Almost every step of the way, there are no embodied emissions.

I say almost every step of the way, because maybe some of the materials will cross oceans. That will have to be done on ships. Bear that exception in mind.

Half way through the process, the emissions from constructing wind turbines will be about half what they are now.

So the answer is the embodied emissions are a real problem now, but a small one. In a low carbon world, they will not be a problem.

The Rebound Effect

A common worry is that using renewable energy will not in fact cut emissions because of the "Jevons Paradox". This is an idea first developed in 1865 in a book on *The Coal Question* by the economist William Stanley Jevons. The paradox is also sometimes called the "rebound effect". What Jevons said was this: as people used more and more coal, they learned to use it more and more efficiently. So the same weight of coal could provide more heat and power. You might think that would mean people would then use less coal. In fact, they used more coal. The more efficient coal was, the cheaper it was, and the more money people had left over to spend on other things. And those other things involved burning more coal in trains, factories and mills, and to heat larger houses.

1865 was a long time ago. Since that time economists have shown that the same thing happens with oil and natural gas. The better we get at using the fuel, the more we use. And the paradox also works with other natural resources, like water.

Many people therefore assume, quite reasonably, that the same thing will happen with renewable energy. We will build more and more renewable energy, but emissions will still increase at the same time. It is easy to see how this would work. We increase the amount of renewables so that they supply half of all energy. But the total amount of energy used is increasing too, so we are also using more and more fossil fuels. Moreover, we can save money on household bills by insulation and conversion to save energy. That gives people more money to spend. And public transport costs less than cars. That gives

people more money to spend too. They go right out and spend more on things that take more energy to make and run.

That is likely to be the problem with most plans for renewable energy. But that won't happen if we ban any further use of fossil fuels. Once everything runs on renewable energy, governments simply make selling coal, oil and gas illegal. People won't be able to do it. There may be more demand for energy. But that demand will have to be satisfied by renewables. And if it can't be satisfied by renewables, it won't happen. This will be a matter of agreed public policy, in much the same way that selling anthrax is illegal now.

There need to be some qualifications here. It is difficult to think how to power ships and planes with renewable energy. Moreover, 100% renewables mean that planet warming emissions can be cut to almost nothing, but that does not solve the problem of other resources, like water. The Jevons Paradox need not be a problem for climate change if we rely on democratic decision making rather than the market, but it will still be a problem for other resources.

Market Incentives

Now, what about carbon taxes, congestion charges and carbon trading?

These are different proposals for market incentives to push people into using less fossil fuel. For example, a carbon tax would charge companies or people so much for each kilo or ton of CO₂ emitted. Then they would burn less fossil fuel.

There have been many proposals for general carbon taxes over the years, in many countries. None has so far been implemented. But one specific form of carbon tax has been in use in most countries for many years. This is a tax on the petrol and diesel used in cars, trucks and other vehicles. These taxes are often quite steep. In many countries, particularly in Europe, they are more than half the cost of petrol at the pump. Steep taxes certainly have an effect in reducing petrol use. Cars in most countries in Europe, for example, have tended to be smaller than in North America, and there are fewer SUVs.¹⁵¹

But the effect is limited. Car emissions are less per mile in the UK and Germany than they are in the United States, but they are still very substantial. What we are proposing instead is replacing all petrol and diesel vehicles with vehicles run on renewable electricity. Then the amount of fossil fuel burned is not reduced – it is eliminated.

Congestion charges are similar. In 2003, for example, London brought in a charge of £5 a day for anyone driving in the inner city

on a weekday. The idea was to make traffic flow more quickly and reduce emissions. Traffic does now move more quickly, and weekday traffic volumes before the pandemic had fallen by almost 25%.

But banning cars in the inner city would have lowered vehicle emissions by more than 90%. Moreover, once a tax is in place the local or national government has an interest in keeping the status quo. In 2004 one of the major architects of the London plan explained to me how the mayor's office had chosen a charge which would produce the highest possible total tax take. Their research showed that a tax of £10 a day would have led to very low levels of traffic, but also low levels of income. So they set the rate at £5.

Carbon trading proposals are another way of reducing emissions through the market. The idea is that companies bid against each other for permits to emit specified quantities of emissions. The largest attempt to make this work was the carbon trading network in the European Union, which failed abjectly, because so many corporations were given such large free allowances at the start. Again, a carbon market does not eliminate remissions. At best, it reduces them somewhat.¹⁵²

Offsets and Net-Zero

Another idea is international carbon trading, or offsets. The way these projects are supposed to work is that large corporations in the US or Europe buy permission to continue to pump out emissions. In return, they pay for some country or company in the global south to reduce emissions or plant trees.

Let's take a hypothetical example of how this works. Imagine that Amalgamated Steel in Canada is emitting 10 million tons of CO₂ globally. They pay money to a company called United Trees in Brazil, which contracts to plant enough trees to take 10 million tons of CO₂ out of the atmosphere. That way Amalgamated Steel has offset their emissions. They have reached net zero.

But at net zero, they are still pumping 10 million tons of CO₂ into the atmosphere. Those 10 million tons each year are still heating the Earth.

This is a trick. Central to this trick is the assumption that without Amalgamated Steel the Brazilian government would not be replanting trees. The climate jobs approach we are setting out means that Amalgamated Steel will emit nothing, and Brazil will plant trees. One reason I have gone through all the detailed calculations in this book is to show we will need both the new steel plants and the new forests.

This is the danger in the climate movement calling for net-zero. Almost all the ways of producing net-zero are some kind of trick. Often the companies or governments promising net-zero know it is a trick. Usually the activists demanding net-zero do not know this.

Also, promising 100% or net-zero can lure climate planners into deceiving themselves. This can, and does, happen to the best of people with the best of intentions. The recent report from the IPCC on 1.5C is written by distinguished scientists. Clearly, they desperately want to make sure the world avoids a temperature rise of more than 1.5 degrees. But once they make that their goal, they are trapped into two ways of massaging the data. The first is that they accept the assertion that we can offset emissions by burning biomass with carbon capture and storage. I have already laid out the drawbacks of biomass, and why carbon capture and storage is a fantasy. The second thing the IPCC does is to assert that we will go over the threshold of 1.5 degrees, but in future we will be able to claw our way back by taking CO₂ out of the air and storing it. As I have pointed out, that's a maybe. And it would happen after we passed the threshold.

It is only too easy to get sucked into this way of massaging problems. I feel the same pressure. One of the last things I had to do in editing this book was go back through my estimates of emission reductions one last time, and ask myself: "Really, Jonathan? In the real world?" And then increase some of the estimates.

Also, when activists ask a government or an employer to promise net-zero by 2030, or whenever, they are deceiving themselves. If the government or employer agrees, it is not a victory. It's an agreement to accept an untruth.

That is why scientists are increasingly arguing that "positive" emissions cuts – cuts that will actually happen – should be calculated on one side of the ledger. "Negative" emissions cuts, like those from planting trees or taking carbon out of the air, should be calculated on the other. That is the approach I have followed in this book.¹⁵³

Subsidies

All of these ideas – carbon taxes, congestion charges, carbon trading and offsets – may have made some kind of sense when many people thought we would have to reduce global emissions by a third. They make no sense in a world where we have to reduce emissions swiftly and deeply.

Which brings us to subsidies. Again, many people want to reduce government subsidies to fossil fuel companies, to level the playing field. You have to be careful in reading this literature. When we think of subsidies, we often think that the government gives payments to producers of gas and oil to enable them to sell their products more cheaply. Such subsidies exist in some places, but they are trivial. However, the literature on subsidies for fossil fuels classifies under subsidies such things as tax reductions, the cost of building and maintaining a highway system, and a notional calculation of the cost of the impact of pollution from fossil fuels. To this they add an imaginary calculation of the cost of all future damage from climate change, an enormous number. Calculating in this way can produce very large estimates of subsidies, but these are not what most people understand as subsidies.¹⁵⁴

We can then fool ourselves into thinking we can make a significant difference by simply cutting subsidies. This is a red herring.

However, the more important point is that a climate jobs project would eliminate any need for subsidies by simply not allowing fossil fuels onto the playing field.

What about SUVs and Laptops?

Similar arguments apply to the possibility of SUVs and laptops in the future. People may or may not want SUVs. They will almost certainly want laptops, and there are substantial embodied emissions from rare earth mining in those laptops.

The logic is the same as with wind turbines. Today an SUV requires materials that are mined, transported, processed, assembled and delivered with emissions from fossil fuels at each stage. In a low carbon economy the SUV will be built with almost no embodied emissions. It will be an electric SUV run on renewable electricity. It will be wasteful of energy. But it will be wasteful of renewable energy.

The point to grab hold of here is that we can use up enormous amounts of energy without producing any greenhouse gas emissions. We can build enough renewable energy to replace all our current uses of energy. Then we can double the amount of energy humanity uses. And then we can double it again. And still this will have nothing to do with making climate change worse.

We can only do this if humanity has decided that all ground transport, all electricity, all motors and engines, and all heating of every kind will run on renewable energy. That "if" is important.

So is the fact that we will have to ban all these uses of fossil fuels. Just encouraging people through market mechanisms will leave us with expanding greenhouse gas emissions forever.

You may well feel, however, that you don't want a world full of SUVs. You are entitled to feel that, and I agree with you. But what I am arguing about in this book is how to stop climate breakdown.

Maybe an analogy with smallpox and capitalism will help. I remember seeing women, hundreds of women, lining up with their children on a dusty field in Kabul in 1971. They were waiting, for hours, for smallpox vaccinations. I met a lot of people in Afghanistan who had the scars of smallpox on their faces, and all the women in that long line of course had known children who died of the pox. Now humanity has eliminated smallpox. We still have capitalism.

No one in their right mind would have gone up to those women in that line and said, "what's the point, we will still have poverty and capitalism". Because if a woman had bothered to answer thoughtfully, she would have said, "yes, but I will still have my daughter".

So maybe we will stop climate breakdown and still have SUVs. Maybe we will still have laptops and capitalism. But we will have those things without the extra, special, overwhelming horrors of climate breakdown.

**WHAT PART OF
"CATASTROPHIC
AND
IRREVERSIBLE"
DO YOU NOT
UNDERSTAND?**

*Official placard
Time to Act Demonstration
London, 2015*

CHAPTER 19

TOTAL EMISSION REDUCTIONS

Now we have covered all the possible sectors. Here are our total estimates of emission reductions. Do bear in mind what I said about net-zero. CO₂ and other long-lasting greenhouse gases are up first.

Reductions in long-lasting emissions, in billion tons of CO₂e

	Before	After
Producing electricity	15	0.5
Transport	10	2
Industry	8	2
Deforestation	5	0
Heating buildings	3	0
Nitrous oxide	3	1.5
F-gases	1.5	0
TOTAL	45.5	6 billion tons a year

Here are the figures for methane.

Reductions in methane emissions in billion tons of CO₂e

	Before	After
Natural Gas Leaks	4	0.25
Livestock	3	1.5
Waste	1.5	0.50
Rice	1	0.75
TOTAL	9.5	3 billion tons of CO₂

That is a reduction of 69%. It's the equivalent of a one-off reduction of 650 billion tons in CO₂ emissions.

Reforestation could have the same effect as another one-off reduction of 370 billion tons of CO₂ emissions. And we can add the carbon from 100 billion tons of CO₂ stored in the soil.

Now we can repeat a table we presented at the beginning of the book on a carbon budget if we can begin global climate jobs by 2025.

Additional emissions in billion tons of CO₂e

Until 2025	180
Transition	500
Feedbacks	100 to 300
TOTAL	780 to 980 additional billion tons of CO₂e

Offset emissions in billion tons

Methane reductions	650
Reforestation	370
Storing carbon in soil	100
TOTAL	The equivalent of a reduction of 1120 billion tons

The reduced emissions are slightly larger than the added emissions. That would mean we could probably stay more or less where we are now. And we can probably avoid a temperature rise of more than 1.5 degrees.

One last point, though. We will still have emissions every year of 6 billion tons. And that's a problem. Over a period of 17 years, that adds up to 100 billion tons. Over fifty years, we begin to approach the possibility of passing 1.5 degrees Celsius. Over a hundred years, the odds are we will pass that threshold.

I am not sure what we will be able to do. We can buy time if we find a way to heat all industrial materials with renewable electricity and hydrogen. We may be able to slice a bit more off nitrous oxide or livestock methane emissions. Rail lines from Buenos Aires to Alaska to Siberia to London and Cape Town could make it possible to live almost completely without airplanes.

The likeliest solution is probably some way of taking carbon out of the air. I know I rubbished the idea of carbon capture and storage in an earlier chapter. But that was the idea of burning coal to put extra CO₂ into the air and then expanding an enormous amount of energy to scrub that carbon out of the air and put it back under the ground. A colossal waste, when we do not have time and energy to waste.

But still, although they require a great deal of energy, we already have ways of taking carbon out of the air. It is perhaps not beyond the wit of humanity to figure out a way of storing that carbon safely. If not, if we have time, if we have fifty years, we may invent something we have not yet imagined.

That's not a sure thing. But if we can get down to 6 billion tons a year, we have time.

PART FIVE

**CONFUSION
AND
COVID**

PHOQUE LE SYSTÈME

*French, untranslatable
Climate striker, Montpellier*

THE POLITICS OF CONFUSION

As you read through this book, you will notice many areas where I am trying my best to clear up confusions. It is surprising how much confusion there is in the public understanding of the science of climate change, but there is even more in understanding the solutions.

Part of the reason is that climate change is something new. Everyone is feeling their way towards new understandings. Another part is that we are dealing with a very wide range of matters, each of which is complex.

But something else is happening as well. There are complex political reasons for the confusions. In this chapter I will try to unpick these controversies so that we can develop a clear understanding of what is happening, and how we can change that.

Some of the reasons for the confusion are widely understood. There is a global coalition of oil and gas, coal, aviation and similar corporations. This is sometimes called "Big Carbon" and sometimes "carbon capitalism". These corporations are an enormously powerful force. They have been behind the endless climate denialism that was taken seriously by most of the media until yesterday. The Koch brothers, two American oil billionaires, have been central to the infrastructure of denialism, and they have been funding the American right for a generation. For them, these are just two different sides of the same project. And when you watched a meeting between Putin and Trump, you were also seeing a meeting of the political front men of Big Carbon.

The point of all this activity is not to convince people that climate change is actually a hoax. It's to simply instill doubt, to make people unsure and so less likely to act. It's also to get private control of government policy, and to block policy behind closed doors.¹⁵⁵

The reasons Big Carbon acts this way are not hard to fathom. It is clear to anyone who thinks about the matter at all that addressing climate change would mean stopping burning fossil fuels. That's obvious, and it has long been obvious to oil company executives. They would not die, but it would mean the end of their personal careers, and the death of their corporations.

Sometimes people suggest that Big Oil could change and become Big Wind. Indeed, oil company commercials often suggest that. The problem, though, is that this is not how technical change happens. When the motor car replaced railroads, Ford and Fiat grew and the railway companies shrank and went broke. Personal computers and software bypassed IBM and made Microsoft rich. Big Tobacco did not become Big Fruit.

So it is not hard to understand the politics of Big Carbon. But there is another process that is even more important, and it is hard to understand. To get a handle of that, let me tell you a story about Barack Obama, the former US president, in Copenhagen.

Obama in Copenhagen

In January, 2009, Obama began his first term as president of the United States. I cried watching his speech at the inauguration, as I had cried at his speech the night he was elected. I am white, American, spent much of my childhood in Texas, and came of age in the time of civil rights. When Obama was elected, I was not naïve about what his presidency would be like. Or so I thought. But his election represented a triumph for the movement that was closest to my heart in all my life.

Climate activists all over the world were also excited by his victory. Obama, a Democrat, was widely regarded as a welcome change from George W. Bush, a Republican. Finally, we had an American president who wanted to do something about climate change.

That spring, some of the president's staff called the leaders of environmental organisations from all over the United States to an off-the-record meeting in the White House. Obama did not attend. But at that meeting, his key environmental advisers told the assembled leaders and executives that they should make a shift in language.

They should stop talking about climate change, and use the word “energy” instead. The environmental leaders understood that Obama wanted them to downplay climate.

They admired and supported the president, and wanted to help. He was smart. He was one of them. He knew what he was doing. They complied, and suddenly we were hearing, “energy, energy, energy”. The only leader at the meeting who refused to comply was Bill McKibben of 350.org, a pillar of integrity. McKibben and 350 continued talking about climate change. But McKibben said nothing in public about what had happened, probably a sign of the pressure he was under and how lonely he felt. There the matter rested until Suzanne Goldenberg published an account of the meeting in *The Guardian* in 2012.¹⁵⁶

Had we known about that meeting in 2009, we might have been given an early warning of what was coming next. Every year, except 2020, the governments of the world meet somewhere in the world for two weeks at the UN sponsored Convention of the Parties (COP) to decide global policy on climate change. Politicians, civil servants, scientists, environmentalists, business people and campaigners come too. The first year of Obama’s presidency, 2009, the meetings were in Copenhagen. Some 30,000 scientists, experts, civil servants, campaigners, students and activists attended. I had spent much of the year organizing global protests over climate, and the march at the COP in Copenhagen was 130,000 strong, the largest climate demonstration in the world up until that time.¹⁵⁷

The COP was special that year because the Kyoto Treaty was expiring. The Kyoto agreement was the international treaty the UN had brokered in 1999. There were many flaws in it, but Kyoto had committed all the rich countries in the world to fixed reductions in their emissions. This was the treaty that George W. Bush, alone among world leaders, had famously refused to sign. The climate world waited to see what would replace Kyoto. The question was how much deeper would the mandatory reductions in emissions become. There were many loopholes in the Kyoto agreement. But everyone understood that it was a step to binding all the main emitting countries to mandatory reductions.

Many climate campaigners thought the big conflict at the talks would be between the rich countries of the North and the poorer countries of the South. The flash point would be how much aid the Northern countries, like the US, were prepared to give the Southern countries so they too could begin to decarbonize.

We got that wrong.

For the first week there was deadlock at the talks. There is always deadlock at those talks, and then it is miraculously resolved late at night on the last day, or sometimes in the early hours of the next morning. Obama was supposed to arrive, on cue, on the last day, Friday.

Wednesday night I went to a reception for Nancy Pelosi, the Democratic Party speaker of the House of Representatives, organised by the US AFL-CIO union confederation. I was a union climate jobs activist, I got invited to those sorts of dos. Two things struck me about the event. The first was how many of the AFL and Democratic party people were fit young men and women, who had dressed up for the reception in very expensive suits and dresses. I could see the Ivy League dripping off them.

Pelosi addressed us all informally. One of the things she said was that we might not like what President Obama would do when he got here on Friday. But if we did get upset, we should remember that without him, none of us would be here. Pelosi was obviously preparing her people.

Uh-oh, I thought, but I still did not understand.

Friday morning Obama flew in. He had a 45-minute meeting with President Xi of China. They drew up a short agreement, which they must have prepared ahead of time. Then Obama and Xi had a two hour meeting with President Lula of Brazil, President Zuma of South Africa and Prime Minister Manmohan Singh of India. Lula had been the leader of the metal workers strikes that effectively ended the military dictatorship in Brazil in the 1980s. Zuma had been the leader of the military wing of the ANC, the organization that brought an end to apartheid. Singh was a more moderate man in his youth, but he was heir to the mantle of the Indian National Congress that had won independence from Britain.

Of these five men, four were from the South, and the fifth – Obama – had a father from Kenya. They all agreed to the “Copenhagen Accord” that Obama and Xi had drawn up. At lunch that accord was conveyed to the delegates from all the other countries in the world, not for discussion but for approval. They approved.

That agreement was two and a half pages long. It said, simply and clearly, that there would be no mandatory cuts in emissions for any country in the world. In future every government could choose whatever increase or decrease in emissions they felt like.

Obama had not saved us. Nor had the global South. Leaving Copenhagen early that evening, I was in the airport ticket line behind a former director of one of the largest environmental organizations in Britain. He did not recognize me, but I recognized him. He was crying. He flourished three pages of paper, and said he had managed to get a copy of the accord. "It's shit," he said, shaking the paper and crying again. "It's shit."

He was a middle aged man who had spent all his life trying to save the planet.

I read the three pages of paper quickly, sick at heart. It was so simple, so clear, so blatant, no attempt at hiding what they were doing.

I passed the pages back to him. "It's shit," I said.

"It's shit," he said again, shaking with rage. Then he turned away. Maybe he didn't want to share his feelings with a stranger any longer, or maybe he did not know what to do with his anger and despair. I did not intrude any further.

The environmentalist in the line never said it was shit in public. Some environmental organizations hailed the result of Copenhagen. More organizations said they were disappointed in the accord, but at least there had been international agreement and we had all moved a step forward.

Almost none of us believed that. Two pieces of evidence made that clear. One was that the big environmental organizations moved on from climate campaigns to doing something else. The other was that the marches we organized grew tiny. Everyone, the leaders and the rank and file, knew that hope had suffered a historic defeat. It would be four more years before anti-pipeline protests by indigenous First Nations communities in Canada showed us a way for grassroots revolt, and the movement again began to grow.

The Moral of this Story

I have told you this story for a reason. It's probably not the story you will have heard, and I'm still angry more than ten years later. But that's not why I told it. Instead, I wanted to draw your attention to two things. First, it's a surprising story, and it's a good way to get you to think about why Obama did that. The second thing is this: I want to draw your attention to the silence – how almost no one said anything clear about what Obama had done.

It's not just Obama, of course. In September of 2019 I was in a crowd listening to Greta Thunberg speak at a climate strike in

New York City. Greta had already changed the whole conversation about climate by pointing out, relentlessly, that the leaders of the world had done nothing about climate change. All of them. Nothing.

Now she spoke with fury about all the world leaders who wanted to meet her. She said as far as she could see, it was just because they wanted a selfie with her. I listened, and I kept thinking about the photo of her shaking hands with Barack Obama three days before.

Something bizarre is going on here. To understand it, we have to see that on this issue there are two wings among the rich and powerful in the world. One wing is those who own and manage Big Carbon, or represent it, like George W. Bush and Donald Trump. But those people are a minority among the rich and powerful. The majority represent corporations which are not deeply invested in the carbon economy. They understand the threat of climate change, because they read the same scientists the rest of us do. They usually have children or grandchildren whose futures they want to protect. And they own and run the world. Why should they want to destroy it?

They don't want to. When they say they want to do something about climate change, they are telling the truth. Their difficulty, though, is that they can't do the things which need doing. Anyone who thinks about climate solutions for any length of time realizes it will take massive government action; it will have to move far beyond the rules of the market; and it will change everything.

The people who now run and own the world have spent their adult lives convincing the rest of us of three things. First, we have to obey the rules of the market. Second, there is no alternative to the market. Third, if we disobey, we will be crushed. The most powerful weapon the rich and powerful have is that we believe them. Until very recently, even the most radical among us believed those things in a part of our heads.

So the majority of the rich and powerful do in fact want to do what needs to be done, but they cannot. It's a genuine conflict. They really do want to act. And they really cannot do what needs to be done. Part of this is because they believe their own propaganda, and cannot imagine an alternative to the market. But most of them, in another part of their heads, are old enough to remember a world before neoliberalism. They are conscious of just how much they have to lose if the rest of us stop believing in the omnipotent power of the market.

After all, if we stop bowing the knee to neoliberalism, we can fight for free health care, free education, decent pensions, guaranteed

housing and all the rest. That was a terrifying prospect for the people who managed the world in 2009. It still is.

We also have to take account of one more pressure upon world leaders and the corporate rich – global competition. Again, everyone who has thought about solutions to climate change knows it will cost an enormous sum of money. That money has to be spent by governments, and at least partly funded by the rich and the corporations. But we live inside a competitive global economy.

The great corporations are competing with each other. The corporations who make the most profits can invest the most money. The corporations who invest the most money have the most cutting-edge machines, plants, workers and intellectual property. So those corporations make the most profits. And the cycle spirals upward.

The spiral works downward as well. The corporations which make low profits can invest less money. So their profits decrease further, and they invest less, until they face a takeover or bankruptcy.

The same spirals work for small businesses too. And they work for countries as well. National governments are, among other things, a place that different corporations come together to try to defend themselves in the global economy.

In normal times established corporations and national economies can mostly live with the spiral of competition. Honda and Nissan do better than Ford and General Motors, but GM bumps along the bottom.

Then came the financial crisis and economic crash of 2008. General Motors, for fifty years the largest manufacturing company in the world, went bankrupt. The company was rescued, at the price of the workers' wages and pensions. But the warning was there. This was suddenly a situation in which any corporation could go to the wall.

It was also a situation in which massive government spending was suddenly a burden and a problem in global competition. It was not that governments were averse to spending money. Obama's government, and every major power, were spending enormous amounts to rescue the banks, the financial sector and sometimes major corporations. The country that spent an enormous amount on climate action, on top of the economic spending of 2008, would be the country that lost out in international competition.

I think that's why Obama did what he did. Until 2008 candidate Obama was in favour of doing something about climate change, just not enough. That was the same position as other mainstream politicians like Al Gore and Arnold Schwarzenegger in the US, Gordon Brown in

the UK and Angela Merkl in Germany. By 2009 President Obama felt he had no alternative but to make it much harder to solve the climate problem, if he was going to lead the financial recovery after 2008.

Of course, I may be wrong about the reasons why Obama did what he did. I may also be wrong about why all the other established leaders have done so little over the last two decades. You do not have to accept my economic analysis. But it is the case that Obama and the other world leaders did do what they did. And I am right about what we have to do to save ourselves and the planet.

If the economic analysis feels wrong, please still hang on the kernel of what I am saying here. The powers of the world are stalling on action. The result of that stalling is one of the ways that climate politics is different from other politics.

I have been active in union politics much of my life. There are always disagreements in unions, and we have debates. You more or less know who is on which side. When people disagree with you in public, you usually know beforehand, because they tell you. When you win or lose the decision, you know that too. I don't mean to make union activists look like saints, but basically you know what's going on. This is true of decision making in many other walks of life as well.

But with climate politics, decent people are constantly telling you one thing and then doing another. This is usually because they want to do the right thing, but then the people above them lean on them. They are ashamed to admit that, and the people at the top are ashamed to admit it too.

Let's take the example of a group of students going to the college finance officer and asking him to disinvest from fossil fuels. Or a group of union members going to their full time official to ask her to support climate jobs. Or a group of scientists engaged in negotiation with government officials on forest policy at the COP, or a group of grassroots activists meeting with the director of their environmental organization.

In each of these cases everyone in the room knows that something radical has to be done about climate change, and it has to be done now. If you are one of those students, union members, scientists or environmentalists, you can see that the officials probably want to do something themselves. But they have people above them, somewhere else, who they have to answer to. Sometimes the people above them are their bosses, and sometimes their funders. In unions, the official often has to report to a higher official, who then consults with the union officials representing the

oil workers. That official believes the oil workers have a vested interest in the status quo.

So the official you are talking to often says they will do something and get back to you. And then they don't get back to you. Or they get back to you with a plan that sounds good but really means doing nothing.

The result is confusion. That night in Copenhagen, Nancy Pelosi was transmitting that pressure from above her, telling us if we did not like what happened, remember that none of us would be here without him. And she was readying us to pass on that pressure to the people below us.

An enormous part of this pressure is money. Or as they say in the NGO world, the "funders". This is another area of massive confusion.

Scientific Confusions

Similar processes operate to make even the science confusing. And as we have learned from Covid 19, the arguments among the scientists are also partly arguments about politics.

In Chapter Two on *Science* I talked about Professor Myles Allen and striking school students. As I said there, the students had reasons to be suspicious. The IPCC scientific reports have been consistent in under-estimating the dangers. And under-estimating them by a lot.

There are reasons for this. One is that a dire prediction that does not come true can make a scientist look foolish to other scientists. Such predictions can mark them out as radical and hurt their careers.

Moreover, all the big UN reports are written by scientists, but they are edited by scientists and politicians. Actually, it's worse than that. They are edited by scientists and politicians and representatives of the coal, oil and gas industries. Line by line, the scientists fight for what they think is the truth. The politicians and the carbon capitalists fight for words that will not sound so bad. Words that will reduce the pressure on them to act. And the report that comes out is a compromise.

Then there is the money. Funding for climate research usually comes from national research boards. Scientists influence the decisions of those boards. But so do politicians.

Scientists worry, too, that they might go too far. If they sound too terrifying, people will not believe them. And they want people to believe them. For many years, most scientists believed the leaders of the world could be convinced of the scale of the problem. Then, they thought, the leaders would take the necessary action. So best not to say things the leaders could not hear.

Now more and more scientists are beginning to believe the leaders will not act.

Climate scientists face two ways. On the one hand there is all the pressure on them to put the science in a moderate way. This pressure does not simply influence what they write. It influences what they think. They are human. Humans find it difficult to think one thing and say another. So they adjust their thoughts.

On the other hand, they are scientists. They spend their working lives looking at measurements, and making sense of measurements. Those measurements are dire. And their respect for the work pushes them to respect that news.

There is another pressure on scientists, too. Climate scientists created the IPCC in 1990 because they saw what was coming. They wanted to tell governments, and the people of the world, what was coming. This was united political action of a kind scientists had never done before. They have been at it ever since. In that process, they give each other courage. Every time they hold a professional conference, every time they publish a paper, every time they fight line by line for the words in a report, they are giving each other courage.

We give them courage too. The bigger the climate movement, the more student strikers, the braver the scientists can be, the more clearly they can think. They do not feel they are simply holding the line against all the established powers and all the carbon industries in the world. Instead, they feel they have the majority of the world behind them.

This means that scientists are growing braver, more desperate and more reliable. The balance of all these pressures, though, means that scientists still tend to underestimate the danger.

Here's the problem though. Just because they often underestimate the danger does not mean they are wrong at any given moment. It means they are wrong about some things, but not other things. It also does not mean that the most extreme view on anything is necessarily the right view.

There is a thing that happens on social media all the time. People read an extremely frightening post on the internet. That article exaggerates a somewhat less frightening scientific paper. That less frightening paper is only one of many articles on the subject, and for sure there are other scientists who do not agree with it. But because it is frightening, and because everyone knows the UN and governments have been hiding the full extent of the climate threat – which they

have – the person reading the internet assumes the extreme post is the truth. And so they share it.

It's easy to do. I've done it myself. Then someone else comments that maybe the danger is not that great as that particular article suggests, and the sharer gets angry. They assume that the doubter is not angry enough, but probably a moderate – probably even denying the danger and stopping action.

It's an easy slide. But it involves a mistake about where radicalism lies. It's not radical to think the future will be much worse than scientists think it will be. What the scientists are now saying is as terrifying as we could possibly want. The person with the most radical predictions is not the most radical person. The most radical people are the people who are looking for ways to organize mass movements for rapid and radical action.

Degrees of Confusion

These are the reasons why confusion runs through so many controversies about climate change. But the extent of confusion is very different in different areas. The basic science of climate change is not much in doubt. The controversies over tipping points and time scales are somewhat more contentious.

However, where it starts to get really confusing is in the arguments around solutions. Here there is a stunning amount of valuable work done by engineers and architects. Their work is the bedrock of this book. But these professionals are also working in industries, or in university departments producing engineers and scientists for an industry. They constantly feel pressure, and they constantly push back. You need to read their work with an eye to both processes. Then you can see, for instance, why physicists always seem to have a soft spot for nuclear power, or why geologists are open to arguments for carbon capture and storage.

But also, as a rule of thumb, both the scientists and the engineers are more likely to insist on the truth in the face of power than the economists and the environmentalists who work for the NGOs. The economists are largely hemmed in by the delusions of their discipline, the social science most important to the people with money. The NGOs mostly see their job as lobbying power, so they have to watch what they say.

So as a general rule, the scientists are the most radical. The engineers are reasonably reliable. The social scientists and the political people are

most likely to be confused, and to confuse. Mainstream economists use models that do not correspond with reality.

This continuum is reflected in the reports of the Intergovernmental Panel on Climate Change, convened by the UN, which come out every seven years. Those reports are divided into three long volumes. Volume I, on the science, is written by the scientists. Volume I has flaws, but basically you can take it to the bank.

Volume II is on mitigation, which means how to reduce emissions. It's written by engineers. It's full of flaws, and you constantly have to watch out because the section on carbon capture is written by the people working on carbon capture, and the section on biofuels by people working on biofuels. But the good chapters are very good indeed.

Volume III is on "adaptation", which means how to cope with the effects of climate change, and how much everything is going to cost. One hidden assumption here is that we are going to have to get used to global warming and adapt. The other hidden assumption is that the key to decision making is how much things cost. That volume is controlled by economists. Far be it for me to stop you reading it, but hold it a distance and wear gloves.

One of the things I am trying to do in this book is give you a way through all these controversies. In most cases this is a way I have learned over the years from the work of radical specialists far more expert than me. I have also learned that one theme runs like a red thread through almost all these controversies. Again and again, the same two underlying questions are posed in different ways:

Do we really have to stop burning all fossil fuels? And, can we really do that?

**THE
EARTH
WANTS
YOU
TO GIVE
A SHIT**

*Climate striker
Oxford, UK*

THE LESSONS OF COVID

The Covid 19 pandemic has been a learning experience for billions of people. Many of the things we have learned can be, and should be, carried over to our thinking about climate change.

In one way this has been a practice run. I don't want to make light of the suffering that flows from Covid. But the suffering is still far less than will come from climate change. This is a foretaste, and a series of lessons.¹⁵⁸

One lesson is when the scientists warn us about doom, believe them. And also, don't wait to act until the worst has already happened. Start now. And, nature does not compromise.

Other lessons are not immediately obvious. One is that we have to do everything. The countries that have had very low death rates have been those which acted fast, locked down fast, isolated most people who might be affected, made sure everyone had food and an income, tested very large numbers, traced all their contacts, offered everyone care and treatment, gave essential workers proper protective gear, told the truth and explained everything clearly.

Do only three of those things and you have a massive epidemic. Climate change is the same. We have to reduce emissions from coal, oil, gas, electricity, housing, transport, aviation, industry, waste, air conditioners, deforestation, soils, fertilizers and meat and dairy animals. We have to cover the world with solar power, wind power, wave power, tidal power, buses, trains, high speed rail, electric vehicles, new strains of rice, conservation agriculture and much more.

Anyone who tells you that their favourite solution is the only one that matters is missing the point.

We have also seen that in the pandemic the inequalities in the world stand out like bursts of light against the night. We have seen many things that we already knew. People in the poor countries suffer far more, and in very different ways, from people in richer countries. Within any country, the vulnerable die far more. Those vulnerabilities arise because people have less money, worse food, more crowded housing, dirty water and lungs wrecked by work. The pressures of class and racism become the statistics of death and the experience of grief. Climate change will be the same

Another thing we have learned is that governments can make enormous changes, very quickly. Activists can demand the impossible, and sometimes it happens next week. When the people who run the world decide they need the money, the money is there.

We have learned, too, that serious environmental disasters become economic disasters. Heretofore, most discussion of the economic effects of climate change has concentrated on demonstrating the costs and lost growth of delaying action. What they have said less about is that droughts lead to famine. Or that the floods and storms that make Miami, New York, Houston, Durban, Maputo, Lagos, Mumbai, Dacca, Karachi, Shanghai, Tahiti and Ho Chi Minh city unlivable will also destroy jobs, homes, companies and wealth.

We also learned that the struggle for economic equality and the struggle for environmental survival are fused. Johnson in the UK, Bolsonaro in Brazil, Trump in the US and Putin in Russia all tried to let the virus rip through the population in order to save the economy. The result was that they both increased the death rate and wounded the economy.

In South Africa and India the governments tried to enforce a lockdown without spending the necessary money. These countries were full of poor people already. They did not have money, they did not have rent, and they could not feed themselves and their families. The poor lived crammed, cheek by jowl, often without sanitation and without running water in their houses – easy meat for the virus. And hunger destroyed the possibility of a lockdown working.

The hunger did not happen just because these were poor societies. The income per person in South Africa is on a par with the income per person in China. It is higher than the income per person in Vietnam, which contained the coronavirus. The difference

in South Africa was that they locked down to save the lives of two overlapping groups – the white and the wealthy – and they showed utter callousness to the black and the poor.

It is entirely true that India is poorer than any of those countries. But the government of India has not allowed a famine since the British left in 1948. Always, they have distributed the grain where it was needed. They too could have fed the hungry.

There is also the countervailing example of the United States, one of the richest countries on earth. In both the US and Britain, it remains difficult for most citizens to come to terms with what their leaders did. Those who dislike Trump and Johnson tend to see them as incompetent, stupid, bumbling, ignorant and foolish. It is hard, in those countries, to accept that your rulers are intelligent men who tried to kill hundreds of thousands – or millions in Trump's case, for what they regarded as good economic reasons. It may be possible to accept that your country would do that in war abroad. It is harder to accept they would do it at home – in part because it is terrifying to know our lives are in their hands.

There is also an important lesson in which countries controlled the virus, and which did not. South Korea, Taiwan, Singapore, China, Vietnam and New Zealand did exemplary jobs. They have varied political systems. Singapore is right wing, China and Vietnam are dictatorships, and South Korea, Taiwan and New Zealand have mildly left wing governments. What they had in common was that the governments knew they had to act, and when they acted, they were competent.

It is striking that many of the governments that failed most grievously were led by men of the new populist and racist far-right. Trump, Bolsonaro, Johnson and Putin did a disastrous job.

The UK and the US are the two countries where neoliberalism and privatization have gone furthest. These were also the two countries unable to contain the virus because they outsourced the contracts for testing and tracing to private companies. Those companies were incompetent, because incompetence was cheaper.

The lesson for climate change here is, do not let out the contracts for climate jobs. Instead we need public works by public sector bodies. There may have been a time when private companies did good work for the public sector. But the web of corruption, cronyism and incompetence is too far gone now.

Perhaps the most important lesson is that the coronavirus is global. It crosses borders. If you follow the spread, Milan and Madrid are closer to

London and New York than London is to Wales or New York to Virginia. Until everyone can have a free and effective vaccine, the persistence of the virus anywhere will be the persistence of the virus everywhere.

The solutions to the epidemic are global too. This is evident as scientists in many countries rush to find medications, a vaccine, perhaps a cure. It is evident as governments and public health experts look all over the world to see what works, and what does not. We are reacting within our national borders, but we are reacting as a species.

Climate change is the same. CO₂ and the other greenhouse gases that humans pump into the air mix thoroughly with the atmosphere all over the world within two years. This is a problem which cannot be solved anywhere without solving it everywhere.

However, the scale of climate change is far bigger than the pandemic. Energy use runs through every part of the world economy, and every aspect of our lives. The changes we have to make will fundamentally transform our economic and social systems. Organisations, political parties, corporations and banks with enormous power stand to lose everything in the process of saving the planet. Eight billion people will enter a world of pain if we do not save the planet. This means the struggle over solutions will be extremely hard. And unlike Covid 19, children will die in the disasters to come, and babies will go into the fire.

One final point. In the battles in different countries about what to do about Covid 19, we have learned that the science and the details matter. People have had to learn to understand the details of masks, testing, tracing, R-rates, economic support, how the virus affects children, transmission indoors as opposed to outside, and far more. The political fights have been about these details. To be politically effective, to deal with misinformation, and to campaign for complex solutions that will work, we have to understand the details.

This too is true of climate change. That's why this book is full of detail, of the nuts and bolts. Campaigners, activists and citizens have to be on top of this stuff now.

PART SIX

**SOLIDARITY
SOUTH
AND NORTH**

**FOR THE
CHILDREN**

**GRANDPARENTS
CLIMATE
ACTION**

London, 2015

THE CENTRALITY OF THE GLOBAL SOUTH

The next five chapters make an argument about climate change and the global South, the poorer countries of the world. The global South will be central to climate change in several ways. Five human beings out of every six live in the South. The suffering wrought by climate change will be greatest in those countries, and worst for the poorer people in those countries.

There was a time when the majority of greenhouse gas emissions came from the rich North. That time is past. Now the majority of emissions come from the South. That means we will need cuts in emissions both South and North.

Both liberal and radical activists have long been working with a model of the transition to a low carbon world where the industrialized nations lead the way, and their little brothers in the South tag along. To stop climate breakdown, we have to flip that script.

I will argue that there is only one way we are going to be able to get emissions down far enough, and keep them there. That is if there is general agreement that every country is trying to get down to the same level. That would be about 1 ton per person.

That is also the only kind of agreement that will be politically possible. We can, possibly, get farmers in India, textile workers in China, bus drivers in Germany and retired people in Canada to agree to that goal. There is no other goal we could get those people to agree on.

But that goal will only work on one condition. We have to decouple growth, industry and emissions. To do that, we have to agree that

every country will get as close as humanly possible to 100% renewable energy. That will mean that every country will be able to have as much industry as they want with almost no carbon dioxide emissions.

This won't be perfect, and it won't work if we keep using cement. But it is possible. One of my key purposes in this book is to show you that Kenya and Niger and Afghanistan can still have industry, transportation, decent warm housing, schools, hospitals and universities, with tiny greenhouse gas emissions.

The reason it is important to show that is that otherwise we cannot build the global movement we need. Because of where emissions come from now, we have to build mass movements for green new deals and climate jobs in Europe and China, India and North America, Latin America and Africa. And we have to persuade the majority of people in all those places. The only way I can imagine doing that is if we say to the poor of the world that it is possible to both stop climate change and make poverty history.

Solidarity

Throughout this book I keep returning to two linked issues. The first is the importance of solidarity between the climate movements in the poorer countries and the movements in the rich countries. We cannot stop climate breakdown without that solidarity.

The second is the importance of linking climate movements with other struggles. So I have written about the solidarity we need between climate jobs campaigns, people who stand to lose their jobs, and the unions who support them. I have also written about solidarity with the campaigns of farmers faced with losing their livelihoods, about herders and forest people. The idea of Green New Deal is to link the struggle to stop climate breakdown with the people who need jobs in an economic crisis and with the people who need health, care and housing services.

The argument for these alliances is not that the climate movement should be politically correct. I am not compiling a checklist of good causes. Rather, I think that we will have to form these alliances to stop climate breakdown. We need all the help we can get.

Moreover, building these alliances could go a long way towards solving the problem of timing. Most political and economic conflicts are about now. Climate politics is in large part about the future, however near that may seem. But being in the future makes it possible for many people to put off action until it is too late. The beauty of climate jobs

and the other alliances, is that they help us to build a movement now that is also a movement to change the future.

The next five chapters are about global solidarity. This chapter is about the numbers – where the emissions are coming from, and how deeply we have to cut them.

The next chapter is about solidarity with the people, often in poor and out of the way places, whose lives will be devastated by the extractive industries that seem likely to be part of the energy transition.

Then there's a chapter about economics and how to pay for the Green New Deal. It's also about the solidarity that poorer countries will need in order to withstand the might of the global financial system. The fourth chapter tells the story of the campaign win free retroviral medicines for everyone with AIDS in South Africa, and draws some of the lessons for solidarity in the face of climate change. The last chapter in Part Six is about the region in the global South that will probably be hit hardest of all by climate change, the Middle East and North Africa.

There will be no easy answers in these chapters. But there will be answers.

Growth and Degrowth

I am only too aware that talking about growth will not be comfortable for many environmentalists. But there is a deep dilemma here, and we have to grasp both horns if we are to leap the bull.

Many environmentalists have been drawn to the idea of degrowth. This is particularly true in the richer countries. Degrowth argues that consumerism, and the endless drive of capitalism for accumulation, is devouring the world. The richer countries already have more than enough stuff. But that stuff – and all the income and the life chances and even life expectancy itself – are very unevenly shared.

The degrowth argument says that pervasive inequality makes people deeply unhappy. The sociologists Richard Wilkinson and Kate Pickett, in their book *The Spirit Level*, have shown that the more unequal the society, the more unhappy are the people on every measure of well being. And that inequality leads people to measure themselves against others in things. Those in the middle, and in the bottom half of the pile, can dream and strive for more things to lift them out of humiliation. Those at the top indulge in obscene displays of conspicuous consumption, because they can, and because they are competing with each other.¹⁵⁹

The solution here is to share out the stuff, the money, the life expectancy and the dignity far more equally. Then there will be less pressure for growth, and we can take the pressure off the Earth.

This is an appealing analysis, particularly to people trapped in the rat race in the richer countries. There is also a great deal of evidence for it. There is the enormous waste of food, and of plastics, in the rich countries. There are the endless new versions of computers, televisions, phones and electronics that are built to break down, and cannot be repaired. So you have to buy a new one. There is the obscene carbon spewing waste of SUVs. And there is fast fashion, with the average American buying more than 70 items of clothing each year, and discarding them swiftly.¹⁶⁰

All this is true, and a waste of human work and nature's resources. From that obvious truth, it is only a step to the argument that the people in the South must not follow the example of the richer North. Moreover, it is said, climate change means that they cannot and must not, or we are all lost.

At that point the degrowth argument runs up against an even more passionate argument, which springs from greater suffering. People in the South, and particularly the poor and working majority in those countries, want what people in the rich countries have. They cannot be recruited to stop climate breakdown by a movement that tells them they must remain at the bottom of the hierarchy of the world. Still less will this work if someone with an Apple Mac lectures people who are ashamed of their clothes and worried about their sick children.

This does not mean the argument about degrowth is stupid or misplaced. But we have to stop climate breakdown now. And we cannot do that without working for an end to poverty. Once poverty is history, then people in the South will be able to choose. They will be open to the same arguments that inspire many environmentalists in the North now.

A Rock and a Hard Place

For three decades now, the United Nations climate negotiations have been built around the widely accepted principle of "common and differentiated responsibilities." This phrase means that countries will cut their emissions to different extents, with regard to differences in wealth and historic emissions. In those terms, the cuts must be fair.

Everyone has always taken that to mean that cuts in the North will be deep, but not in the South. There was a time when that looked

possible, but here is the problem we have to wrestle with now. We need reductions in emissions of at least 80% overall, and of 90% in CO2. Now just under 40% of emissions come from the North (Europe, including Russia, US, Canada, Japan, Korea, Australia) and just over 60% from the South. Let's imagine that the global North cut all of their emissions. Then we get the following table.

Possible shares in cutting emissions

Total Emissions	100%
Rich North emissions	40%
Cut all of them	-40
Global South emissions	60
Cut two-thirds of them	-40
Remaining Emissions	100% – 80% = 20%

There is no way to get those 80% cuts other than cutting emissions in the global South by two-thirds. You can't cut the North more than 100%.

There is another complication which is new. Emissions per person in China are now almost four times those in India, and even more compared to Pakistan, Bangladesh and many African countries. If China does not cut emissions deeply, people in India will want to let their emissions grow to parity. That would raise global emissions more.

There is a rock and a hard place here. The rock is that deep cuts in emissions in the global South are unfair in terms of historic emissions. They are very unfair in terms of wealth and poverty. They are obscenely unfair in terms of historic and continuing plunder and exploitation.

The hard place is that without deep global cuts in emissions in the South, Africa will burn and flood, the Asian monsoon will fail, and we will have famine, flight, war, racism, and hundreds of millions dead around the world, and the South and the poor will be hit hardest.

The Changing Balance of North and South

For a very long time, economists and social scientists have divided the world into the rich, industrialised countries and the rest. The industrialised continents and countries were Europe, the US, Canada, Japan and Australia. The rest were the countries of Asia (minus Japan), Africa and Latin America. They were also sometimes called the

“developed” countries and the “developing” countries, or the “West” and the “Third World.” Not by accident, the rich countries were mainly white, and mainly former colonial powers. The developing countries were mostly non-white. Many were former colonies. Some, like China, had never been colonies. Others, like the countries of Latin America, had become independent more than a century ago. But China and Latin America had still been dominated by the empires of Europe, North America or Japan. That colonialism, and that domination, is why the “developing” countries were poor, and less industrialised.

More recently, the labels have changed. The developed countries are now called the global North, and the developing countries are the global South. South Korea, Taiwan, Hong Kong and Singapore have grown richer and been reclassified as part of the “North”. But the categories and the economics are basically the same.

It was once assumed that the countries of the North were industrial, and the South was agricultural. Forty years ago, that was broadly true. And only 25 years ago, the great majority of CO₂ emissions still came from the global North. All that has changed.

Now only 38% of total CO₂ emissions come from the rich countries. 62% come from the countries of the “South”, like China, India, Africa and Latin America. Many of the developing countries, like China, India, Brazil, Mexico and South Africa, now have thriving industries and rising CO₂ emissions.

The proportion of emissions coming from the poorer countries of the South is constantly increasing also. In the not too distant future two-thirds of emissions will come from the “South”. This means that humanity cannot stop climate breakdown unless we reduce the emissions in both the North and the South.

Two centuries ago there was not much difference between the standard of living of people in Europe and people in the rest of the world. Then came capitalism, industry, colonialism and imperialism. An enormous gap opened up between Europe and its white colonies on the one side, and the rest of the world on the other. Now the colonized and dominated countries are clawing their way back towards equality. China is leading the way, showing that it is possible. But others are following.

There is a contradiction here. The growth and industrialization of China, India, Latin America and much of the rest of the world is a great good. Ordinary people are healthier, they live longer and in greater comfort. But this also carries with it the possibility of great evil, because that growth makes it much harder to stop climate breakdown. And that

breakdown will impoverish people across China, India and much of the world. This chapter explores that contradiction.

A Great Good

Let me get personal for a moment, to explain why I believe so strongly the industrial growth of the Global South has been a great good. It comes down to death.

I was born in 1948, and spent my childhood in three countries – the United States, India and Britain. But my politics, and my whole moral universe, were formed by the poverty I saw in India sixty years ago. I have been a revolutionary all my adult life, but I remain indifferent to any revolution that does not eradicate poverty in India.

I went back to India again when I was 50. I got off the plane and it felt and smelled like home. But soon the change jumped out. The desperately poor, the poorest quarter of the population, were still desperate. But the people in the middle, the average workers and peasants with a bit of land, were better off than they had been. I could see it in their bodies, their faces, their clothes, their bicycles and scooters and homes. It was still a brutal place, as was the US, and like the US, India was even more unequal than when I was a child. But that progress in the middle was real.

When I was twelve, I asked my father if he had ever been to China. We were taking a walk in Shimla, in the foothills of the Indian Himalaya.

Terry, my father, said he was in Shanghai in 1945, when he was in the US Navy, just after the fall of Japan. He was the junior officer trying to control the gangplank onto the ship. He said it was terrible, so much suffering, so many hungry people, having to keep them off the gangway.

I asked if it was worse than India.

He said it was like Calcutta (Kolkata), but cold.

Calcutta in 1960 was a byword for poverty and suffering, and people sleeping and dying on the streets. Shanghai was like that, but cold. I never forgot, because my dad didn't want to say more.

Shanghai is one of the great cities of the industrial world now. People there now are as rich as they were in Britain in 1951, the year I first came to London as a three-year old.

I don't mean to say that the world has become equal. In terms of what money can buy in each country, the average income per person in Germany is three times the average in China and nine times the average in India. But the industrialization and growth that has happened has made a difference. ¹⁶¹

The year I was born, India won independence from Britain, and life expectancy was 36 years. Now people can expect to die, on average, at the age of 69. Life expectancy has almost doubled in a single lifetime.¹⁶²

In 1950, five years after my father was in Shanghai, life expectancy was 44 years. In 2019 it was 77. That is an extra 33 years.

For comparison, life expectancy in the United States in 1950 was 69, 25 years more than in China. Today life expectancy in the US is 79, only two years more than in China.

The figures for infant mortality have improved even more strikingly. In 1950, 181 out of every 1,000 children born in India were dead within the year. Almost one in five died. Now it's 32 out of every 1,000. That means 97% of children survive their first year. In China in 1950 there were 129 dead babies out of every 1,000 born. Now there are 10. Only 1% die.

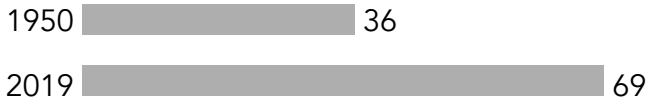
Here are those figures in a bar chart. But remember that these are not just statistics. Billions of parents and children have been spared great grief.

Life expectancy, in years

China



India



Children dead by the age of one, per 1,000 live births

China



India



There is still a long, long way to go before China, or India, or the US are equal societies. But ordinary people in China do not want to go back, even to how it was 20 years ago. Ordinary people in India want

what people like them have in China. And yet both countries will have to cut their greenhouse gas emissions.

For that, the climate movement needs ordinary people in India and China not just getting on board, but driving the bus. This is for reasons of human decency and equality. But it's also because without them the rest of humanity cannot bring emissions down enough. And that means our shared vision of a changed world has to fit what ordinary people want in both the South and the North.

Industry

The big change is that many poor countries have industrialised. The change over the last thirty years has been enormous. The global South, the poorer countries, the developing countries, have 84% of the world's industrial workers. They also have 84% of the world's population. Five out of six industrial workers in the world now live in the poorer countries.

Industrial workers in millions of people

Rich countries	76 million	16%
The rest	376 million	84% ¹⁶³

Let's break this down a bit. Here's a table of the number of the countries with the largest number of industrial workers. (I have included the European Union of 27 countries as one bloc.)

Industrial workers by country

TOTAL	452 million workers	
China	161 million	36%
India	56 million	12%
European Union	33 million	7%
USA	17 million	4%
Indonesia	16 million	4%
Japan	11 million	2%
Brazil	10 million	2%
Pakistan	10 million	2%
Russia	10 million	2% ¹⁶⁴

Several things stand out in this table. Over a third of the industrial

workers in the world now live in China. Just three countries – China, India and Pakistan – are now home to half the industrial workers in the world. China has four times the population of the United States, but nine times the number of industrial workers. And the US and Indonesia have almost exactly the same number of industrial workers.

When people talk about climate change and industry, they are talking about what should happen to those 452 million people and the children, women and men who depend on them.

So half the industrial workers in the world are in China, India and Pakistan. The majority of greenhouse gas emissions come from poorer countries like that. But the workers in the US, Germany and France are far richer.

If you divide total national income by the number of people, then the average income in the US, France, Germany and the UK is three times as much as the average in China, and eight times as much as the average in India.

This is a key contradiction we have to face: *Most industrial workers are in the South, but ordinary people in the North have much higher incomes.*

This leads us to a second contradiction. It has to do with greenhouse gas emissions from the rich and the poor countries. The relative shares of these countries have changed radically in the last 20 years, and much thinking about them is radically out of date. Here are the figures for global CO2 emissions in 2016:

Share of global CO2 in 2016

The rich North	38% of emissions	16% of population
The South	62% of emissions	84% of population ¹⁶⁵

In terms of population, the rich countries produce much more than their fair share of emissions. But the poorer countries of the South produce the majority of emissions.

The rich countries do not have higher emissions because they have more industry. In fact, emissions per industrial worker are a bit higher in the newly industrialised countries than in the rich countries.

The reason emissions are proportionately so much higher in the North is that people there have more money. They take more planes, they eat more meat, and they have more cars and bigger cars. They have bigger schools and universities, bigger hospitals, bigger offices and bigger homes to build and light and heat and air-condition.

Twenty years ago the majority of CO₂ and other greenhouse gas emissions came from the Rich North. Now the South has as much industry as the North, and the majority of emissions come from the South.

Industry in China

Many climate campaigners have worked for a long time with the understanding that the rich countries of the North are industrial, the South is agricultural, and most of the emissions come from the North. Now that has changed. But many of them now argue that the industrial jobs have only been offshored. The workers in the poorer countries are still producing mainly for export to the rich countries. And they argue that the rising emissions of China and other countries only benefit the North. The people in the South are not part of the problem.

This view grew out of a passion for equality, but it is no longer accurate. Let's look at the figures for China.

China is by far the most important emitter of greenhouse gases, responsible for 29% of the global total. It is also the world's largest industrial power. As we have seen, those 161 million industrial workers are more than a third of the global total of industrial workers.

Chinese industry has grown massively in the last 25 years. The Chinese strategy 30 years ago was to build industry by producing for a foreign export market. But for twenty years now the government has also been encouraging industry to manufacture more and more for the Chinese market. This encouragement has worked. Most industrial production in China today is for the domestic market.

The OECD has produced very helpful tables of value added and the flow of industrial goods internationally. What their tables show is that in 2015, 70% of industrial production in China was for the domestic market. Another 9% was for export to other middle and low-income countries. Just 21% was for export to high income countries.¹⁶⁶

But even that 21% overstates the importance of exports to rich countries. One reason is that these are figures from 2015. Year by year, the proportion produced for the domestic market has been steadily increasing. After Covid-19, and after the strained trade and political relations with the US and EU, we can expect the domestic market to become even more important.

Another reason is that the main export industries in China are "IT and electronics" and "textiles and apparel". However, the industries that

produce the most emissions are cement, steel, fertilizers and “other chemicals”. All of these industries except “other chemicals”, which includes nylon, produce overwhelmingly for the domestic market.

We have also ignored all the other sources of emissions in China. These emissions come from transport, heating buildings, agriculture and electricity for use in homes, schools, hospitals, shops and public buildings. Taken together, those uses account for over a third of Chinese emissions.

Given all these reasons, a reasonable estimate is that exports to rich countries are responsible for a bit less than 10% of current Chinese greenhouse gas emissions.

Other Countries

China is only one country. It matters, because it is responsible for almost a third of global emissions, almost half of emissions from the “South”, and it is where a fifth of humanity lives. But we can see the same pattern in other countries.

The OECD studied the percentage of value added by industry that went to export in 20 countries. Here are the countries that have industrialized more recently, and are still not rich. Notice that in all of them more than half of production is for the internal market.

Manufacturing exports as % of all manufacturing value added

Mexico	42%
South Africa	41%
Turkey	36%
China	30%
India	28%
Indonesia	27%
Brazil	21%
Argentina	15% ¹⁶⁷

The richer countries export a larger percentage of their industrial production. Here are the figures. But notice also that big countries with a large internal market, like the US, export less.

Rich countries, manufacturing exports as % of all manufacturing value added

Korea	61%
Germany	60%
France	53%
Italy	50%
Canada	47%
UK	44%
Japan	33%
Australia	29%
USA	22% ¹⁶⁸

Who Cuts What? What is Fair? What Will Work?

Here's the big problem. We have to build green new deals country by country. The climate movement has tried to do it by influencing the governments as they meet together at the UN conferences. We have tried to get international agreements, and we have failed. So we have to campaign country by country. But at some point we will have to come back together.

So on what basis will we decide who cuts how much? The obvious, fair solution is for the richer countries to cut the most, and the poorer to cut less.

But that won't work. The trouble is that too many poorer countries have emissions that are too high. China produces 29% of total global emissions. The global average of long-lasting emissions is 6 tons per person. We have to get that down to no more than 1 ton per person, for reasons you have seen as we worked through the numbers in this book. That's an average global cut of 84%.

But emissions in China are 9 tons per person. If China does not cut their emissions deeply, there is no way we will ever get down to a global average of 1 ton per person. It's mathematically impossible. China has to cut, and cut deeply, or we are all lost. Perhaps more to the point, Chinese people are lost too.

But this can't be fair. China may have emissions of 9 tons per person a year, but so do South Africa and Germany. The European Union as a whole has lower emissions than China – 8 tons a year. The UK emits 6 tons a year per person.

How can it be fair for China, so much poorer, to have to make cuts on the same level as the European Union, with median incomes 8 times as high?

How can it be fair for South Africa to make deeper cuts in emissions than the UK, which is so much richer and was the colonial power that conquered South Africa in the first place? No, that's not fair.

Here are the emissions per person for eight countries. Notice particularly the emissions of the country in the number one spot.

Emissions per person of long-lasting gases, in CO2e, 2018

USA	18 tons per person
Japan	9 tons
China	9 tons
South Africa	9 tons
European Union	8 tons
United Kingdom	6 tons
Brazil	4 tons
India	2 tons per person ¹⁶⁹

[These are the figures only for emissions of CO2, nitrous oxide, and F-gases. We have ignored emissions of methane, which is not a long lasting gas. We have also ignored emissions from cutting down forests, because national estimates of that are often fibs.]

US emissions are 18 tons per person. That's twice the level in China, three times the level of the UK, and nine times the level of India. It's because most people in the US must have cars to get to work, because they have bigger cars with lower gas mileage, because they have big houses, and because a lot of the country is cold and needs heating,

There are worse countries, with higher emissions per person, like Saudi Arabia, Canada and Australia. But the US is still exceptional, and produced 14% of global emissions.

To get emissions down to America's fair share of a new low carbon world, 1 ton per person, the US would have to cut emissions by 94%. That is possible. But it is only barely possible. Deeper cuts would not be possible.

China, Japan and South Africa would have to make cuts of 89%. The EU would have to hit 88%, the UK 84% and Brazil 75%. India, already poor, would have to cut 50%.

There is only one way we are going to be able to get emissions down far enough, and keep them there. That is if there is general agreement that every country is trying to get down to the same level. That would be about 1 ton per person per year.

Let me recap slightly here. Many climate activists find the idea of reductions on this scale in the Global South more than challenging. The industrialization of China and India in the last decade has made obvious holes in the traditional argument about common and differentiated responsibility at the UN. That argument assumed that most emissions were in the North, and that the South would not have to make deep cuts. Those assumptions were true twenty years ago. They no longer fit the facts.

So some campaigners have come up with a bridging argument to defend these earlier assumptions. This bridging argument has had a lot of resonance on the left and among the NGOs. I am challenging that bridging argument.

This bridging argument says that the industrial jobs in China, India and other countries do not actually benefit people in those countries. Really, the argument says, those jobs are just producing goods for consumption by people in the North. It's a kind of offshoring, with low wages. So people in the South are not to blame for these emissions. Rather, we should count their industrial emissions as part of the emissions from the North.

Let's assume this argument is right. It is not, but let's follow the logic. If those emissions are essentially Northern, and real, what can we do about them?

There are two options. One is, close those factories down, because they only benefit the North. But workers in those factories would be furious. Their communities would be furious. The Chinese government would be furious. These are the reasons why no one is actively campaigning for such closures.

The other option is that because the emissions from China are really for the North, they should be cut by 90%, but that this should be done by converting to renewable energy. Pursue this logic, and you end with cutting all emissions in the industrial countries of the global South by 80 to 90%. Which is pretty much what my book argues.

But, many people say, a key part of common but differentiated responsibility is that the countries of the North should pay for the transition. After all, there was agreement at Copenhagen that the North should raise \$100 billion a year to help pay for the costs of

climate change in the South. Only, no surprise, the North has not come up with the money.

One hundred billion dollars is a lot of money. But it's trivial compared to the cost of a transition to a low carbon world. That will be 3 to 4% of global GDP. Global GDP is roughly \$80 trillion. So we need 2 to 3 trillion dollars a year, not 100 billion.¹⁷⁰

Most of the people involved in the debate about common responsibility at the UN are honest and decent. But look how it works in practice. It's a game. In the game, the US government says that they cannot cut emissions all the way as it will make no difference because China emits so much. The government of China says that they cannot cut emissions deeply as it would be historically and economically unfair, and why should they anyway, when the US is not doing it?

It's the Obama and Xi two-step dance, and it's elegant. The end result is that the government of the US and the government of China, and all the other governments involved, get exactly what they want – to not cut their emissions, and to blame someone else.

Thinking about international development in terms of funding from the North also involves a mistake about how development works, and about how solidarity could work.

There is a persistent fantasy in the North that development in the South comes about with foreign investment. Many countries have indeed developed while receiving moderate amounts of foreign investment. But in almost all cases, most of the capital comes from domestic sources. Domestic companies generate capital by exploiting their workers. They accumulate surplus value. The key is that local capital has control of the local process.¹⁷¹

Under colonialism, the colonial power sucked the value and profits out, and actively impeded local development. After colonialism, many countries are still trapped in economic relationships that drain their capital. But other countries have been able to build their own centers for the accumulation of capital. China, India, most of Southeast Asia, Brazil and Mexico are examples.

What countries need in order to develop is not foreign investment or aid. They need to be spared the relationships of skewed exchange, forced structural adjustment, rigged markets for primary products, and endless debt slavery. These relationships are not just abstract economic processes. They are enforced, in the present, by real people and real powers. That is what we need international solidarity to break. The next four chapters are about how we can make that solidarity a powerful reality.

**SAVE
OUR
ONLY
HOME**

*Primary school climate striker
Cape Town, South Africa*

EXTRACTIVE INDUSTRIES

In the chapter on *Transport* I talked briefly about car batteries and mining in the lithium triangle of the Atacama desert, where Bolivia, Chile and Argentina come together. I raised then the question of what to do about the environmental and human consequences of using lithium. I said the answer was complicated, and that I would come back to it. Here is the complicated answer.

I come to the particulars of the lithium triangle in a bit. But the place to start is with what has happened to mining in the global South over the past thirty years, and a set of changes often referred to as “extractivism.”¹⁷²

The traditional way of mining coal, iron and copper was to dig shafts into the seams deep beneath the earth. This created a particular kind of trade unionism and working class solidarity. Very large numbers of skilled mineworkers were needed. By and large, they lived in out of the way places, in communities with a strong sense of working class solidarity. Men, women and children all worked in the mines until the middle of the nineteenth century in most countries, and after that it was only men and boys. Because the work was both dangerous and skilled, underground miners depended deeply on each other’s experience, quick thinking and courage.

It was back-breaking work, but miners also occupied a key bottleneck in the national economy. They built unions on the basis of the existing workplace and community solidarity. Those unions had to be defended, in almost all countries, against murderous violence from

the employer's security forces, the police, and sometimes the army. But when mineworkers managed to combine at a national level, strike action could and did rapidly choke the economy. Until the widespread use of oil after 1939, this was true for coal miners everywhere. Their action could cut off electricity, shipping, foreign trade and heating. It brought down governments.¹⁷³

Copper miners in Chile, tin miners in Bolivia, and gold miners in Ghana and South Africa were also working in industries absolutely critical to the national economy.¹⁷⁴

It was important that underground mining required large groups of workers. In 1920 there were one million mineworkers in Britain, and over a million in the US. As late as 2000, there were five million coal miners in China and three million in India. This gave the workers considerable social weight in the mining regions. It also meant that the key cost for employers was labour, not machinery or mineral rights.

The result of all these factors was that mining unions were central to working class movements in many countries. In Britain, where I live, they were the best and strongest among us in the union movement. The same was once true in Bolivia, Chile, South Africa, Ghana, the US, France, Germany, Belgium, Spain, Poland, Ukraine and many other countries.

Then mining changed. At first this mainly affected hard rock mining – especially iron, copper and gold. But then it spread to coal mining and rare earth mining. The change was a shift from underground mining to excavating the earth with massive machines. In coal mining this is often called “open cast” or “mountaintop removal”.

The OK Tedi mine in Papua New Guinea is an example. In 1984 two companies, BHP and Bechtel, began work in the highlands. The company removed the top of a 2,000 meter mountain, and extracted all the gold. Then they began drilling down for the much larger amounts of copper beneath. When they are finished, they plan to have an open pit that goes down to sea level.¹⁷⁵

This kind of mining produces enormous pits and requires huge machines, and therefore very large capital investment. What it does not require is a lot of mine workers. That is the point of all the machines – to save money on wages. But open cast mining also produces thousands upon thousands of tons of mined material. In most of the world, the richest seams of minerals have already been mined. More and more, mining companies are turning over large amounts of earth, to extract less and less mineral from each ton of earth.

That extraction, for most open cast mines, relies on a series of processes that use acids and great heat to separate out the desired material. In many cases, these processes have to be repeated several times, with different mixtures and strengths of acids. One consequence is the mine requires a great deal of electricity for heating. The larger consequence is that very large amounts of contaminated sludge is dumped into rivers. In the case of the OK Tedi mine, at least 70 million tons of acid-bearing sludge is produced in a year. That's 70 billion kilos a year into a single river.

The original, official plan was for the OK Tedi mine to build a dam that would hold back the tailings and acid. That dam was never built. Instead the sludge has poisoned the 650-mile long Fly River, the second longest in New Guinea, and poisoned the land of 50,000 people in 120 villages downstream.

Those 50,000 people have been trying to close the mine or get proper compensation for more than 30 years. They have not succeeded. The people along the Fly face the same problems as people threatened by the new open cast mines in many parts of the world.

In 2005, the OK Tedi mine was already making a profit of between \$2 billion and \$3 billion a year. Taxes from the mine paid for 16% of the national budget of Papua New Guinea. As late as 2019, copper from OK Tedi still accounted for 25% of total exports from Papua New Guinea. That kind of money can buy politicians in any country, but it has even more weight in a small country like PNG. Probably more important, both governments and national economies often become dependent on one mine, or one oilfield. Then the corporation will be allowed to break any environmental regulations it wants.

Indeed, the business model of an extractive mine in a poor country depends on pollution. The OK Tedi mine is competing with copper mines in Chile, Peru, Mexico, Indonesia, Australia and other countries. The comparative advantages that make super profits possible come from three sources. One is the luck of geology. The second is low wages. The third is pollution. The profits, and the markets, are made because of the race to the bottom. Literally, in an open pit, but also in the competition to pollute more at less cost. The pollution is not a side effect of the mine. It is why the mine is profitable.

With underground mining in the old days, in Bolivia, Wales or Zambia, most of the company's profits came from exploiting the labour of the workers. In extractive mines, some of the profits still come from that. That's why low wages in poor countries are a bonus

for corporations. But more of the profits come from being able to pollute the environment.

There are certainly situations where there is a real conflict between jobs and the environment. In these places communities face a choice between losing large numbers of jobs or enduring disease and death. But this is not the choice with extractive mining. A company can easily employ 2,000 workers and destroy the farming livelihoods of 50,000. The environmental impact is far greater than the employment offered.¹⁷⁶ However, communities in many parts of the world have fallen for the story that new mines will bring jobs. They may be able to resist before the mine arrives, if an NGO contacts them, or if they have seen what happened to other communities. That's the best time to do it, before all the capital is sunk. But more often, the mine goes ahead, and then people slowly come to understand. Then, usually, they organize.

At this point the mining corporation usually replies with small bribes and with terror. Thirty years ago trade unionists were killed by employers and police in many parts of the world. That still happens, but it is far more dangerous to be a local environmental organizer against extractivism in the global South.¹⁷⁷

When the villages downstream of OK Tedi began to organize in the 1990s, the activists said over and over that they wanted to be nonviolent. They said that because they wanted to stay alive. The activists, the mining company and the PNG government were all thinking about what had happened on Bougainville, a large island that was part of PNG. There Rio Tinto, a multinational corporation, had opened a copper mine. The islanders were outraged by the environmental destruction that followed, and by the refusal of Rio Tinto to pay local people a share of their profits. The islanders rose up in guerilla resistance in 1988, and in May 1989 they closed the mine. PNG troops, supported by Rio Tinto, arrived on the island heavily armed and supported by the Australian government. In total, something on the order of 20,000 people were killed in the conflict, on an island with a total population of 250,000.¹⁷⁸

The people of Bougainville remained solid, however, and retained occupation of the mine. But their story is exceptional. Much more common is the murder of one local leader, or three, or a group of protesters. This can only happen with at least the silent approval of the local and national government. In some cases the killers are unknown, and in others there is good reason to believe that they are the police, army or security forces themselves. But quite often they

are the security forces of the mining company, or hired guns. The compensation offered by the companies involved can be incentive enough for criminal gangs to commit violence against those who resist. This terror is not incidental. It is structural. And it happens when the mining company think that the local people might make such a fuss, with national and international support from NGOs and campaigns, that the project might actually be closed down.

This story is repeated, over and over, not just with open pit mines, but with big dams and some oil fields. With dams, in particular, the profit margins are dependent on not compensating large numbers of people whose lands will be flooded. Moreover, the corporations or national government has an enormous investment in the dam working. And as with extraction, their profit comes from the villagers who are not compensated. This logic has led to massive dispossessions, like the destruction of the ancient land of Nubia to build the Aswan Dam in Egypt, and more recently, the Narmada Valley Dams in India and the Three Gorges Dam in China.

Lithium

Now let's return to the example of lithium and batteries. I start by describing the situation simply, and then add in some of the complexity.

Lithium is a metal used in almost all electric vehicle batteries today. About half of global production of lithium currently goes to electric vehicles. And in future we will need to increase the production of electric vehicles from hundreds of thousands to hundreds of millions. And that will require vast amounts of lithium.

There are three ways to mine lithium. It can be extracted from rock. It can be extracted from the brine that is left over when sea water passes through a desalination plant. Or it can be extracted from those brine deposits which are particularly rich in lithium. These brine deposits are the common way of mining lithium currently, because it is by far the cheapest. Most of the known deposits of lithium rich brine are in the arid highlands where Bolivia, Chile and Argentina come together.

Lithium mining is well established in Chile and Argentina. In both countries the local indigenous people have organised against the mining, but so far have been unable to stop it. The mining is toxic, because large amounts of acid are used in the processing. But the mining also uses large amounts of water in places that already have little enough moisture. The result is that ancestral homelands become unlivable.

Bolivia may have even richer deposits of lithium than Argentina and Chile, but mining has not begun there. The Bolivian government was led by the indigenous socialist Evo Morales from 2006 to 2019. Morales had been propelled to power by a mass movement committed to taking back control of Bolivia's water, gas and oil resources from multinational corporations. Morales was unable to nationalize the corporations, but he did insist on the government getting a much larger share of the oil and gas revenue.¹⁷⁹

His government planned to go even further with lithium. Morales wanted to mine the lithium in Bolivia, but he wanted to build factories alongside the mines to make batteries. In a world increasingly hungry for batteries, that could have turned Bolivia into an industrial nation, not just a place to exploit resources. The Morales government, however, was unable to raise the necessary investment funds. Global capital, Tesla, the big banks and the World Bank had no intention of supporting such a project. And if they had, they would not have done it in conjunction with a socialist like Morales. Then, in 2019, a coup led by Bolivian capitalists, and supported by the United States, removed Morales. Widespread popular unrest forced a new election in October, and Morales' party, the Movement for Socialism, won.

That's one level of complexity. The local indigenous people did not want the lithium mined. The socialist government did not want extractivism, but they did want industrial development.

Those are not the only choices.

For one thing, there are other, more expensive ways of mining lithium. It can be mined from hard rock in China or the United States. More important, batteries do not have to be made out of lithium. Cars had used batteries for almost a century before Sony developed a commercial lithium-ion battery in 1991. Engineers in many universities are experimenting with a range of other materials for building batteries. But even without looking to the future, it would be possible to build batteries in the ways they used to be built. Indeed, in January 2020, the US Geological Service listed the metals that could be substituted for lithium in battery anodes as calcium, magnesium, mercury and zinc.¹⁸⁰

The reason all manufacturers currently use lithium is that it provides a lighter battery that lasts longer. That gives the car greater range without recharging, and it makes it possible to build a much lighter car. In other words, lithium batteries are cheaper.

Rare Earth Metals

Similar arguments apply to “rare earth” metals. There are several different kinds of rare earth metals, each with different properties. They are widely used, in small amounts, in wind turbines, car batteries and much other technology necessary for climate change. It is often said that this rarity is an obstacle to decarbonizing the world.

This is not quite right. First, rare earth metals are not rare because they are found in only a few places in the world. They are found in many places, all over the world. Some rare earth metals are common. The word rare in this context means that they are found in very, very small concentrations in the ore which is mined. This makes them expensive. It also requires mining a vast amount of ore and then processing it with acids. If unregulated, the pollution is intense. In other words, this is more extractivism.¹⁸¹

Right now most rare earth metals are mined in China. There is nothing special about the geology of China. Most of them could be mined in the United States, or a range of other countries.

Coltan is a good example. It is used in small, hand-held electronic devices. At one point in the civil war in the Democratic Republic of Congo (DRC), the coltan mines were cut off by fighting and for a few weeks there was a global shortage of smartphones, and a delay in the supply of video game consoles. By 2009, many sources were repeating that 80% of coltan reserves were in Africa. Reserves are hard to estimate, but in 2009 about 30% of coltan was being mined in Congo DR. That was because the largest coltan mine in the world, Wodginga in Australia, had closed at the end of 2008. Until that point Wodginga had been supplying 30% of the global markets for coltan, but found production uneconomic. Wodginga opened again in 2011, closed in 2017, and is now a lithium mine. There is almost always an alternative place to mine.¹⁸²

China has two “advantages”. One is that the government can deal brutally with local protestors who are against pollution. The other advantage is that the Chinese government decided that they would move their economy towards high-tech, high-value industry, and that to do this they need a reliable supply of rare earth metals.

The Chinese government, which can control trillions in investment including in industry, has also made a decision to open mines for a wide range of rare earth metals. This makes China dominant in the market, because it is not possible now to tell what metals will be needed for which industries in ten years’ time. What China can

do, and the United States or Australia so far cannot do, because competing private companies control investment, is decide where to put capital in advance of knowing exactly what production, and what commodities, will be needed.

But as with lithium, there are always alternatives. The main use of rare earth metals now is for screens, smart phones, games consoles, electronics and laptop computers. You can have a phone, a computer or a screen without rare earth metals. But a pinch of the metal gives the screen better resolution, and it allows the device to be made much smaller. Steve Jobs knew what he wanted to do with phones long before he made the iPhone. But Jobs had to wait for the necessary rare metals to come onstream.

All this means that when the climate jobs programs seems to need rare earth metals and therefore extractive mining, we can always go back to an older technology. We would just have to live with big, clunky phones. And a shortage of rare earth metals does not mean renewable energy won't work.

Batteries

We have established that batteries do not have to be made out of lithium. Other materials are available and they do not necessitate the same environmental and social harms. We have established that shortages of lithium do not mean we have to give up on the prospect of all vehicles being electric. Other kinds of batteries can be used. Lithium can be mined from other parts of the world. Hydrogen from electrolysis can be used instead.

So we don't have to use lithium in electric batteries. We need not poison the homelands of indigenous people. Moreover, much of the poisoning takes place because mining is unregulated. We can regulate.

Which is all well and good. But so far I have ignored the relations of power that enable destructive extraction in poor countries all over the world. We cannot ignore this any longer. So, we must ask, is it naïve to think we can do anything about that?

Well, as things stand it is difficult for local people, or indigenous people, to defend themselves. This is true in PNG, but also in Argentina, China and with mountain-top removal in West Virginia. In many parts of the world, international NGOs encourage local people to campaign in the media, and to take out court cases, in countries far away. Sometimes this works, but the record is not good, and it takes years. Moreover, local people lose control of their campaign, which

means the foreign NGO and lawyers can settle in the courts whenever they decide to, on whatever terms they accept.¹⁸³

Agitation and organization inside the country can have a larger effect. In 2020, a court ruling in Chile in support of the indigenous communities brought lithium mining there to a halt, and may stop it altogether.

All this is worth fighting for. But once you have a government climate jobs service, then it would be possible to challenge the destructive power of extractive industries. The people whose lives and lands are polluted or drowned, in Bolivia for instance, could appeal for solidarity from the people who work in the new climate service, in France for example.

The balance of forces would be quite different from the way it is now when NGOs attempt to lobby and shame great corporations. The workers in the climate service in France would be unionized. Union organization is never automatic. But if people cannot organize a union in a public sector service of a million people – and moreover a service that has been won in the teeth of established power by a mass movement of millions, a mass movement in which the unions have been central, a mass movement where everyone knows they are part of a global movement to save the Earth – then, frankly, you cannot organize a union anywhere.

All of this presumes that the workers in the climate service have job security and government jobs. As we have seen, there are many other reasons why we need those protections anyway. But in that situation, with those feelings and forces in play, an appeal for solidarity from indigenous people in a river valley somewhere could easily lead workers 8,000 miles away to tell their management: “We are not working with lithium that has blood on it.”

Similar arguments apply to almost all other cases of extractive industry. Workers who offer each other solidarity can turn a race to the bottom into a race to the top. And if that feels unlikely to you, it is because you live now, here, on this Earth. The process of saving that Earth will change what people can do and imagine.

In sum, the energy transition right now is powered, in many places, by appalling destruction and poisoning in the extraction of raw materials. It does not have to be that way. The solution to climate breakdown is the same solution to ending extractivism: solidarity.

**SI EL CLIMA
FUESE
UN BANCO**

**YA LO HABRÍAN
SALVADO**

*"If the climate was a bank,
they would already have saved it"
Climate striker, Madrid*

CHAPTER 24

MONEY

So how will we pay for the massive green new deals we need? On one level the answer is obvious. On another level, it is not. Let's take the obvious answer first.

When governments think they really need to do something, they spend the money. Let's look at three examples: World War Two, the 2008 financial crash and the Covid-19 pandemic.

The United States joined World War Two on 7 December 1941. Before the end of the month, President Franklin Roosevelt had sent a letter to Congress, asking them to authorize between \$50 and \$55 billion dollars of military spending. Congress agreed. That spending was roughly equal to the total GDP of the United States in 1941. The equivalent would be for the US Congress to decide to spend 20 trillion dollars on climate jobs next year.¹⁸⁴

As we shall see, we need the whole world to spend only a tenth of that, 2 trillion dollars, on climate jobs each year.

Immediately the US went to war in 1941, all the car factories closed down. They reopened three months later, making planes, military jeeps and weapons. No new cars were built for the duration of the war. The Ford automobile company opened one plant 30 miles north of Detroit, where 43,000 workers built 8,685 bomber aircraft before the war was over.¹⁸⁵

The US was in no way exceptional. The other major powers had very different political systems. Britain was an empire, with democracy at home and dictatorship abroad. Germany was a fascist dictatorship.

The Soviet Union was a communist dictatorship. Japan was a military dictatorship with a royal figurehead. But whatever the political system, the governments of all the major powers took effective control of industry and spent whatever it took to make as many weapons to kill as many people as fast as possible in order to win the war. We want to do the same now, but to save lives.

When the war was over, there were roughly 60 million dead and hundreds of millions of wounded and homeless. But the carnage and the spending had not bankrupted governments. Instead, the economic consequence of the war was the end of the Great Depression.

The point is that when governments want to spend the money, they spend the money. Our second example is the global financial crash of 2008.

In 2008 and 2009 it looked like the whole global financial system might collapse. Governments reacted with stimulus packages. Japan spent \$1.35 trillion dollars. The Chinese government spent roughly \$1 trillion dollars. The US Congress passed a stimulus package of \$775 billion dollars. In addition, the US Federal Reserve Bank provided dollar loans to other central banks in Europe, Japan, Korea, Australia and Singapore so that they could bail out their major banks. In a single week in October 2008, the United States loaned \$850 billion dollars in this way. The total loans over the next few years amounted to many trillions.¹⁸⁶

Covid in 2020 is our third example. The United States government, under Trump, spent more than \$2 trillion dollars on the CARES stimulus. Japan announced a \$1.3 trillion stimulus, China \$530 billion. These amounts are the spending in the first few months of the pandemic – the cost of stimulus will rise far higher.¹⁸⁷

So, the money is there. Governments spend it when they need to. Money will not be a problem for Green New Deal programs. It's simple. Problem solved, right?

Well, no, because there are other examples. Let's take South Africa at the end of apartheid. The African National Congress (ANC), led by Nelson Mandela, won the first free and fair election in the history of the country. The ANC had a deep commitment to social and class equality, because their power came from a series of mass uprisings by working class people. So from 1994 on the new government began to implement the Reconstruction and Development Programme. The new government would build public housing and expand health care on a massive scale. Deficit spending would bring social equality.

For a while the global and local businesses stayed quiet. This was a new government, with a mass movement and great moral authority behind it. But early in 1996, local and national business turned on the government. They said that the new finance minister, Trevor Manuel, was running the economy irresponsibly. The deficit was too high. Currency traders and banks inside and outside the country began to sell off the currency, the Rand. The big mining corporations in the country also bet against the Rand. Foreign investors began moving their money out of the country. The value of the Rand, measured against the dollar, fell.¹⁸⁸

The government of South Africa had to go to the International Monetary Fund (IMF) for a loan. The IMF is run from Washington, DC, and controlled by the governments and banks of the US, the European Union and Japan. The IMF put conditions on their loan. They insisted the South Africans had to stop the Reconstruction and Development Programme. Instead, they had to cut public spending and try to balance the budget. In other words, they had to introduce austerity and stop trying to meet the needs of the people. And they had to stop trying to make the country more equal.

The IMF loan in itself was not that large. But the IMF seal of approval mattered. If the IMF did not approve the loan, global banks and corporations would refuse to lend to the government and the companies in South Africa. The ANC government felt they had no choice. They ended the Reconstruction and Development Programme. That is a big reason why South Africa is one of the most unequal countries in the world today.

But it's not just South Africa. The IMF has made similar emergency loans, with similar conditions, to more than 100 countries in the last 40 years. In just four years, from 2008 to 2011, the IMF made such conditional loans to 55 different countries.

The novelist Kim Stanley Robinson describes the process well:

The “structural adjustment programs” [SAPS] enforced by the World Bank on the developing countries caught in the debt crises at the end of the twentieth century set the conditions for what became the world order in the twenty-first century. These SAPs were instruments of the postwar American economic empire, which was unlike the older empires in that it did not insist on ownership of its economic colonies; it only owned their debts and their profits, no more than that. The best empire yet, in terms of efficiency, and the neoliberal order was all about efficiency, in its purest economic definition: the speed and frictionlessness with which money moved from the poor to the rich. So there was a reason it was called the Washington Consensus. Its SAP requirements, made of any country that wanted a bail-out in the form of further loans, came only by adhering to the following conditions: a reduction in public spending; tax reforms, especially reducing taxes on corporations; privatization of state-owned enterprises; market-based interest and currency exchange rates, with no government controls on these; a set of strong investor rights, so investors could no longer be given haircuts (the long hair provisions, so-called); and the massive deregulation of everything: market activities, business practices, labor and environmental protections. Even though these structural adjustment programs were widely criticized, and judged a failure by some analysts at the end of the twentieth century, they were the template for dealing with the EU crises in the small southern countries, and were inflicted on Greece in full to scare Portugal, Ireland, Spain, and Italy, not to mention the new EU countries from eastern Europe, at the prospect of what the EU (meaning in this case France and Germany) would do to them if they tried to create and hew to a line of their own.¹⁸⁹

So that's how things are in the world. Some richer countries are able to spend massive amounts of money when the politicians and the bankers think it is necessary. And the international financial system forces some countries to do the opposite, with dire results.

Is there an alternative? There are three main answers to this question among economists today. The mainstream, free market, answer sticks with the old Washington consensus that no countries can tolerate large debt.

Keynesian economists, who were respected during World War Two for suggesting governments could manage the economy, argue that most countries can carry large debts, but there are limits.

The third answer comes from Modern Monetary Theory economists, who argue that the US, China and other countries with powerful currencies can easily run large deficits to fund green new deals, but that poorer countries probably cannot.

Here I will argue something different from all three of those answers. I will argue that both rich and poor countries can raise the money for climate jobs, and for green new deals. But that will require the mother of all political struggles, and will not happen without solidarity between mass movements in the North and the South.

Paying for It All

But first, it's time to look at how much all this will cost. This is important, because most arguments about climate finance overestimate the costs by a great deal.

There are two parts to the cost. One part is the cost of all the climate jobs that will be necessary. The other part is the rest of the green new deals, the money that will go on housing, health services, social care, child care, the environment and so on.

We will start with the climate jobs. I am building here on previous estimates for climate jobs programs in Britain, South Africa and across Europe.¹⁹⁰

Basically, the cost of a climate jobs program is about 5% of the total economy, the Gross Domestic Product, each year for 20 years. The product of the whole global economy is \$80 trillion dollars a year. 5% of that would be \$4 trillion dollars a year.

Which is a lot of money to you or me, of course, but not so much on a global scale. Moreover, climate jobs programs will get about half of that back, for two reasons. First, climate jobs will be supplying electricity for houses and businesses, which will pay electricity bills. The jobs will be

supplying transport, and people will pay for bus and train tickets, and for electricity to charge their vehicles. About two thirds of climate jobs will be in these two areas – electricity and transport. The climate job service will not get all that money back. There will need to be some ongoing subsidies to public transport and to the cost of heating materials in industry. But a good portion of this money will be coming back.

Climate jobs will also get money back in a second way. In richer countries when an unemployed person gets a good full-time job, they stop claiming unemployment and welfare benefits. That saves the government money. The newly employed also start paying income tax. They buy more things, on which they pay more sales tax and value-added tax. So the government pays the unemployed less and gets more money from the employed.

It's not just the climate jobs workers who pay more taxes. In Britain, for example, the Campaign against Climate Change calculates that the climate service would hire about one million workers. But there would be another 500,000 jobs in the supply line. Those people might come straight out of unemployment. Or they might come from other jobs, and unemployed people would replace them. Either way, that is 1,500,000 less unemployed people.

Then there would be roughly another 225,000 "induced" jobs. This means jobs that are created because the workers who now have jobs are buying more clothes, cars, electronics and everything else, and someone has to make those goods and provide those services. In all, that would be 1,725,000 workers who stop claiming benefits and start paying taxes.

In Britain, the campaign's estimate in 2014 was that the government would have to spend £66 billion a year. They would recover:

- £25 billion from travel tickets and electricity bills
- £22 billion in new taxes paid and unclaimed benefits
- For a total of £47 billion
- But the government had spent £66 billion
- So the real cost to the government would be £19 billion.¹⁹¹

In other words, the actual annual cost to the government would be less than a third of up-front spending.

The proportion of savings that governments can make will vary from one country to another. There are countries with much higher welfare benefits and levels of taxation than the UK, like Germany and Norway. In those countries, the government will get almost all of the cost of a Green New Deal back. And there are countries with low welfare benefits and low taxation, like South Africa and India. In those countries the government will get less of the money back. But people there will still be buying bus tickets and paying electricity bills.

The UK climate jobs campaign suggested several different ways of raising the remaining £19 billion each year through taxation. Together, they came to a possible £208 billion.

Total needed 19 billion pounds

Total available 208 billion pounds:

75 billion	Current quantitative easing from Bank of England
74 billion	Stop illegal tax evasion
25 billion	Close tax loopholes
12 billion	Tax the income of the wealthiest 1%
12 billion	Small tax on the wealth of the wealthiest 1%
10 billion	"Robin Hood Tax" on currency transactions. ¹⁹²

In 2016, the South African climate jobs campaign estimated that the upfront costs of a million climate jobs each year would be 346 billion Rand. Electricity sales and tickets could raise R149 billion. Taxes paid by new workers could raise another R85 billion. That would leave a net cost of R112 billion. The campaign made several suggestions for taxing the rich that could raise R195 billion a year – more than enough.¹⁹³

So from country to country, the government will recover between 40% and 90% of the upfront cost. I estimate that on a global scale, only about 40% of the cost of climate jobs will have to come from government revenue. And much of that can come from taxes.

I said above that climate jobs spending globally will be about \$4 trillion dollars a year. But governments will only have to come up with about 40% of that total – \$1.6 trillion. That is 2% of total global income each year.

New Deals

That's the situation with the cost of climate jobs. My focus in this book is on those jobs. But I should say something about the costs of the other jobs that go to make up a new deal.

In South Africa, for example, a new deal might spend money on a range of things, but probably housing and health more than any other. In Britain I suspect the focus would be care, health and housing. In other countries the balance would be different.

In all cases, the government would still get some of the spending back from the new workers who stopped claiming benefits and started paying taxes. Money spent on building public housing would also eventually come back as rent payments – that is how public housing works in most countries. But there would still be services, like care homes in the UK, which the government would largely have to pay for itself. The maths will vary from country to country, but basically part of the cost will be recovered and the government will cover part of it from “deficit financing”.

We will need some deficit finance for climate jobs too. Deficit financing means that the government spends more money in any year than it takes in through taxation that year. The government runs at a deficit that year. So the government has to go into debt. The usual form that debt takes is that the government borrows money by selling bonds. These bonds are loans from rich people and corporations to the government. The government agrees to pay the money back in three years, or five, or ten or more, plus interest on the loan.

This is normal. All governments have deficits some years, sell bonds, and almost never pay off the national debt. Sometimes the accumulated debt is large, and sometimes small. The US government very nearly paid off all its national debt in 1835, when they got it down to a mere \$33,700. Then it began rising again, and since then they have never been anywhere near paying it off.

The best way to measure the national debt is to compare it to the total incomes of everyone in the country. The total amount of accumulated debt for most governments runs between about 50% and 200% of annual national income. That means between half and double national income for that year. This does not mean that the government runs a deficit of 50% that year. It means that their total accumulated debt – what they owe – is equal to half the total incomes that year.

In the United States, for example, the total debt was 114% of national income in 1946, because of all the money spent on World

War Two. The accumulated debt fell to 31% of annual national income in 1974. It was back up to 114% in 2019, and is still rising.

In the UK national debt was only 22% of annual national income in 1991. It was 85% in 2019. It has only been over 200% twice. Once was at the end of the long war with Napoleon in 1815, which Britain won. The other was at the end of World War Two. National debt in Britain, as in the US, has been highest at the moments of national greatness.

Large government debts are not necessarily a sign of weakness. They are often a sign that rich people trust that government and are willing to loan it large sums of money.

In short, in many years governments borrow so they can spend more than they take in taxation. All over the world, almost all governments have been doing this for the last ten years. And now, as we slowly emerge from the Covid epidemic, we are going to want governments to run large deficits.

Any Green New Deal is part of that. Most countries in the world, maybe almost all, will have high unemployment this year and next, and maybe for several years to come. A big part of the point of any Green New Deal is creating more jobs for the people who are out of work. But if you try to pay for those jobs from existing taxes, you cannot bring down unemployment.

Here is why. People often suggest that we could pay for Green New Deal jobs in health and renewable energy by cutting military spending on arms and soldiers. And indeed we could do that. But if we transfer the money from arms and soldiers, then all those soldiers and armament workers lose their jobs. The new jobs in health and energy are balanced by the lost jobs in the army and armaments factories. The level of unemployment stays the same.

Right now, with mass unemployment, we want to reduce the total number of unemployed people.

There is the same problem if we move money out of nuclear weapons. And actually, there is a similar, but not identical problem with taxing the rich. Let's say we take away much of the money the rich can spend on yachts and diamonds. Then yacht crews and yacht builders lose their jobs. So do jewelry store workers, and 200,000 badly paid underground diamond miners in South Africa. And so do the people who sell boat shoes to the yacht crews and lunches to the diamond miners, and all kinds of other people as well.

Still, it is better to tax the rich than the rest of us. This is because the rich spend some of their money on new diamonds and new

yachts, but they leave a lot of it in bank accounts or invest it in speculations of the stock market where the money creates no jobs.

The rest of us pretty much spend all the money we have. If we pay more taxes, we buy less. When millions of us spend less, people start losing their jobs in textile mills, plastic bottle factories, supermarkets, pubs, shops and everywhere else. So if the government taxes ordinary people more to make new jobs, roughly the same number of old jobs disappear.

This is why a Green New Deal is so important. Let's say there are two million new jobs in Britain in health, care and climate jobs. One million of those jobs are paid for from taxation, tickets and electricity bills. But one million jobs are paid for by the government simply spending more than they take in. That creates an extra million jobs and takes a million people out of unemployment.

This idea comes from what is called Keynesian economics. It is named after the British economist John Maynard Keynes. In 1936 he published a book called *The General Theory of Employment, Interest and Money*. That book revolutionized establishment economics. It's a difficult book to read, but Keynes sums it up in one easy example.¹⁹⁴

He proposes that in a depression with mass unemployment the government could pay people to dig holes one day and then fill the holes with earth the next day. The workers would have more money. They would go out and spend it in the pub and the shops. Other people would have more jobs. They too would spend more money. The country would begin to come out of the depression.

Keynes argued that when a country is stuck in a depression, ordinary people are not going to borrow to spend money. They are too scared of running out of money. Businesses are not going to invest money on new projects either. They are afraid of going bust. So only government spending can turn the tide and restore confidence.

Keynes was not writing in a vacuum. His country, Britain, had had mass unemployment for eighteen years when he wrote his book. Keynes was looking over his shoulder. In Germany the Nazis had put a stop to mass unemployment by building up the armed forces. In Soviet Russia, Stalin was doing the same by building up heavy industry. In the United States President Roosevelt had been running deficit spending and hired seven million workers into emergency jobs on low pay. Keynes was a rich man, a liberal politician and a professor at the elite Cambridge University. He feared and hated both the Nazis and Stalinists, and did not mention their example

much. He concentrated on the New Deal example, as have all Keynesians ever since.

Three years after Keynes published his book *World War Two* began. As we saw, all governments did massive deficit spending in that war. When the war ended, the Great Depression was over. That pretty much convinced all mainstream economists to be “Keynesians”. Even now, in moments of crisis, they are all Keynesians.

But – and this is important – they are not the same kind of Keynesian that Keynes was. Remember, his example is the government gives money to hole diggers, and the diggers spend money on basics to get the economy going again.

The Keynesian economics we have now is Keynes for the bankers and the rich. A good example is what President Obama did in the United States. In 2008 there was a global financial crash. It began in the United States, and spread outwards to Europe and much of the world. The driving force was that people, banks and companies had trouble paying their debts. Many people in the US could not pay their mortgages, companies could not pay off their bank loans, and banks were wary of loaning money to each other. The whole financial system was seizing up, and it looked like mammoth banks, corporations and even governments could go bankrupt. So the United States government stepped in and shovelled money into the banks. Obama gave the stimulus money to the rich, not the unemployed.

Modern Monetary Theory

There is a weakness to Keynes’ theories. He has no explanation of why countries go into recessions and depressions. And his work provides no explanation of the rate of profit and the rate of growth in developed economies has been falling since 1970. These are serious flaws. But for our purposes here, the important point about his thought is that he explains why governments should turn to deficit financing in a recession.

There is another school of economists, called Modern Monetary Theory, who build on but go beyond Keynes. I am going to spend a bit of time explaining their theory. They are particularly important to us because of the influence they have had on ideas around the Green New Deal in the United States. So let’s look at these ideas with some care.¹⁹⁵

The starting point for Modern Monetary Theory is trying to get past a common confusion about money. Most people, most of the time, think of money as a real thing, printed by the government. In this common way of thinking, banks take in deposits from people. Then they loan out that same money to borrowers. Companies borrow money from banks, and when they make profits they pay back the banks.

This is how the system looks at first sight. But Modern Monetary theorists point to a basic flaw in this model. Banks in fact create money. Imagine that a corporation called Amalgamated Lobsters goes to a bank and asks for a loan of one million dollars. The bank says yes. The loan manager then draws up a contract that says that Amalgamated Lobster owes the bank one million plus interest on the loan. At the same time, the bank opens an account for Amalgamated Lobster with one million dollars in it.¹⁹⁶

Where did that one million dollars come from? Did the bank go to accounts where many small customers held a total of one million dollars, and use those savings to loan to Amalgamated Lobster? No. The bank manager just created one million dollars by the act of entering that amount into Amalgamated Lobster's account in the computer. Then she said that Amalgamated Lobster owed the bank one million. Where there had not been one million dollars, now there was one million dollars.

This is how banks create money.

In other words, money is socially constructed. This does not mean that just anybody can create money. I can't. Nor probably can you. A very small bank cannot create a million dollars very often. You have to be quite a big bank to create several hundred million dollars in one account and get away with it.

Banks make money, but there are limits to how much they can make. Those limits are not set in law or rules. They are negotiated and tested in back and forth processes between the players in the financial world.

An anecdote may help. When I was a senior in high school in Austin, Texas, I used to go round to the house of one of our English teachers, whom I admired. His wife was a legal secretary, and smart as a whip. She told me a story about her working life.

This was fifty years ago. Austin is a big city now, with a population of almost a million, full of high tech firms, a music centre. Back then it was a small city, sleepy, dwarfed by the power of Houston and Dallas. But Austin did have the state government, the university, the Longhorns football team and some powerful law firms that dealt with the state. There were

twenty rich and influential men in Austin, she said. The secret of becoming one was that you had to owe money to many of the other twenty.

In the last month she had witnessed a man become the twenty-first. She worked at one of the most powerful law firms in town. The guy, we'll call him Jack, was originally from West Texas, in the oil business. He was in his thirties, personable, good looking, expensive boots, sometimes a cowboy hat. He had managed to get to the point where he owed several powerful men in Austin money.

That week Jack had been standing in front of her desk, talking with two other men, when one of them asked him about some money he owed. Jack took a piece of paper off her desk and wrote a note of hand. A note of hand is a written promise to pay someone a certain sum of money on a certain day. An "I owe you". This was a lot of money. What really impressed her was that Jack wrote the note of hand standing up, while he was talking to the two men, barely looking at the paper as he wrote, and then handed over the note. He did it, she said, as if it was nothing.

She thought this was probably the most tense, and most crucial, moment in Jack's working life. He gave no indication of that. It's not that she was fooled, or that the two other men talking to him were fooled. It was that the other two were thinking what she was thinking – if he can do that, there's no stopping that boy.

That's a small city, in a state full of informality and cowboys, and a long time ago. The process of becoming a person or a bank who can create money is vastly more complicated now, with more gatekeepers and paperwork, whether in Atlanta or Lisbon. But it is not fundamentally different.

Jack was not a con man. He was doing what men in the oil business did. The whole process relied on debt, and loans, and contacts, and what is now called venture capital. It relied on other business people weighing you up. And it also relied on your ability to deliver. Companies and people who cannot make a profit, whose ventures do not work, drop out of the system. It is not simply confidence, and style – delivery is crucial. But confidence, and style, education, race, nationality, gender, good looks, boots or suits, and good luck, these all matter.

At the level of the City of London or Wall Street, the process is infinitely more complex. Nor is it static. Banks, institutions and sometimes people can make money, and then one day they can't.

Ordinary people, like you and me, can get very nervous when we first find this out. Money is powerful in our lives. We need it to be a

real thing, because our work is real, and our needs are real. There is a kind of rage people feel when they first find out that some people can just create money.

One result of that shock, and that rage, has been that people try to provide a simplified explanation of how the creation of money works. Modern Monetary Theory simplifies that situation by saying that governments are in charge of creating money. Look, they say, banks can create money. So can governments. The only guarantee for a US bank creating money is that the US government is willing to accept that money in payment of taxes. It follows, Modern Monetary theorists say, that a sovereign government can create money for itself too. This is why the US government can create quantitative easing. And it's why governments can and do run deficits.

Modern Monetary theorists make two caveats, though. The first one comes from Keynes. They agree that extra job creation by governments will work in a recession, but not in a boom. This is because inflation is not a danger when a government makes money, as long as the economy is in a bad way. Then there will be a lot of goods for sale, and not many people with the money to buy them. Put some extra money into the economy, and prices won't rise. But if almost everyone who wants a job has one, and there is a lot of money in the system, and not enough goods for those people to buy, then prices will increase. But in that situation we will not need extra jobs.

So, Modern Monetary theorists say, it is all right for governments to ignore deficits and even create money in an economic recession.

The second caveat is that Modern Monetary Theory only works for a "sovereign economy". By this they mean something technical and quite specific. A sovereign economy is one where a nation state has its own currency. Examples would be the dollar in the United States, the pound in the United Kingdom, and the yen in Japan. A non-sovereign economy is one where the state does not control the currency. One set of examples would be countries like Greece and Portugal, which use the EU Euro as their currency. Other examples would be countries where the government or businesses borrow heavily in another currency, like the dollar in Turkey, Lebanon or South Africa.

Governments with sovereign currencies, it is argued, can do pretty much what they want with their government spending.

That's Modern Monetary Theory. There are many technical arguments about the theory among economists. But from our point of view, there is one great strength. They have argued strongly and

loudly that governments do not have to run balanced budgets, and they have been widely heard.

Two Flaws in Modern Monetary Theory

There are two important flaws, however. The first has to do with the idea of “sovereign currencies”. The United States government may be able to do what they want with the dollar. But that is to start with the nation state as the unit of analysis. In fact, there are no national economies. What there is, is a global economic and financial system. Every country, and every government, is deeply influenced by their place in that financial system. Some countries seem to have power over their own currency because they have power over the currencies, governments and economies of other countries. The United States and China are powerful because South Africa and Nepal lack power.¹⁹⁷

I described earlier what happened to South Africa in 1996, when there was a run on the Rand and the government had to go to the International Monetary Fund for a loan. As a condition of the loan, the government had to slash expenditure on human need.

Most of the countries that the IMF has forced to slash government expenditure were in the global South. Some were not – Iceland, Ireland, Ukraine, Bosnia and Poland were trapped too. The big powers of Europe, the USA, Japan, China and India were not trapped in this way. But austerity and inequality has been imposed on much of the world in this way.

When economists and politicians in the weaker countries think of how to fund a Green New Deal, they think about those moments of crisis. If South Africa began a Green New Deal, what would happen? The South African banks and big corporations, the global banks and big corporations, the stock market investors, the bond market investors, the IMF and the World Bank would all declare that deficit spending on that scale would bankrupt the government of South Africa. They would then stop lending and let the currency crash until the South African government came to heel.

That is what everyone in the South African government believes would happen. It is why they have not yet started a Green New Deal. I agree with those politicians. It’s what I think would happen too. It is also what would happen to Nepal, Cambodia, Serbia, Bolivia, Mali, Lebanon or any of the other smaller powers in the global system.

The economists who invented Modern Monetary Theory also believe that is what would happen in those countries. That's why they make that key caveat about MMT only working in countries with sovereign currencies. The upsetting thing, for me, is that they appear not to care. Most of MMT seems to be an argument about what could happen in the United States.

It is not just people in poor countries who find this annoying. Andrew Jackson has written a very good, short, clear article on what is wrong with Modern Monetary Theory. Jackson is the chief economist for the CDC, the federation of labour unions in Canada. One of the things that gets under his skin is that Modern Monetary Theory does not apply to Canada. The banks, corporations and government of the United States dominate Canada. If all those powers moved against a Canadian New Deal, the Canadian government could be expected to crumble. Everyone in the trade union movement in Canada is aware of this.¹⁹⁸

Does this mean we have to give up? No, it just means there will be a serious fight for climate jobs and new deals, and we will need international solidarity.

Let's think again about the example of Jack, the twenty-first powerful man in Austin, Texas, in 1966. The point of that story was that many forces determine whether someone within the system can take on debt. Those things include how likely they are to pay back the debt, who else supports them, and what political pressure they bring to bear. The same thing is true of conflicts in international political economy.

What happened in Europe between the 2008 crash and 2018 is one example of this. We have two good accounts of this. One is *Crashed*, by the economic historian Adam Tooze. The other is Yanis Varoufakis' *Adults in the Room: My Battle with Europe's Deep Establishment*. Varoufakis was the finance minister of Greece when the socialist government led by the Syriza party tried to refuse to pay the debts which the IMF and the European Union insisted that they owed. What both Tooze and Varoufakis describe is endless conflict and negotiation, in a situation where the playing field is tilted toward the "deep establishment". But the result is not foreordained, for they also describe constant conflict, with all sides jockeying for national and international support.¹⁹⁹

One point that emerges from Tooze's book is that Greece was humiliated, but Italy and Spain were not. The central bankers of the

world left Lithuania and Estonia to rot after 2008, but they rescued South Korea and Poland. Greece was not allowed to default, but Russia defaulted on its debts in 1998, and Argentina did the same in 2001.

What does all this economic theory actually tell us? It is possible that national governments can run up large debts and pay for the Green New Deals. And in fact, that investment will bring big returns and pay most of the debt back in short order. The governments can financially bear the cost of the debt that is not paid back. But to do this they need is the "confidence" of the markets, of corporations and other states. Or we need to build a movement of international solidarity strong enough to force the markets to accept the will of the people.

**OUR
GOVT.
IS LYING
TO US**

*Young protester against the coal hub planned
by the Ambani Corporation
Goa, India*

SOLIDARITY AND THE TREATMENT ACTION CAMPAIGN

What I have been saying about financial solidarity between North and South may sound like wishful thinking. Perhaps it would help if I give you a concrete example so you can have an idea how that solidarity could work in practice. The best example I know about is how a mass movement in South Africa won free retroviral drugs for people with AIDS. So I will tell that story. It is an interesting story in its own right. But the point of this story is to provide ideas about how to mobilise the kind of pressure which would be needed to stop the global financial system closing down a climate jobs program.²⁰⁰

This story tells you how solidarity wins, and should be an inspiration for every climate jobs activist.

As I have said, I was an AIDS counsellor for six years in London. In the 1980s, the centers of HIV infection globally were in two places. One was the United States and the Caribbean. The other was East Africa. For the first decade of the epidemic, there was no cure, and no drugs that could keep people alive. But gay men and their allies in the United States organized a mass movement called ACT-UP. The US government had done almost nothing to fund research into medicines for HIV, or to fast track any possible drugs. ACT-UP's mission was to save lives by getting drugs funded, invented and approved. Because they were out, and proud, and numerous and desperate, they won. By 1994 combination retroviral therapies were available, and most gay men and other people in the US with AIDS got those drugs.²⁰¹

People in poor countries in Africa and Asia did not get those drugs. They were “too expensive”. People with HIV could live for decades, if they took those drugs every year. But one year’s supply cost \$10,000 per person. Everyone understood that “of course” almost all Africans could not afford that. And “of course” governments in poor countries could not afford those prices. Hardly anyone in the United States or Europe thought much about that, except for people with relatives in Africa. It was a pity that millions would die in Africa, but that was “normal”.

Meanwhile, the virus had spread from East Africa to the countries of Southern Africa. By 1998, there were at least two million people with HIV in South Africa, the number was increasing rapidly, and people there were beginning to die in large numbers.

Then something happened that was not “normal”. A small group of activists in Cape Town founded the Treatment Action Campaign. The leader of TAC was Zaki Achmat. He brought together in his person the two traditions of struggle that would make TAC powerful. One was the freedom struggle against apartheid. Achmat had been sent to prison as a teenager for setting fire to his secondary school in protest against apartheid. When he got out of prison, he became the underground leader of the Marxist Workers current in Nelson Mandela’s African National Congress.

The other tradition of struggle was global gay liberation. Achmat was defiantly out and proud. Once apartheid fell, he became one of the national leaders of the gay and lesbian movement in South Africa. This was a powerful and serious movement. Because the African National Congress had won freedom as a radical, mass liberation movement, and because many lesbian and gay activists had been part of that, the new government supported gay rights. The new constitution of 1996 became the first one in the world to make discrimination against people because of their sexuality unconstitutional. So, for example, on Day One of the new constitution, same sex marriage became legal, the first country in the world where this happened.²⁰²

And Zaki Achmat had HIV. He had a well paid professional job in the movement, and could afford the new retroviral drugs. But he promised he would not take them until all South Africans had access to them.

Ten people, mostly men, mostly white, mostly professionals, founded the Treatment Action Campaign. Within two years, TAC was leading protests of thousands of people, mostly working class, mostly

black, the majority of them women, marching down the street, singing and dancing and shouting, all wearing the same tshirts that said, in enormous letters, HIV POSITIVE.

TAC had one simple, central demand. The drugs might cost \$10,000 brought from the companies that held the patents. But pharmaceutical companies in India and Thailand were making exact copies, generic drugs, without patents, and these cost far less. The South African government could import those generic drugs and treat everyone who was sick in South Africa for free. That was what TAC demanded.

The main obstacle to what TAC wanted was the government of the United States. President Bill Clinton's Democratic administration did not want the South African government importing generics. When it looked like that might happen, Clinton sent Vice-President Al Gore and Commerce Secretary Micky Kantor to South Africa. Gore and Kantor told the South African government publicly that the US would take out a dispute against South Africa at the World Trade Organization if necessary. Privately, they threatened the South African government with trade sanctions.

This may seem astonishing, but has to be seen in context. Big Pharma – the large global pharmaceutical corporations from the United States and Europe – were very concerned by the threat of generic medicines for South Africans with AIDS. The South African market itself was unimportant to Big Pharma. Indeed, since almost no South African could afford the retrovirals, there was no market. Total sales of all medicines in all of Africa accounted for less than 2% of global sales, and sales of AIDS drugs accounted for less than 2% of the global market for pharmaceuticals.

Big Pharma's stake was different, and elsewhere. The really important market for Big Pharma, for all drugs, was in the United States. A quarter of all drug sales went to the US, and more than half of all the profits of Big Pharma globally came from US sales. This was because the prices of drugs in the US were far higher. And that was because all the other rich countries in the world had some kind of national health insurance, or national health service. Each government negotiated with the pharmaceutical corporations on the price of medicines, using bulk purchases to drive down the price. Only in the United States was there no central control of prices, and that was why profits were so high.²⁰³

The import of generic AIDS drugs into South Africa would encourage the import of other generic drugs into other poor countries.

More threatening, it could encourage the import into the United States of drugs from Canada – not generic copies, but exactly the same drugs, made by the same companies, and sold at far lower prices.

Clinton's government saw their proper role as supporting Big Pharma. Some of these corporations were American, but in a larger sense, supporting corporations was what the American government did. Moreover, Clinton was trying hard to build the power of the new global World Trade Organization. As the American government saw it, one of the central tasks of the WTO was to protect copyright and patents, what was now called "intellectual property". This was because the US was moving out of low-end industry like making clothes and assembling electronics. Instead, US industries were moving into research and development of high end products, and for that preserving intellectual property was now important. Think of computers and electronics. A small part of the cost of any computer is the labour from Asia that goes into assembly. A much larger part of the cost is the research, design and software that goes into the computer. Protecting intellectual property in pharmaceuticals was part of the larger defense of intellectual property.

So when the South African government under President Mandela passed a law saying that generic drugs could be imported in an emergency, 37 multinational pharmaceutical companies sued the government in a South African court. The case dragged on.

In the summer of 1999 Thabo Mbeki replaced Nelson Mandela as president. Mbeki folded under American pressure and refused TAC's demands. He defended this action by embracing a mixture of crank theories. At various times he claimed that HIV was not the cause of AIDS, that the drugs were poisonous, that the drugs did not work, and that traditional African healers had drugs that did work. In 2000, it was new and unusual for a head of state to talk nonsense and lies about science and medicine. We are more familiar with that now.²⁰⁴

But early in 2000 the Treatment Action Campaign reached out to ACT-UP in New York and explained the problem. There was a presidential election that year, and Al Gore was running in the Democratic primaries. ACT-UP, outraged and in solidarity, began sending squads of people to every rally Gore held. When he spoke, gay men stood up and screamed about AIDS drugs and dying children in Africa.

Gore had begun the campaign publicly backing the pharmaceutical corporations in South Africa. Soon he had to back

down. Once Democratic voters knew what was happening, they knew it was wrong.

More international solidarity carried the truth to more people. The 37 pharmaceutical corporations dropped their court case against the South African government. The road was open to the import of cheap drugs. And still Mbeki's government refused to act. Perhaps the American government and the WTO were still leaning on them privately. Perhaps not, but Mbeki was so far committed to his crazy theories he could not back down.

Whatever the case, the Treatment Action Campaign launched full scale civil disobedience across the country. They drew on the rich tradition of the freedom struggle. Four years before there had been less than ten people in the country who were open about their HIV status, and one of them had been lynched by her neighbours the week after TAC was founded. Now thousands marched, singing, in their HIV Positive T-shirts, most of them working class, the majority of them women, occupying buildings, heckling politicians, barricading the Parliament Building in Cape Town, so the president had to sneak out the back, humiliated.

The protesters had enormous moral weight behind them. They would die if they did not get the drugs. Everyone in the country, everyone in the ANC, everyone in the government, knew people who had died or were dying. Once the truth was spoken, something must be done. The rest of the cabinet and government, minus Mbeki and a few toadies, stepped in and promised the campaign that action would be taken for treatment. And it was. People began to get the medication. The national conference of the campaign voted to instruct Achmat to take the medicine now. It would be six long years before Mbeki was removed, and in those years he would do everything he could to obstruct people getting the medicine. But Zuma replaced Mbeki as president in 2008, and by that point most people who were sick were getting medication.

The campaign's victory was larger than that. The right-wing, Republican president of the United States, George Bush set up PEPFAR, a program to pay for AIDS drugs for people all over Africa. There were flaws in that campaign, Lord knows. There was a rule that no NGOs should be funded unless they recommended sexual abstinence. The drugs were not generic, they came from Big Pharma, though at discounted prices. But millions upon millions of people were given life, because those in grave danger had organized and fought.²⁰⁵

Some Lessons

So what are the lessons for climate jobs?

First, solidarity was crucial. But almost no one in the rich countries had cared that people were dying all over Africa. That was normal. Hardly anyone in Europe really seems to care right now about all the people dying of climate change across Southern Africa. That is normal. And the gay men who had been through hell in the US did not really notice either.

But once people organized in large numbers in South Africa, once they began shouting, then the people in ACT-UP in New York heard. And once they heard, they started shouting, and many more people in the US heard.

The people shouting in the United States did not do so because they pitied South Africans. They did not do so because they felt guilty about what their ancestors had done. They did so out of empathy, and solidarity, because they knew and hated and were terrified of that virus. And they also responded to resistance and organization and direct action, because theirs had been a movement of resistance and organization and direct action.

In the same way, when movements win new deals for jobs in Nepal, Argentina or South Africa, they will need solidarity from movements in the global North. That solidarity will only be forthcoming if there are such movements, and they too are campaigning for new deals. That is beginning to happen now.

It was crucial that the solidarity from ACT-UP targeted Gore. The South Africans thought about the weak link, and went for it. The same would have to happen when the global financial system moved to punish a deal for jobs in poorer countries. By all means barricade the Stock Exchange in London, or the Bourse in Paris, or to coin a phrase, occupy Wall Street. But also target Vice-President, or maybe President, Kamala Harris, and the president of the Federal Reserve Bank, and of the European Central Bank. One way or another, raise the political price to force them to act to save the deal for jobs.

In doing this, remember, as they said in ACT-UP, silence is death. But the converse is also true, that speaking the truth is life. Because any major attempt, anywhere on earth, to give millions jobs and halt climate change, would resonate through the hearts of people all over the world.

Notice, also, that South Africa was a special place. Working class people had fought a long and massive battle against apartheid, and

won a great victory. The lesbian and gay movement was stronger, and winning more, than in other countries. Both those movements asked themselves, almost automatically, not only what is my identity, and not only how do we get jobs at the top, but far more insistently, what do the poor need?

Because South Africa was a special place, the movement for free drugs for the sick started there, and first won there. But that victory saved tens of millions of lives across the continent, and indirectly, across Latin America.

When people in many places confront the same horror, solutions and hope cross borders. That same process will be far more powerful with climate change. We do not know where we will win through first for real climate action – climate jobs. In hindsight it will be obvious to every historian that of course that place was special in a particular way. Looking forward, we don't know. But we do know that winning or losing in that one country will be dependent on the strength and mass support of all the movements around the world. And after that one victory will come the cascade.

**İKLİMİ
DEĞİL
SİSTEMİ
DEĞİŞTİR**

*"System Change, not Climate Change"
On a bag in Istanbul, 2013*

THE MIDDLE EAST AND NORTH AFRICA

This chapter is about the countries of the Middle East and North Africa – “Middle East” for short. Most of what I say is largely true of the countries of central Asia as well – Azerbaijan, Uzbekistan, Turkmenistan, Kazakhstan, Kirghizstan and Tajikistan.²⁰⁶

Many of these countries are oil rich. Because of this, all of them have long been the playthings of empires. These countries are often thought of as rich, but most of them belong in the same category as the middle-income countries of the South. Saudi Arabia is rich, but the average income per person is still just over a third of the average in the United States. Egypt, Tunisia, Morocco, Jordan and Tunisia all have lower average incomes than China or South Africa. Afghanistan is one of the poorest countries on earth.

Climate jobs programs are essential to these countries. I know this is a weird thing to say, but this chapter will explain why.

The region faces three major threats from climate change – drought, unbearable temperatures, and a sudden collapse in the price of oil. The last threat is the worst, so I’ll start with it.

At some point the world market in oil is going to collapse. No one knows when this will happen, but when it does it will be catastrophic for the region. Before Covid 19 the global demand for oil was beginning to level off. The main market for oil is transport, and at some point a global shift to electric vehicles will begin to take off. This will happen even without climate jobs, and it may well happen while large numbers of oil powered cars and trucks remain on the road. To stop climate

breakdown, we have to go all electric. But a shift of one half, or one third, or maybe even less, will precipitate a crisis in the oil market.

The reason is this. Imagine that demand for oil is running at only 80% of the available supply for oil. Does this mean that the price of oil falls to 80% of the oil price? No. It means that the price falls to 50%, or 25%, or even lower. The reason for that is that there are a lot of suppliers now with oil they cannot sell at all, and so they compete bitterly with each other to sell the oil to get at least some money.

When this happens, there will have been a warning. But the exact moment will still be a sudden shock. This is because the price of oil will be more or less steady, and then it will suddenly collapse when demand falls enough below supply. At that point, many of the economies of the Middle East will be very vulnerable. Here are the percentages of total national income that come from oil for several countries:

Percentages of GDP from oil in 2018

Iraq	45%
Kuwait	42%
Libya	42%
Saudi Arabia	38%
Oman	37%
UAE	26%
Qatar	26%
Algeria	24%
Iran	24% ²⁰⁷

These figures are not percentages of government expenditure, or of exports. They are percentages of the national income, all the income and profits of everyone in the country. If those incomes crash, the economies will crash.

This will not just affect the countries with oil. Many people from poorer countries without oil, like Egypt, Jordan, Yemen, Palestine, Afghanistan, and some regions of Pakistan and India, are working in those countries too. The collapse of oil prices will hurt those countries as well as the migrant workers return home, hungry and penniless.

It will not just be the price of oil, though. There will also be a collapse in economic confidence among foreign banks. Loans will dry up, and other businesses will crash. This is a recipe not just for

recession, but for prolonged depression and mass unemployment. It is likely to lead to both uprisings and suffering.

The second threat to the region is temperature rises. At the moment the record breaking temperatures on Earth are in Death Valley, an isolated desert in the United States – and in densely populated cities in Kuwait, Iraq and Iran. Temperatures there have reached 54C. Temperatures in some of the rest of the region are not far behind. Scientists are predicting that an average temperature rise of 2C globally, will produce an average rise of 4C in much of the Middle East. That is an average, and it will be worse on some days. Summer temperatures across the region will reach an average of 46C. Temperatures of over 55C (132F) will be common in some places on summer days. Temperatures over 60C (140F) will not be unknown. And there is already a trend for heatwaves in the region to last longer. This means that in some places, and in the cities near some of the great oil fields, life will become extremely difficult, and many will die whenever the air conditioning breaks down.²⁰⁸

The third threat is drought and famine. There has been chronic drought for 50 years in countries on the southern edge of the Sahara, like Sudan and Chad. In the last twenty years these droughts have been spreading west to Mali and south to northern Kenya and northern Ghana. There has been intermittent drought across much of central Asia for decades. Nancy Lindisfarne and I have written recently about the effects of drought in Afghanistan, Syria and Darfur. Our conclusion was that in all three places climate droughts inflicted much suffering. But the Russian invasion of Afghanistan in 1978, and the American invasion in 2001, were more important in driving the long civil war there. In Syria the deep popular hatred of the Assad regime was the driving force in the civil war since 2011. Only in Darfur, we argue, was drought the central force behind civil war.

However, that was then. In the future worse, and wider, droughts are to be expected, and they will at a minimum make life much harder. But most people in the Middle East are not living in villages any more. They live in towns and cities, and temperature rise and a collapse in the oil market are likely to hit them even worse.

Climate Jobs

So what can people in the region do to avert this hell? Climate jobs would help a lot. They would give people an alternative economy in several ways.

Much of the region has enormous resources of sun and wind. This is true of North Africa, but also of Syria, Turkey, Iraq, Iran and Kazakhstan. Estimates vary, but there is general agreement that a small fraction of the land area could supply enough renewable electricity to meet the all the current energy needs of the entire earth. Technically, it would be entirely possible for the export of renewable electricity to replace a substantial proportion of the export of oil.

Solar PV, you may remember, produces three times as much electricity on the shores of the Persian Gulf as it does in Germany. But the great advantage of the region would be in Concentrated Solar Power. As we have seen, this really only works efficiently with very large amounts of sunlight. When there is enough sunlight CSP can store heat energy for up to twelve hours. That means CSP farms in the Middle East could provide renewable electricity around the clock.

The technology to do this is already well established. High Voltage Direct Current (HVDC) cables can already carry electricity over thousands of kilometers with little loss of power. They are expensive to build. But they are beginning to crisscross the world. Undersea HVDC is now working as well. The two longest working undersea cables are one of 580 kms between Norway and the Netherlands, and one of 420 kms between Sardinia and mainland Italy. Two longer cables of 1,000 kms each are planned, one between Iceland and the UK, and the other between Israel, Cyprus and Greece. Undersea technology is developing apace as cables are constructed from offshore wind farms. It is only 300 km between Tunisia and Sicily, and far less across the Straits of Gibraltar.²⁰⁹

The Sun Power corporation has now received approval from the Australian government to build a 120 square kilometer solar PV farm on an old cattle station between Alice Springs and Darwin, and send the power 3,800 kms to Singapore, most of that by undersea cable. They hope to finish the project by 2027.²¹⁰

Christian Breyer and his colleagues at LUT University in Finland have been doing interesting work on very large scale grids in the last two years. This is research on the feasibility of such grids – it does not mean they are being implemented yet. But one study shows a considerable saving in energy from a super grid that takes renewable electricity from the Gobi Desert and shares it with China, Russia, Japan and South Korea. In another project, they looked at the possibility of a super grid linking North America and South America, and using only renewable energy. For that one, they decided that the

extra savings in linking the continents would be marginal, but super grids for each continent made sense. They also saw considerable saving in costs and energy from a 100% renewable energy super grid linking together the whole of the Middle East.²¹¹

These super grids have not been built. But the technology is ready. Indeed, ten years ago there was considerable interest in the proposal by the German Aerospace authority of the Desertec project. This project would have built massive renewable electricity in North Africa for export by cables to Europe. The project was cancelled in 2014 without a clear explanation as to why. I suspect that the Arab Spring frightened potential investors. More recently, though, there has been renewed interest in a similar proposal.²¹²

Massive renewable energy in the Middle East would have other advantages as well. It could make an enormous difference for the poorer countries without oil. Egypt, Yemen and Afghanistan spring to mind. Cheap, widely available renewable electricity could power, and encourage, new industries in those countries. And throughout the region, climate jobs would mean jobs. In countries facing hard times this can make a great difference.

However, there is a reality to be faced. There is noise and official chatter about renewable energy in Morocco, UAE and Saudi Arabia. But very little is actually being done. This is not surprising. The region has been path dependent on oil for decades. Even the elites in countries without oil fear what powerful neighbours might do to them if they turn away from oil. No existing political force is actively organizing for renewable energy or climate jobs. But there is one force that might be able to push for an alternative.

For 75 years the economy of the region has been dominated by oil. Nancy Lindisfarne and I have argued elsewhere that has meant not just oil, but cheap oil. Oil and gas have been the blood in the veins of global capital. Growth and profits in North America, Europe and Japan have depended on keeping prices low. This has only been possible because imperial power and armies have backed the dictatorships in the region prepared to keep the price down. The most important of these has been the Saudi Arabian regime, which has almost always been prepared to raise production when asked by the US government to lower the price.²¹³

Imperial interventions and cruel dictatorships have produced a string of terrible wars, sometimes in oil producing countries, and sometimes in places like Afghanistan and Yemen, which matter only

because they are adjacent to the oil production. This has gone hand in hand with dictatorships which control the oil for the benefit of a small elite, and which shortchange the majority of the people at the same time by agreeing not to sell the oil for more.

By and large, people in the Middle East value democracy and fairness deeply, and they hate inequality, corruption and foreign domination. They have resisted the oil regimes for many decades. Until the 1970s the resistance was mainly led by nationalists, Baath socialists and communists. From the 1970s on resistance continued, often led by Islamists. The Arab Spring began in 2011, with a new politics of the street. There was a time when the Spring seemed defeated, but armed rebellions have survived in Syria and Yemen, and street unrest in Morocco. Since 2019 resistance has come roaring back in Lebanon, Iraq and Sudan.

The scale of this unrest over decades, and the deep moral hatred people feel for their rulers, has meant that great cruelty has been required to keep people in their place and maintain control of the oil. These regimes go by many names. Some are kingships, some socialist, some nationalist, some Islamist and some military. They all serve the same purpose. To read the history of the last century in the Middle East is, in the end, to feel that there are many different styles of tyranny, but that the interrogators and torturers are all the same.

The brutality that flows from oil has blighted generations. But it has also produced waves of resistance. That resistance increasingly confronts hard economic times, and will confront worse. The idea of climate jobs projects and new deals in the Middle East sounds odd right now. But if people in the region take up those ideas, and they gain support in the movements of resistance, a different future would become possible.

PART SEVEN

FUTURES

ةروث

*"Revolution"
Written on Covid mask of protester
Beirut, Mayday 2020*

CLIMATE BREAKDOWN

We come now to the last two chapters in the book, about two possible futures. In this chapter I want to talk about what happens if we don't get climate jobs and the shit does hit the fan. My voice in this chapter is more personal than in the rest of the book. The next chapter is about how we can start fighting now.

I start with three hard truths. Firstly, climate change has been moving much faster than scientists predicted. Things are going to get very bad within the lifetime of some of us now living. We don't know and can't know how bad, or how quickly this will happen. ²¹⁴

A second truth: scientists have, for many reasons, been under constant pressure to downplay the dangers and extent of climate change, and not to scare the mob.

Non-governmental organisations have constantly colluded with governments and corporations to conceal the scale of the catastrophe, and to push solutions that will not solve it. Scientists and NGOs do this because their funders demand that.

Most of the mainstream world has been pretending that solutions are working that will not work. And on present form, we are headed down a dark road. This chapter is about how we can continue to fight even if we go a long way down that road.

A third truth: It is hard, at first, to accept what is probably coming.

Two memories keep coming back to me. In one, I am six years old. Mr. Dhillon is my father's best friend in Ludhiana, the city in Indian Punjab where we live.

Mr. Dhillon tells me that during partition his parents hid a Muslim under their house – under the porch, I think.

Mr. Dhillon is above me, smiling down. I understand he is proud, and that there is some terrible tragedy in the air around him. He tells me they saved the Muslim's life. I have few memories from that age, but that one I have remembered.

The Partition between India and Pakistan was not ancient history then. It was seven, one year older than me. What Mr. Dhillon told me was important to him because no one else he knew, just his parents, had done that.

A million people, more or less, had died in a few weeks in Punjab. Half of them were Hindus and Sikhs killed by Muslims. Half were Muslims killed by Hindus and Sikhs.

I grew up knowing that it is people like us, people all around us, who do the massacres. And that very few of us are lucky enough to be Mr. Dhillon's parents. And that he was telling me to try to follow their example.

In the other memory I am twenty-three, a young anthropologist beginning my first fieldwork, in the town of Lashkargah in southwestern Afghanistan. Walking back to the only hotel in town for my supper, I pass a teenage boy standing on the side of the road. He says something quietly. I am well past him by the time I understand what he said. I am so proud of myself. It is the first Pushtu sentence I have understood outside of a lesson. But I am too embarrassed or shy to go back to him.

He said: "I am hungry".

To the north of Lashkargah a terrible famine was beginning. I understood that boy was a refugee from that starvation. That famine, I know now, was caused by drought caused by climate change. Like every famine it was also caused by inequality and cruelty.

In the North of the country the government delivered foreign aid grain. The district officers put armed soldiers around the piles of grain in the middle of the towns to prevent the hungry getting the food. The poor sold their land at knockdown prices to the rich to buy wheat from the district officers, who were charging five and ten times the usual prices for the grain. Those with no land to sell died.

My friend Michael Barry asked some starving people why they did not storm the grain piles. One of them said: "The King has planes. They will come and shoot us down."

Those were Russian planes, flown by pilots trained in America. US Aid knew what was happening to their grain aid. I know that because

the wife and daughter of the man who ran US Aid told me so as I drank scotch in their nice house in Kabul. They were upset because they could not get their husband and father to do anything.

I have told that story many times since, in many ways. I will go on telling it until the day I die. I tell it to make an important point about what serious climate change will feel like – and what it already feels like for many millions.

No one dared to storm those piles of grain. But when the “leftist strongman” Daoud, the King’s cousin, staged a coup two years later, no one would die for the King. The famine had left him with the mark of Cain. And when the Communists staged a coup against Daoud four years after that, no one fought for Daoud, the King’s cousin, either.

The story of Afghan politics after that is endlessly complex. But the direction is clear: war after war, betrayal after betrayal, endless grief. Always in the background, the failure of the rains, across all of Central Asia, for decades.

Social collapse

It would be wrong to reduce the Afghan tragedy to climate change. There was much else involved, many great powers, unspeakably murderous invasions by Russia and the United States, and dishonest greedy resistance leaders. But as time goes on, in our world, climate change becomes more and more of a driver of such tragedies.

The massacres at Partition and the Afghan tragedy are not what most people in Britain mean when they say “social collapse”. Jem Bendell has put it clearly: “Starvation, destruction, migration, disease and war.” He’s right.²¹⁵

But what most people mean is what you see over and over in the dystopian movies. There are little groups of savages wandering the roads, scavenging and fearful, making tentative friends to keep the dark at bay. That is not remotely what it’s going to be like.

That fantasy of disorganized savages goes back to the ugly ruling class British thinker Thomas Hobbes in the seventeenth century. He believed that only the firm supervision of the state prevented a war of all against all. This is a long running fantasy among all elites, because their deepest fear is that the rest of us will loosen ourselves from their iron grip. It is fantasy that still appeals to people who grew up in privilege. It is the fantasy that informs the Pentagon, which warns us that climate change will mean “civil unrest”. I cannot imagine a world

so degraded that we did not react to runaway climate breakdown with civil unrest.

The most influential promoter of this view of “social collapse” has been Jared Diamond. Many of my friends love his book *Collapse*, because they see it as a warning about climate.²¹⁶

But in fact he tells one historically inaccurate story after another about how civilisations fell into dark ages because they strained the environment too far. If you read *Questioning Collapse*, edited by Patricia McAnany and Norman Yoffee, you will find that most of these stories are actually about how a population overthrew tyranny and went back to living in smaller scale, more egalitarian communities. It’s also worth reading *The Creation of Inequality* by the archaeologists Kent Flannery and Joyce Marcus. They show how, again and again in human history, people overthrew the unequal class societies that oppressed them and went back to a better way of living. And when Diamond’s civilizations collapsed, the people did not disappear. The Easter Islanders on Rapa Nui are still there, and so are the Maya, and the Native Greenlanders remained.²¹⁷

In any case, Diamond’s fantasy is not what we are going to face either. We have enough experience of horror in modern history to know what the collapse of climate breakdown will look like. Consider the middle of the twentieth century, when sixty million were killed. Probably a small number compared to what we will face, but useful for thinking on.

Of those sixty million, think of the killing fields of Stalingrad. The six million dead Jews and Gypsies. The two or three million who died in the Bengal famine because the government of Clement Attlee and Winston Churchill in Britain decided they needed the Indian railways to move war material, not grain.

There were one million famine dead in northern Vietnam because the Japanese army made the same decision. The three million or so dead in the North China famine. Then there were the dead of Hiroshima and Nagasaki. (The US Air Force bombed two cities, because although the first nuclear bomb won the war, they still had another design of nuclear bomb to test.)

Or think about the fire bombings of almost all Japanese cities which killed far more people than the atom bombs, mostly in more painful ways. And there were all Stalin’s deportations and camps. The murdered during Partition in India. The many millions dead in actual uniforms, which seems so old fashioned now. The tens of millions raped here and there.

All these numbers are approximate, you understand. No one was counting properly.

Almost none of those horrors were committed by small groups of savages wandering through the ruins. They were committed by States, and by mass political movements.

Society did not disintegrate. It did not come apart. Society intensified. Power concentrated, and split, and those powers had us kill each other. It seems reasonable to assume that climate social collapse will be like that. Only with five times as many dead, if we are lucky, and twenty-five times as many, if we are not.

Remember this, because when the moment of runaway climate change comes for you, where you live, it will not come in the form of a few wandering hairy bikers. It will come with the tanks on the streets and the military or the fascists taking power.

Those generals may be climate deniers. But it is much more likely that they will talk in deep green language. They will speak of degrowth, and the boundaries of planetary ecology. They will tell us we have consumed too much, and been too greedy, and now for the sake of Mother Earth, we must tighten our belts.

Then we will tighten our belts, and we will suffer, and they will build a new kind of gross green inequality. And in a world of ecological freefall, it will take cruelty on an unprecedented scale to keep their inequality in place.

Our new rulers will fan the flames of new racisms. They will explain why we must keep out the hordes of hungry homeless who live on the other side of the wall. Why, regrettably, we have to shoot them or let them drown. Why, unfortunately, we are running out of food for the refugee camps in the desert on the other side of the wall, or across the channel. Why the people on this side of the wall who look like the people on the other side of the wall are now our enemies. Why we have to go to war.

It is easy to hear those voices, because they are all around us now.

I think a lot about my grandchildren. I don't know the timing of breakdown. Twelve years is possible, but I think unlikely. In the lifetime of my grandchildren, very probably. The youngest is now five, and the oldest is ten. Of course I worry they will die. But that's not really what I fear. More, I worry about what they will have to watch and have to do to survive.

The usual version of the wandering savages is not just a mistake. It's a lie that conceals the state. But it also conceals what Mr. Dhillon told me. It was our neighbours, he was telling six-year-old Jonathan.

Because it was something important to him, and something I needed to know. It will be your children, or your grandchildren.

Becoming the perpetrator

If you look at the places where people are living social collapse, what you see is that anybody can become the perpetrator. Anyone who knows the recent history of Syria understands why someone might find themselves in a Christian death squad, a Hezbollah death squad, an ISIS death squad, a Kurdish spotter calling in American death on the heads of Sunni Muslims, an American special forces soldier, a Russian pilot, a medic with the White Helmets saving lives, a volunteer in the Free Syrian Army, an Assadist nurse saving lives in an emergency room, a prisoner in an Assadist torture camp, an interrogator, or a father holding his dead child on the shores of the Med.

Anyone who has lived through the last forty years in Afghanistan or Somalia understands the same. There are so many accidents of birth and experience. There but for the grace of God go I.

And of course there are right choices and wrong ones. The differences matter, and there are rivers of blood between them. But you cannot assume you, or anyone you love, will come out on the right side. That is part of the tragedy.

Syria. Afghanistan. Somalia. Darfur. Southern Sudan. Somalia. Eritrea. Iraq. Haiti. Congo. There are invasions in the history of many of those countries. Not all. Mostly American invasions. Not all. There is serious climate change already in all of them except Congo. Climate change is not the main thing driving the collapse in most of them. Yet.

Except for Darfur and Chad. What is happening there is insanely complex, and partly driven by a proxy oil war between China and the US. But the rains failed in Darfur and Chad in 1968, and they have never properly returned. Some years are better, some years threaten famine. At heart what has happened there is a war between herders and farmers for disappearing grass.²¹⁸

Socialist solutions

Never expect a pure climate change horror. Always it will arrive dripping with the blood and excrement of capitalism and empire.

Scientists and environmentalists have discovered the problem of climate change. They have told us all about it. Brilliant. Without them we would march uncomprehending into hell. And now most people know. This is a great achievement.

But scientists and environmentalists are often conservative people. The green movement is mostly white, mostly posh, mostly in the rich North. The deep wish of many environmentalists is to be a small business person.

Most of those suffering now are in the global South, or they are poor, or people of colour in rich countries. But the movement against climate change is still small in the poor countries.

The solutions we need are socialist solutions. The kind trades union activists have always liked. We need a hundred and fifty million climate jobs now to rewire the world. Not business jobs, but public sector jobs.

Yet the unions have done little about climate change until almost yesterday. The socialists have done far less.

There are two possible reactions to this divide. One is to slag off the other side. Socialists, anarchists and trade unionists point out that Extinction Rebellion is a bunch of posh people who do not understand climate justice. Environmentalists point out that socialists and trade unionists have done nothing.

Another political alternative is emerging, though. I have been part of what unions did, and small as it was, last year I heard student strikers all over the world repeating what we said. They talk about a Green New Deal and climate jobs because that's the only solution that makes sense. In New York, I heard Greta Thunberg call for a general strike.

Three Famines

When the famine hit Bengal in 1943 the Indian National Congress, the opposition to the British colonial government, did nothing. The links are complex, but that's why they had the partition massacres four years later.

When the famine hit northern Vietnam early in 1945, the tiny bands of Communists in the mountain jungles came down into the city and led crowds trying to seize the grain silos. Within a year they controlled the North.

Until now those who suffer most from climate change have mostly blamed God, under various names.

I have a dream. In Mozambique, or South Africa, or anywhere, those who suffer collapse march on the American embassy. They demand the small amounts of money they need to survive on the land. And they demand eight million climate jobs in the United States. For Americans. And a million climate jobs in South Africa.

I have often mentioned this dream in front of audiences of NGO people and environmental activists. It goes down like a lead balloon. They know they cannot bite the hand of the funders. But also they fear the rage of the mob.

Imagine a million victims of the storms, or a million farmers who have watched their crops die. Imagine their rage on the streets. Anything could happen.

The soldiers could mow down the crowd. Or not. The crowd could lynch the people in the embassy, or not. The black people of Washington DC could march on the White House.

Here's another thing about uncertainty. Maybe we have time. Or, more important, we are not going to hit a single tipping point, and then hit a single feedback and suddenly find ourselves dealing with runaway climate breakdown. There are many tipping points, each worse than the last.

The key factor is the basic driver of the feedbacks – carbon dioxide emissions from coal, oil and gas. The more of that, the more the feedbacks.

At each point we can act to slow down and reduce the damage. That's the good news. It doesn't mean we will be OK.

But also remember that social collapse is not the end. Remember Darfur. The rains failed there in 1968. There was drought, rape, murder, revenge, hunger and starvation. People buried the dead and got on with living and made peace for a while. Repeat.

Then in 1985, in the midst of the first really bad famine, the people rose up in Khartoum, the capital of Sudan. They stormed the grain silos, the workers came out in a general strike, and the military dictatorship fell. Many of the crowd storming the grain silos were refugees from the famine in Darfur and the West.

The main opposition, the Umma, led by al Mahdi, a graduate of the University of Oxford and the grandson of Sudan's national hero, came to power. His government would not, or could not, give people what they needed. There was another military dictatorship, more hunger, civil war in the South and Darfur. To read what it was like to live in those times makes your head hurt and your stomach lurch. So think what it would be like to live through those times.

Now the people of Sudan have moved again. It started in December, 2018, in Atbara, the old center of the strongest union, the railway workers, and the Communist Party. The protests started because the government tripled the price of bread.

People demonstrated all across Darfur too. They marched to surround the military garrisons. In the center of Darfur, the crowds marched from the many camps for displaced persons, marching on the army, demanding the abolition of the militias, the opening of the prisons, and above all the right to return to their land.

People had learned in fifty years. The leadership of this uprising lay with Sudan Professional Association, an alliance of new unions of doctors, teachers, veterinarians, lawyers, pharmacists and others.

This was because people do not trust Al Mahdi's Umma, the Communists or Turabi's Islamists any longer. The crowds in Khartoum surrounded the military headquarters, nonviolent, because they knew they must bring over the ordinary soldiers to their side. They were hundreds of thousands. In August, 2019, they had a sort of victory. The dictator was removed, and replaced by a provisional government of generals and civilians that promised reform. As of November, 2020, it is unclear whether that government will deliver democracy.

I don't know how it will turn out. No one knows. But there are two lessons. One is about what happens when collapse comes to where you are. People survive, and endure. They learn and come back again.

The other is that if those people in Darfur and Sudan, or in the other Darfurs elsewhere and those to come, make it their business to halt climate change, they can change the world.

I don't want to sound too hopeful here. One insight I have taken from Jem Bendell's influential paper, *Deep Adaptation*, is that wisdom only begins when we let in the grief, despair and rage of understanding the climate tragedy. But what we are seeing in the climate strikes, Extinction Rebellion and all the rest, is that hope too can only begin when we allow the grief and rage to course through us.²¹⁹

Life and death

I know why people want to go off grid, run for the hills, live in bioregional communities. But they are so wrong. They abandon the people of Khartoum, Shanghai, the Mekong Delta, Birmingham, London, New York, New Orleans, Mumbai, Kolkata. Shame on them.

Maybe many are going to die. I don't want to say extinction is impossible. James Hansen is probably the most eminent living climate scientist. His book *Storms of My Grandchildren* contains a terrifying chapter about what might happen.²²⁰ But there is a good way to die. I learned that when I was an AIDS counsellor in London for six years, back before we had the drugs to keep people alive.

I watched how my patients died, and how the gay men I worked with died. The former drug injectors and the heterosexuals mostly died in lonely shame. Sometimes I was the only person they could talk to.

But the gay men who were out, who had been part of gay liberation, they died for the people around them, the people who would follow them. They were not stoics – that kind of fake courage would be no use to the others. They showed panic and despair. But they also showed, by the way they lived, you can do this too. And the other men of their community, and the lesbians, and their families, held them. And because of that strength they won the drugs that let so many who followed live.

They had politics. They had love. They died well. When your time comes, die like that. And try to live like Mr. Dhillon's mother and father.

EXPECT RESISTANCE

Climate striker, London

THE STRUGGLE IS A RIVER

The last chapter was about what we do if and when the shit hits the fan, at the moment when the tanks appear on the streets. My answer was that climate breakdown is not the end of the struggle. It's the moment when struggle just got a great deal harder, and a great deal more serious.

This chapter is about strategy and tactics – how to fight for the climate action and green new deals we need.

Let me summarize the argument so far. To stop climate change, we have to cut emissions globally by close to 90%. And we have to do that as soon as possible. To cut emissions, we will have to build another energy system. We will have to change how we provide each other with heat, light, energy, fuel, goods, food and transport. Those changes will mean physical changes in how humanity works.

The scale of the changes means that we will need a large number of new jobs. If that work is not done, we will not have a new energy system. Promises will not get the job done. Nor will declarations of emergency. Nor will just closing down the oil industry.

Once the work of climate jobs begins, though, we are no longer making promises about the future. Then we will just need to keep doing what we are already doing. That will have an enormous momentum.

We have to do this across the world. It will make no difference to the atmosphere if we only cut emissions 90% in South Africa or Britain, in Chile or Australia. Each of those countries produces a tiny percentage of global emissions. But it will make all the difference if

we win in just one of those countries. Because then the whole world will have an example. A living example to show that people who need work have jobs. A living example to show that we can stop emissions and save the planet. And a living example to show how a determined people can organise and fight to win action.

People will see that example on television. They will visit. Prophets and missionaries will spread out across the world. Everyone will know a dream has become possible.

So, wherever you are, campaign, fight, talk, march, beg, shout. And we will need to keep in touch with each other, across the world, learn from each other. The internet lets us do this in real time. If we have mass movements in several countries, and a breakthrough in one, then it will far easier to break through in the others, and then we will have a cascade.

I am not saying we are bound to win. That would be silly. I am saying we have a chance.

The economic crisis in the world makes that chance stronger. That is the importance of the Green New Deal, and of the other jobs that need doing alongside the climate jobs. There is going to be a lot of suffering. The economic crisis means there is already unemployment, illness, anxiety, emotional torment, hunger, homelessness and lonely fear. There will be a great feeling in many places that something must be done.

Climate jobs and new deals meet that feeling. We have an answer. Something must be done. So let's do this. It's simple. One million new jobs, we say in Britain. Or two million. Twenty million in India, or forty million. Government jobs, now. That's simple, and we know when we have won.

Tactics

There are two questions that people in the climate movement ask me a lot. The first one is what tactics should the movement adopt?

One answer is that anyone who tells you that there is only one tactic that will win is trying to sell you the Brooklyn Bridge. Do not buy it. It's a con.

Any serious, lasting campaign for jobs and climate action will require small demonstrations, vigils, mass demonstrations, human chains, direct action, vehicle caravans, photo stunts, petition drives, music festivals, art festivals, school strikes, union strikes, school occupations, workplace occupations, street occupations,

highway blockades, bank occupations, blockades of immigrant detention centers, marches to the US Embassy, angry mass dancing, disinvestment campaigns, video documentaries, twitter storms, cycle rides, grandparents chaining themselves to railings, children chaining themselves to railings, parades of dogs, songfests, local meetings, zoom meetings, workshops, lectures, silent vigils with candles, religious services, memorial quilt making, blockading government ministers, local election campaigns, national election campaigns, uprisings and general strikes.

The balance of tactics will vary from country to country, and from one point in the struggle to another. Some tactics will have an enormous impact. Some will have less. You cannot be sure which ones will happen, and which ones will be important, when and where.

But some people will want to do some things, and others will want to do other things. Good. The real impact of these actions is the cumulative impact they will have together.

Moreover, every great movement in history has thrown up new tactics, new strategies, new ideas and new institutions. This one will be no different. The question of strategy and tactics is a question that cannot be answered before or outside the struggle. The answer will be found in life and action.

Revolution

The second common question people ask is will it take a revolution to stop climate breakdown. Many of the people who ask this question want to decide on the answer before embarking on the struggle. Either they believe that it is best to work within the system. Or they want to overthrow the system.

But that is not how revolutions happen. There is a lovely passage on the first page of John Womack's classic biography of Emiliano Zapata, the peasant leader of the revolution that began in Mexico in 1910. Womack says he is going to tell the story of a group of small farmers who only wanted to keep their small plots of land. But they discovered that in order to hold that land, they would need to march on Mexico City and upend every form of power in the country. Because they did not want to change, they had to change the world.²²¹

So, if you want a revolution, let me say this. If you make a condition of the struggle that people agree with you about revolution, your struggle will never happen. If you join the climate movement in order

to build for a revolution, and that revolution is more important to you than stopping climate breakdown, people will smell that. It does not smell good.

What I want you to say to people instead is, "Let's stop climate breakdown, and not go to hell. Take my hand, and I'll take yours, and let's start."

And if you are not a revolutionary, and most people are not, what I ask of you is that you not rule out the possibility of a revolution. Because if your bottom line is that we have to stay on side with the powers that be, we will be lost. There are many reasons why. One is that the powers that be will sense it, and they will abuse that trust. They will not blink first.

So let's walk the road together, and keep our focus firmly on stopping climate breakdown, and see what follows.

What You Can Do

If you have been persuaded about climate jobs, what can you do?

The first thing is maybe the most important. Talk with people about climate and about jobs. Great social movements are the result of billions of conversations. Of course, don't browbeat people, don't monologue, do listen and work out what really matters to people.

If this book has persuaded you, please suggest it to other people. We want as many people as possible to read it. That's why we've made it free online.

If there is a climate demonstration anywhere near you, please go. It's good to ask around to see if one other person, a relative, friend or workmate would like to go with you. That will make it more fun for you, and increase the size of the action.

If you are of working age, please join a union. How to do it may be obvious because there is a union at your work. But quite likely there is not. Still, for the great majority of people there is a union in the country that fits your kind of work, often with a branch near you. It's worthwhile joining a union just for some protection at work. But unions are also very important in terms of climate jobs. The idea first came from unions. It fits with the kind of politics many unions have. Historically, unions have been built by people who were fighting for greater causes beyond the workplace – the vote, the welfare state, education, health, socialism, colonial independence and racial equality. Climate is that kind of cause.

But also, unions can go either way. They can be persuaded to back inaction over climate, or to change the world. Climate activists inside unions make a difference to that.

There are other routes to activity. If you are a person of faith, ask around in your temple, mosque or church. Almost all faiths have some kind of national network concerned with climate. Many have local groups, or can tell you how to start one. Or you can just talk to your congregation, and get them on board.

Environmental groups are an obvious route. In many countries they come in all flavours. Pick the one that works for you.

Political parties are another obvious route. So are bird watching clubs. You can also make a difference in an activist group which does not seem to be directly about climate at all. Examples are an LGBT campaign, or a fight to save the local library, or a service delivery protest to get clean water for your neighbourhood. The struggle is many rivers, all feeding one great river.

Jobs

But we are up against the enormous power of the established world. That means we cannot win unless we have the active support of a solid majority of the population. Democracy is not only a value. It's a method that can change the world.

That means we have to believe, and prove to each other, that people can change. To take just one example, we will not have the majority we need in the United States unless an important part of Trump voters support climate jobs. And Putin voters in Russia, and Modi voters in India.

This is a truth that can derail a radical movement. Many people feel it is obvious that in order to win over those people, those voters, we have to change our method to make it more acceptable to them. They will advocate a little more racism, a bit of sexism, a dash of disgust for trans people. They will say compromise is necessary. But compromises won't work. They gut our own side, our belief and trust in each other, our faith in humanity. They earn us no respect. And we have to stay radical on climate. This is because the fires are radical, the storms, the clouds and the droughts. Nature is radical. Physics is radical. Reality does not compromise.

So you have to do a difficult thing. You have to live in the tension of building a radical movement and staying open to people whose politics, and often their life experience, are very different from your

own. How do you do that? The answer is to treat people with respect, no matter how angry you get. People know – deeply know – when you respect them and when you do not. It also means believing that people can change and grow. That they can change their minds because they learn from their experience.

We have to make a wager on humanity. Specifically, we have to bet the planet on humanity. Maybe we're wrong. Maybe it will turn out that people are, at base, selfish, hateful and worthless. Maybe. There is a lot of evidence for that, just as there is a lot of evidence for the converse. Still, we have no choice but to make that wager, and to live our lives as if love matters.

We have to be willing to *be* the government too. Many people in the climate movement are basically anarchists. They say that people in power, in the end, do the bidding of the system of power, because they are managing a piece of the world economic system. This is true.

But the changes we need – the climate jobs and all the regulations which will go with them – will not happen unless a government makes those changes. One theme that has run all through this book is that the details matter. In any climate jobs program there are endless decisions about what forms of power to use for each purpose, how to set building regulations, how much air travel and shipping is possible, and a thousand other details. Governments are complex beasts, and economies even more so. If we push through a general law, and then leave the administration to the usual powers, they will bury the changes in meetings and paperwork and obstruction by detail after detail.

Again, you have to live in a real tension. You must both become the system, and not become the system. How you do that is a problem people have been struggling to solve for a long time. You will have to solve that problem, and I hope I live long enough to see you do it.

I know three things that will help in living through that tension. One is that you will have to build a mass movement to win climate jobs, and all the other jobs. That mass movement will be made up of human beings, who will watch what happens to their dreams. If those people undertake to watch, to discipline, and if necessary to fight the leaders they elected, it will be easier to live in that tension.

The second power you will have is that there will be a million workers in climate jobs, working for the climate service in a country the size of Britain. Or three million in Pakistan. Those people see every day what the work is, what needs to be done, what will stop the

work and what will help. Those people need to be organized, so they can fight together to save the world.

The third power you will have is doing all this internationally. Watching each other, talking to each other, helping each other build, defending each other. We can all try. And if only one succeeds, we will all be empowered. Then there is a chance we can do it.

Other people, other struggles

Another thread runs through this book. It's about looking at each question of reducing emissions and confronting climate destruction and then asking, "how do we build the movement here?"

I have written about building climate movements among small farmers facing drought, among small herders, and among forest people. I have written about solidarity as the counter to the isolated and brutal toxicity of the new mines and dams. And I have written about how crucial solidarity will be in resisting currency punishments of governments attempting to fund new deals.

That's the point of green new deals too, in the wake of a pandemic, and in the knowledge of pandemics to come. The reason environmentalists ought to fight for new deals is that people need jobs, and we, and the people we love, are some of those people. We need the work those jobs will do. But also, new deals are a strong way of reaching out to build a larger, stronger, faster movement. Also, raise your head and look around the world. The forests are on fire. And as I type these chapters at night in an English garden, I keep switching over on my computer to watch a world in motion. In the last two years there have been uprisings, revolts, mass movements, in Hong Kong and Chile, Sudan and Lebanon, Iraq and Syria, Iran and Mali, Guinea and Belarus, the United States and India, Thailand and Yemen. The scale is different, the methods and the demands not always the same. But there are several things most of these movements have in common.

This is a fight for democracy. Where there is dictatorship, people fight for free elections. Where there are elections, they search for real democracy. They reject almost all the old parties. In the streets of Lebanon they chant, "All of them means all of them," – they reject all the old parties. These movements are clearer about what they reject than they are about any alternative. This is because we live now in the ashes of the old dreams of socialism, of communism, and of liberation from colonialism. We know we have been betrayed. But still we search for the path to a humane and human world.

Almost all these revolts are also uprisings against the old prejudices of race, of caste, against indigenous people, against Muslims. In the United States between 18 million and 28 million people had joined the protests in defense of black lives by the end of July, 2020, and almost half those people were white. Something new is moving in the world.

Women are particularly evident in these revolts. A new wave. "You, the police are the rapists," they sing in Chile. "You, the prosecutor. You," they shout, pointing. They mean the police and the prosecutor shield the rapists and the sexual harassers, and thus enable all the rest. "You, president, you are the rapist," they shout pointing. They mean the president of Chile, of course, but also all the other presidents, Putin and Modi, Trump and Merkl, Clinton and Obama, Lula and Xi. All of them, because every system shields the predators among the powerful.

This is something everyone has always known, and been afraid to say. Now people are shouting it in the streets. Something new is alive in the world.

Notice, too, how similar these new movements are to the student climate strikes. The same rejection of all existing leaders, the importance and power of women and girls, the uncompromising insistence on really making a change. Notice in most countries – not everywhere – a far more radical structure of feeling among the people under 30, and more radical yet again among the people under 18. That is the future growing into the world.

Monsters too are alive, and evil walks in daylight. There are gulags in China, and torturers in basements in dozens of countries. People you know, went to school with, work with, maybe love, vote for some leering racist. Armed men and women patrol the borders, and children drown fleeing horrors.

I know all that. But, also. This is a time of great change, a time when the old center cannot hold. For the people who want to save the planet and change the world, this is our time.

**100.000
KLIMAJOBBER
NÅ**

*"100,000 Climate Jobs Now"
Banner on Mayday march
Oslo, Norway*

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What a long strange trip it's been, Nancy, and what a joy.

FUND THE FIRES

*University students banner in Canberra, Australia,
during the summer of massive bushfires in 2020,
demanding that the government properly fund
the firefighters*

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- PART TWO
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My estimates of jobs in backup technologies are based on the following reasoning. For the US, I am allocating 15% of total electricity production to backup energies, and I am assuming that the jobs needed will be 2.5 times the number needed for the same TW hours from wind and solar. For South Africa I am assuming 10% from backup technologies, at the same ratio to wind and solar. For Philippines I am assuming 20% in backup technologies, at a ratio of only 1.5 to wind and solar, on the assumption that plentiful geothermal will be available. This may not work, in which case it would make sense to use more wind and solar.

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My estimates for jobs on the grid in South Africa are in proportion to the US estimates. For the Philippines I have made somewhat higher estimates for the jobs needed on the grid, because it is an archipelago of many islands, which presents special problems.

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About the author

Jonathan Neale is a professional writer of novels, plays and nonfiction. His eleven books include *The Laughter of Heroes* (Serpents Tail, 1993); *Tigers of the Snow* (a history of Sherpa climbers, Thomas Dunne 2002); *A People's History of the Vietnam War* (The New Press, 2003); *What's Wrong with America* (Vision, 2004); and *Himalaya* (Houghton Mifflin, 2004). His books have been translated into Dutch, French, German, Spanish, Greek, Turkish and Korean.

Jonathan's writing on climate change began with *Stop Global Warming: Change the World* (Bookmarks, 2008). Between 2009 and 2015 he edited three editions of *One Million Climate Jobs* for an alliance of the Campaign against Climate Change and six unions in Britain. He also wrote a book-length report on climate jobs and transport for the European Transport Workers Federation and wrote 40,000 words of educational materials for the International Transport Workers Federation.

From 2000 to 2004 he was one of the organizers of the European Social Forum. From 2004 to 2011 Jonathan was international secretary of the Campaign against Climate Change in Britain, where he helped to organize global demonstrations each year. The high point was 2009, where CaCC coordinated demonstrations in over fifty countries.

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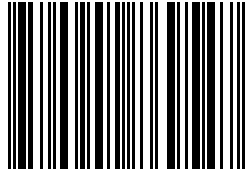
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