How did it come to this? unsustainable global fossil fuel use in historical perspective, 1950-2018

Simon Pirani
Senior Visiting Research Fellow, Oxford Institute for Energy Studies

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This talk is about (1) how did we get into a situation where fossil fuel consumption has grown to the extent that it is causing so much damage? (2) why has it continued to grow, even after the scale of the damage it causes became generally recognised, when in the 1980s science clearly linked it with global warming. The talk is based on a book I have written on the global history of fossil fuel consumption since 1950, Burning Up, which will be published in the summer.

The title refers to “unsustainable global fossil fuel use”. What is “unsustainable”? “Sustainable” is one of those words, like “democracy” and “freedom”, with many meanings. Coal production has always involved the deaths of thousands of mineworkers per year, and air pollution caused by coal burning has caused illness or death for millions of urban residents – and in that sense, it has been unsustainable for a very long time.

The discovery in the 1980s of the global warming effect, and of the causal role of greenhouse gas emissions, made clear that fossil fuel consumption threatens the lives and health not only of coal miners and some urban residents, but of whole nations, through more volatile weather, sea level rise and changes in conditions for agriculture.

This makes fossil fuel consumption unsustainable in a qualitatively new way, and makes the transition away from it necessary and urgent. The history of it matters to anyone who thinks the transition away from fossil fuels needs to happen. Understanding the past helps us look to the future.
1. The overview

This slide shows the level of fossil fuel production globally since 1800, so since the industrial revolution, when the industrial system based on coal burning, and particularly the steam engine, emerged in western Europe. I have marked out two turning points.

1. Around 1870, when fossil fuel production rose sharply, more than doubling between the 1860s and the 1880s. This was the so-called second industrial revolution, when a group of technologies came into use that really expanded fossil fuel use: the steam turbine, the production of electricity, and the internal combustion engine for motor cars. Shortly after that came chemical fertilisers.
fabricated from fossil fuels, a byproduct of poison gas production during the first world war. These technologies of the second industrial revolution still account for most fossil fuel consumption today.

2. The second turning point, around 1950, marks another, even more rapid expansion of the whole system. So in the 1960s, global fossil fuel production was nearly three times the level of the 1940s; and, in the 2000s, nearly seven times. So now, roughly, it takes the world economy three years to consume the same amount of fossil fuels consumed during the whole 19th century.

The context is that there is a limited amount of carbon that can be poured into the atmosphere before global warming hits dangerous levels, the carbon budget. Climate scientists, including people here at the Tyndall Centre, have showed that this budget will be used up by some time in the 2020s, if warming is to be limited to 1.5 degrees above the pre-industrial average, and some time in the 2030s, if warming is to be limited to 2 degrees above the pre-industrial average.

In my view, the hugely expanded level of fossil fuel consumption since the mid 20th century fits with the concept advanced by earth systems researchers of a “great acceleration” in late 20th century of the impacts of human activity on our ecological surroundings. This acceleration is seen as part of a new geological epoch, the Anthropocene, which is characterised by the fact that the impact on the natural world by humans operates at the same scale as the most powerful natural forces. I think this is a useful way to look at it.

This slide shows the consumption of commercially traded energy products over the last half century. It includes small rows showing the use of hydro and other renewable energy, and nuclear fuel, but nine-tenths of this is fossil fuels: the bottom half in blues is the OECD (rich countries), the top part in reds and yellows is the countries outside the rich world.

The marker shows 1992, when all the world’s governments gathered at the Rio summit and acknowledged that global warming was a threat that had to be dealt with by reducing fossil fuel consumption. Consumption growth not only continued after that, it accelerated.
Next question: what are the drivers of consumption growth?

In the front sections of the reports by the Intergovernmental Panel on Climate Change (IPCC), it states that population growth and economic growth are the main drivers. I want to put a case that that is wrong, that while there is a clear causal relationship between economic growth and fossil fuel consumption growth, the influence of population growth is only indirect, and mediated by other factors. This is because, although individuals are sometimes the final consumers of fossil fuels, and often of products made with fossil fuels, most of these fuels are consumed as they make their way through technological systems, such as electricity networks, industrial systems, or urban infrastructure.

The graphs show that there is no direct correlation between fossil fuel consumption growth and population growth.

In China, the world's largest consumer of energy, energy use has long grown faster than population. Early 2000s it accelerated, not because of an increase in population but because of an increase in industrial activity.

We also know from research in India that the addition of hundreds of millions of people to the electricity networks in developing countries causes far less extra fossil fuel consumption than the growth of urban industry and higher consumption by urban residents.

In the USA, the second largest consumer of energy and historically the largest until a few years ago, energy use increased more rapidly than population over long periods, but fell due to the oil price shock in the 1980s and due to financial crisis in the late 2000s.

There is correlation between economic growth and fossil fuel consumption growth. So then we should break down what is meant by economic growth, and look at how fossil fuels are consumed in the course of economic activity, and the technologies through which they are consumed.
2. Technological, social and economic systems

First, let’s consider the dominant technological systems. This slide shows the categories that researchers use, to show the changing forms of energy in the technological systems dominant in society. The point is that energy changes form – and is “consumed” as we non-scientists would say – throughout the technological systems.

I have put two common examples on the slide. 1. Oil (primary energy) is refined into petrol (secondary energy), and turned by a car engine into motive force (useful energy). This provides an energy service, getting from place to place. 2. Coal is burned in a power station, that produces electricity and heat, those are delivered via networks to people’s homes to produce light and heat. The energy service provided is illumination and warmth.

The research of energy flows through systems itself has a history.

In the 1970s, after the oil price shocks and under the influence of environmentalism, researchers began to focus on the relationship of energy services with forms of energy that supplied them, and on opportunities for conservation. They showed that the energy services required (e.g. keeping someone’s home warm) are often not most efficiently provided by the technological systems that had been developed (e.g. a centralised network supplied by a big coal-fired power station). In that example, because of the physical limits on power station efficiency, around half the energy in the coal was, and still is, lost in producing electricity.

Researchers who followed the flow of energy through systems in this way have highlighted that only a small proportion of fossil fuels are consumed directly by individual households. Another important direction taken by research in the 1990s was to distinguish “discretionary” and “non-discretionary” consumption.

For example if I turn the lights on in my home, that is discretionary consumption; I have control over it. But there are many other aspects of electricity consumption over which I have no control: from the way the streets nearby are lit, including the egregious use of electricity to light office blocks or for advertising hoardings, to the way electricity is used for public infrastructure and in industry, and to the losses and inefficiencies in the network.

It is noticeable that research on this distinction is all too often pushed into the background, partly because it disrupts narratives that focus on consumers’ individual responsibility.
The phrase “roads not taken” was used by Amory Lovins, a 1970s pioneer of energy conservation. The point is: energy systems and industrial processes that were not just energy intensive but wasteful have proliferated, and engineers have always understood what was wrong with them.

The first quote on this slide relates to waste inherent in car manufacture in the 1950s in the USA, due to the annual model change and the trend towards heavier vehicles. More fuel and materials were used, and billions of dollars more were spent. The energy service provided (getting from place to place) stayed the same, the profits earned by car makers and oil companies rose. This trend did not abate the 1970s oil price shock, and fuel efficiency improvements were pathetic in comparison with the technological possibilities.

The second quote is about the use of centralised electricity where other forms of energy would do.

The third quote is about the waste inherent in overcapacity in industry.

The last quote concerns the failure to deploy energy-efficient technology, in this case the sort of technology that we all now have on the phones in our pockets, which could transform electricity distribution, reducing overall demand and giving people more control over their electricity use.

For a historian, the question is: why are technologies employed in the way that they are. The answers are mainly economic and social – cost, including the relative costs of energy and labour; market dynamics that encourage energy profligacy; and so on.
The technological systems that consume fossil fuels are embedded in social and economic systems, in which people work and live. These systems have expanded in particular ways in the period since the second world war, and these are the fundamental drivers of greater fossil fuel consumption. The most important aspects of this expansion have been:

- Industrialisation, which has, in particular, expanded beyond the rich countries.
- Changes in the labour process and the introduction of new technologies have driven fossil fuel consumption. Above all the proliferation of industrial materials manufacture.
- Electrification.
- Urbanisation. Cities, with the type of buildings and infrastructure that modern cities have, use far more energy per capita than the countryside.
- Motorisation.
- Household material consumption and the growth of consumerism. Large-scale personal material consumption, which had been confined to tiny social elites until the early 20th century, was by the middle of the 20th century a significant phenomenon for parts of the rich-world population, and by the end of the 20th century, parts of the population outside the rich countries too.
Another important point about the supply of fossil fuels and other energy carriers is that it is done commercially. Fossil fuels, and other energy carriers such as electricity, have been commodified, i.e. have become commodities traded in the market. This way of providing fuels to people has spread along with the spread of capitalist economic relations through the 19th and 20th centuries.

People may take this way of doing things for granted, but note that in mid 20th century more than half the world population lived outside this commercial energy system, mainly in the countryside outside the rich world. Their main fuels were firewood and other materials collected from their natural surroundings, almost always by women and children walking many kilometres per day. The commercial energy system has expanded massively in the past half century, but even now more than one billion people live outside it, and about 1.5 billion live on the edges of it, with incomplete access to commercial fuels, mostly in cities outside the rich world.

On the slides, the green blocks show people without electricity access, which is more or less a proxy for those entirely outside the commercial energy system. The orange blocks are people with partial access, i.e. they have some electricity but still cook with biomass, almost always in poor areas of cities outside the rich world. The left hand graph is the world population, and shows a massive expansion of this inbetween group in the last 20 years. The right hand graph shows Africa, where the majority of the population still has no electricity.

There is a further distinction within the commercial energy system, between fuels, electricity and heat that are commodified, and those that are supplied as a state benefit, either free or at reduced prices. In the 19th century, as rich-world towns became populated with working people, governments very often decided that electricity was a basic necessity that should, like water, sewage and health services, be provided cheap or free.

As the labour movement developed, it usually promoted the idea that such services belonged to working people as of right. Particularly in the case of electricity, its whole history has been characterised by conflicts in many countries between working people who want it as of right, and corporations who see it as a commodity. Towards the end of the 20th century, as hundreds of millions of people outside the rich world have moved away from the countryside into towns, we have seen many conflicts around electricity, in which those people have demanded it for free or even found ways of stealing it, and companies have tried to compel them to pay for it.
This slide is a reminder of the inequalities inherent in the commercial energy system. They show the volume of fuels exported from Nigeria in the form of crude oil (the right-hand columns of the three pairs), compared to the fuels consumed domestically (the left-hand columns). Throughout the last half century, a greater quantity of energy has been exported in the form of crude oil (the black bars) than is used domestically. And what is used domestically is mostly hydro and other renewables, which in Nigeria’s case is 99% biofuels collected from the countryside.

3. Chronologies

The 1950s-60s: post-war boom

- Infrastructure developed in wartime played a crucial role
- The USA was completely dominant
- Roads, electricity, industry went to Europe
- Rich world populations acquired cars
- Household consumption grew
- Appliances substituted for domestic labour, but the didn’t reduce hours

There were two big overarching trends in the 1950s and 1960s. 1. Consolidation in the USA of the fossil fuel-consuming systems established before the war, and their consolidation, or expansion, or introduction, in other rich countries. The economic dominance of the USA, and the development of
fossil-fuel-based infrastructure there during the war, were an important part of this. 2. the rise of oil. This did not mean the decline of coal; it meant that oil use, particularly for transport, rose even more rapidly than coal use.

It is worth highlighting two big areas of consumption: road-based transport, and households.

On roads and cars, the state support given to the development of a car-based transport system in the USA was a key factor. In the 1950s, the interstate highway system (funded directly by the state) cost more than four times as much as the Marshall Plan (the US aid programme for post-war reconstruction in Europe), and more than seventy times as much as investment in rail transit in the same period. The highway infrastructure went together with suburbanisation and the undermining of public transport systems. There was a strong relationship between government and car makers, who were the epitome of corporate lobbyists, weakening all types of regulation, and also the pioneers of planned obsolescence in marketing. One noticeable feature of the political history of fossil fuel consumption is the bitter battle in the USA over fuel efficiency, in which the car manufacturers have been almost completely successful.

In households, the appliances that most households in the USA acquired before the war – gas cookers, electric irons, sewing machines, radios, vacuum cleaners and washing machines – became widespread in other rich countries.

The introduction of such appliances is one of the most profound ways in which people's lives have been changed by the diffusion of fossil-fuel based energy systems. Social historians have researched these changes, and their findings deserve reflection.

In particular, these appliances enabled energy to substitute for labour. Washing machines and vacuum cleaners, for example, eased some of the most back-breaking household tasks. But as with all technologies, the changes they bring are never unilateral or straightforward. While the physical nature of domestic work in rich countries has been eased, the length of time it takes has not, and there is a body of research showing that the hours that women spend on domestic labour have hardly fallen. This was partly because the new technologies not only eased old tasks, but also made new ones possible.

The same is true of fossil-fuel based technologies in industry, of course, the introduction of which have apparently never led to a reduction of working hours.

<table>
<thead>
<tr>
<th>The 1970s</th>
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<td>“Energy crisis” is a meaningless term. There were two oil price shocks (1973, 1979). They caused:</td>
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<td>■ a real crisis for developing-world oil importers;</td>
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<td>■ an oil price adjustment for rich nations;</td>
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<td>■ crises of perception and policy.</td>
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**Fossil fuel consumption, 1972-1985, mtce**

- OECD Oil
- OECD Gas
- OECD Coal
- Non-OECD Oil
- Non-OECD Gas
- Non-OECD Coal

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The 1970s was a turning point: the end of the long post-war boom and the consistently high rates of economic growth in the rich countries. It’s very commonly claimed that the end of the boom coincided with, or was even caused by, an “energy crisis”, but I think that is a meaningless term.

There were two oil price shocks, in 1973 when the price rose four-fold almost overnight, and again in 1979 when it was pushed upwards by the Iranian revolution and other events, while the world market was moving away from contract sales to spot sales.

There was a real crisis for developing countries that imported oil and had to borrow millions of dollars to pay the bills. This was a key cause of the 1980s debt crisis.

There was a crisis that was much less real for rich-world consumers, i.e. individuals, corporations and governments, who had to adjust to higher petrol prices but no genuine shortages.

Finally there was a crisis of perception and policy. Governments realised that oil supplies really were not unlimited, or cheap. Serious political attention began to be paid to energy conservation, and serious funds made available to research it.

The 1980s: crises and oil price shocks

- Consumption is still overwhelmingly in the “global north”
- Efficiency gains and conservation gains. But some of these were reversed after oil prices fell in the mid 1980s
- The discovery of global warming in the late 1980s proves to be a turning point

In the 1980s-90s, the OECD countries (= the rich countries, with less than one quarter of the world population) continued to account for most consumption (62% in 1980, falling to 58% in 2000). But there were big changes in their economies that changed the way that fossil fuels were consumed.

- There were substantial efficiency gains. In the rich countries, energy used per unit of economic output fell by one quarter, in a decade (from the mid 70s to the mid 80s). That continued in the 1990s. But most efficiency gains were achieved by exporting energy-intensive industries, such as the production of steel, cement and aluminium, to the global south.

- With globalisation and financialisation, structure of economy changed and types of work changed. It became more likely that people in rich world would work at a computer than in a factory. These computers were not as energy-efficient as was claimed.

- The nature of work, and nature of personal consumption, changed in other ways. There was a sustained attack on wages and unions in the 1980s, but generally wage levels rose a little in 1980s-90s, partly because people worked longer hours. Fossil-fuel intensive technologies played their part in these changes in people’s lives: the use of cars continued to rise, along with new labour-saving appliances such as freezers, dishwashers and microwaves. This is the start of the takeaway culture,
and also of the throwaway culture – goods, especially electronic goods, that are cheaper to replace than to fix. These were the drivers of higher personal consumption – trends that were shaped socially, not because people are greedy.

In the mid to late 1980s, there was another important turning point: the discovery of global warming, and the consensus reached among scientists on the causal role of fossil fuel consumption and other types of economic activity. This opened the way for the recognition by governments of the urgency of addressing the problem.

Electricity production is of central importance to this story. In 1950, one-tenth of the world’s fossil fuels were used to produce electricity; today, it is one third of a much larger total. In the 1980s and 1990s, fossil fuel consumption starts growing, much faster but from a much lower base, outside the OECD. One element is the wave of electrification that began in the 1960s and 70s but accelerated in the 80s and 90s. In my book I have looked at trends across a series of developing countries. Some conclusions:

- In most countries outside the rich world, the state saw electrification as a development priority. As for the countryside, private corporations have never electrified it anywhere, not even in the USA.

- In the USSR and China, as well as capitalist countries, electricity for industry and agriculture was prioritised over households.

- In the 1990s the IMF and World Bank pushed so-called market reforms that sought to privatise electricity assets and liberalise markets.

These reforms (i) mostly produced hybrid systems, not the textbook model advocated by champions of privatisation and so-called liberalisation; (ii) the reforms made far less of a contribution to electrification than direct state investment did; and (iii) the reforms actually slowed electrification down in some of the poorest countries.

- Social hierarchies shaped electrification. To take the example of India, urban and rural elites, i.e. industrialists and farmers, very often pressured governments to undertake electrification to serve their economic interests. The quality of electrification for the poor often depended on social movts being organised to support it.
In the 1990s, policy is in the foreground. At the 1992 Rio summit, governments formally acknowledged the dangers posed by global warming. The challenge to the historian is to understand the significance of, and the reasons for, the collective failure of the world’s states to act. To the extent that the state, and international bodies, claim to represent the interests of society as a whole, it amounts to a crisis of statehood and of their legitimacy. Some key issues include:

- The main battle at the summit was around the proposal for binding targets for reducing greenhouse gas emissions. The USA, its hegemony enhanced by the dissolution of the Soviet Union in 1991, worked successfully to block any binding targets.
- The USA advocated voluntary targets, to be achieved through market mechanisms, and these were codified in the 1997 Kyoto protocol. Over the last 20 years, (a) the Kyoto approach made no impact on global level of emissions, and (b) where the voluntary targets were achieved, they were caused not by the treaty but, for example, by the 2008 economic crisis, or the massaging of figures through the sale of permits to pollute under the treaty.
- Clearly neoliberalism, which was in its heyday, played a role. Governments and their officials, and international agencies, all under pressure from business interests, put far more effort into so-called “opening up markets” and “rolling back the state” than to addressing the climate issue.
- What role was played by climate science denial? I think it should not be overestimated. By the late 1990s, most of the oil companies had largely dropped their overt support for denial and switched to “greenwashing” tactics. Denial continues to today, and remains very dangerous, but it was not the only or even the main factor in the failure of the Rio process.
- The predominant political view in European powers, and US Democrats, was to accept the science, but insist the issue be addressed through market mechanisms. This approach far more politically influential than climate denial. In 1997, the US Senate reiterated its opposition to binding targets unanimously (the vote was 95 to 0): this was an alliance of denialist Republicans and marketeer Democrats.
- A good measure of governments’ commitment to reducing global warming, and of the success of the Rio process, is the level of subsidies to fossil fuels, which began to be accurately studied by NGOs in the 1980s. World Bank estimate (1992) was $230 billion/year; these increased steadily during the 1990s, and very sharply in the mid 2000s when oil prices rose.
The Rio process was also influenced by the accusation levelled against rich-country governments that they were refusing to take historical responsibility for the damage their countries had done. One trick they played, and are still playing to some extent, is to highlight deforestation, rather than fossil fuel use, as a priority. This cartoon appeared in an Indian environmentalist publication to comment on that.

Social movements in countries such as India increasingly saw their fight for social justice as closely linked to the fight against global warming. They adopted strategies to unite these aims. To my mind this is a very hopeful phenomenon.

In the 2000s, consumption growth accelerated. This was principally driven by the Chinese industrial boom – and you can see on the slide how commercial energy use in China increased, and China overtook the USA to become the largest user.
Much of this fuel consumption was for the production of energy-intensive goods for export, such as steel, aluminium, cement and some manufactured goods.

There was a boom of coal consumption, in China and also in other countries outside the rich world. And there were increases in fuel use in the rich world too, particularly of electricity.

This final slide puts into perspective claims that we are just about to turn the corner on the road away from fossil fuels. These claims are false. The red line shows fossil fuels as a proportion of total commercial energy use. The big reduction, from 94% to around 87% came in the 1970s and 1980s due to the expansion of hydro power and nuclear. There has been a smaller reduction by roughly a further 2% since the mid 2000s, thanks to renewables.

But the economy is still dominated by fossil fuels, consumption is still growing, and the transition away from them has hardly begun.

4. Conclusions

- Fossil fuel consumption since 1950 expanded much more rapidly than before, and in a qualitatively different way – part of a “great acceleration”.
- Fossil fuels are consumed by and through technological, economic and social systems. Interpretive frameworks that isolate consumption from these systems, and/or isolate consumption from production, are misleading.
- Individuals consume in the context of these systems.
- Economic expansion has driven consumption, through specific trends: industrialisation, changes in the labour process, urbanisation, motorisation, electrification and growth of mass material consumption and consumerism.
- Fossil fuels and electricity are exchanged as commodities – or (particularly electricity) provided as a state benefit. A large chunk of humanity remains outside, or on the edges of, the commodified energy system. Energy systems reflect inequalities, in this way and other ways.
The discovery of global warming (1980s) provided an imperative for transition away from fossil-fuel based energy systems. Carbon budgets imply short timescales.

Transition is not only a technological issue. Energy-intensive technologies have been privileged over less energy-intensive ones, and fossil fuels over renewables, for social, political and economic reasons.

Technologies, including non-fossil energy technologies, have to be diffused. This takes time. Investment in e.g. renewables is good; ideologised claims that a “breakthrough” is therefore imminent are bad.

The UNFCCC process has since Rio (1992) made no progress in reducing fossil fuel consumption. Governments’ indifference in practice to UNFCCC aims can be measured e.g. by the high and rising level of subsidies for fossil fuels since then.

Proposals (e.g. at Kyoto) to use market mechanisms as an impetus for change have failed. The limited progress made on efficiency and non-fossil technologies has mostly been due to government regulation and state-directed investment.

There are no easy formulas for hastening transition. The best prospects lie outside the Rio process. Radical technological change should be considered together with radical social and economic change.

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Are fossil fuels history? In one sense, yes. In another sense, not yet – not by a long way

simonpirani@gmail.com / www.simonpirani.com

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Burning Up: 
a Global History of Fossil Fuel Consumption
By Simon Pirani (August 2018, Pluto Press)

More information here
Can be ordered from the publisher’s web site here or from Amazon here