The Political Economy of Climate Change:
Challenges for Muslim Societies and the World

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It is an honor to be here to present the inaugural Keith Griffin Lecture.

I'd like to begin on a personal note. It is not an exaggeration to say that it is thanks to Keith that I became an economist. When I decided to pursue postgraduate studies, almost four decades ago, my most important criterion in deciding where to apply was to find the scholar whose work I most admired, and to try to go wherever that person was located. That person was Keith Griffin, and he happened to be an economist at Oxford.

I knew of Keith above all through his classic book, *The Political Economy of Agrarian Change,* an analysis of the so-called 'Green Revolution' in agriculture – the introduction of highly fertilizer-responsive varieties of rice and wheat in developing countries. In the early 1970s I had worked as an agricultural advisor in Bihar, India, and in the mid-70s my wife Betsy and I had lived in a village in Bangladesh, gathering people's stories for a book on the causes of poverty and hunger. These experiences taught me a lot about the central role of inequalities of wealth and power in explaining how the world functions and malfunctions. They also primed me for appreciating Keith's deep insights into how the political and economic influence of dominant landowning classes bent and often distorted the path of agrarian change.

So I wrote to him saying I wanted to study under his supervision. If Keith had been an anthropologist, or sociologist, or historian, I would have chosen that discipline. But he was an economist, and so, for better or worse, I became one, too. At Oxford not only did he prove to be an exemplary mentor, but also he and Dixie became wonderful friends to Betsy and me, a bond that continues to this day.

So it is a true pleasure as well as a great honor to be with you today. The title of my lecture borrows deliberately from that of Keith Griffin's book on agrarian change. I want to share some thoughts about the political economy of climate change, and what promises to be the greatest technological revolution of the 21st century: the transition from fossil fuels to clean energy.

By 'political economy,' I mean the analysis of how scarce resources are allocated not only among competing ends – which is the textbook definition of economics today – but also how scarce resources are allocated among competing people – competing individuals, groups, and classes. So I will pay attention to questions of *who* as well as *what*, to the winners and losers, in both the fossil-fueled economy of the past and the clean energy economy of the future.

Mindful of our venue, I will illustrate with examples from Muslim societies, but the themes apply also to the political economy of climate change worldwide.

Fossil fuels: benefits and beneficiaries

To begin, let us review the distribution of benefits and costs – wins and losses – during the fossil fuel era that dawned with the Industrial Revolution and is now entering its twilight.

On the benefit side of the scales, we can identify three broad groups of winners: consumers, who benefited from cheap and plentiful energy; producers, who profited by supplying it; and rentiers, who profited by securing property rights to the world's reserves of oil, natural gas, and coal.

Consumers

A first approximation of who benefited as consumers can be obtained by looking at satellite images of the world at night.

[Figure 1]

The consumption of electricity serves as a visible proxy for consumption of fossil fuels; the two are not identical, but they are highly correlated. As we can see, some parts of the world – Europe, North America, East Asia – shine brightly, while others remain in the dark. When it comes to responsibility for climate change, sub-Saharan Africa pleads not guilty.

A similar pattern emerges when we look at data on cumulative carbon dioxide (CO_2) emissions since the advent of the Industrial Revolution.

[Figure 2]

Six countries – the United States, China, Russia, Germany, the UK, and Japan – together account for about 60% of the cumulative emissions; in contrast, the 55 countries of Africa together account for only 3%.[1]

If we define consumption more rigorously, on the basis of where goods and services produced by using fossil fuels are consumed, rather than where their initial production takes place, the share of responsibility borne by the world's high-income countries increases further. About 13% of China's emissions, for example, come from producing goods for export to other countries. And counting the 'embodied carbon' in imported goods, U.S. emissions are about 14% higher than the numbers would otherwise indicate.[2]

Of course, countries themselves are heterogeneous entities – a point that Keith Griffin has always emphasized. Within any given country, not everyone benefits equally from the consumption of fossil fuels and of the goods and services produced and distributed using them.

Three broad generalizations can be made about how fossil carbon use (aka 'carbon footprints') vary within countries:

- First, carbon use rises with income for the simple reason that richer people tend to consume more of just about everything, including fossil fuels.

- Second, as a percentage of household incomes, in high-income countries the poor tend to spend more on fossil fuels than do the rich. Hence policies that increase the price of fossil fuels have a regressive impact, hitting the poor harder than the rich as a percentage of their income.

- Third, in low-income countries, we often find the reverse situation: the rich tend to spend more on fossil fuels as a percentage of their incomes than do the poor. In other words, in these societies fossil fuels are more a luxury than a necessity.

The last point is less widely recognized (and less well-documented) than the first two. To illustrate it, we can look at data from Indonesia, Pakistan, and Bangladesh – the most populous of the world's predominantly Muslim societies.

[Figure 3]

Stratifying their rural and urban populations into quintiles (each comprising 20% of the people), ranked from poorest to richest, and charting their expenditures on 'modern energy' (here taken as a proxy for fossil fuels), we find that households spend higher fractions of their income on fossil fuels as they move up the income ladder. This implies that in these countries, policies that raise the price of fossil fuels would have a progressive impact on income distribution – hitting the rich harder than the poor not only absolutely, but also as a percentage of their incomes – the opposite of the situation in high-income countries.

Producers

Turning to the second set of beneficiaries from fossil fuels – the producers, the private and state-owned corporations that profit from the extraction, processing and distribution of oil, natural gas, and coal – we find some familiar names. Among the world's top ten corporations in the latest Fortune Global 500 rankings, five are in the fossil fuel business: Sinopec, China National Petroleum, Royal Dutch Shell, BP, and Exxon Mobil.[3] The number would be higher if the rankings included firms that do not publish their financial data, including Saudi Aramco, which is often reported to be the world's most profitable corporation.[4]

If we look at cumulative emissions since the middle of the 19th century, we find that the top 10 firms alone accounted for more than 20% of the total, and that the top 20 accounted for almost 30%.

[Table 1]

How did benefits of fossil fuels to producers compare to benefits to consumers? In terms of overall magnitudes, I do not know of any studies that carefully weigh them against each other. But in terms of benefits to individuals on a per capita basis, there can be no doubt that shareholders and senior executives of these fossil fuel firms would top the beneficiary pyramid. It is not surprising, therefore, that these corporations have been the main funders of efforts to delay climate protection legislation and, in their most extreme variant, to deny the reality of human-caused climate change altogether.[5]

Rentiers

The third and final category of fossil fuel beneficiaries are the rentiers, those who hold property rights to oil, gas, and coal reserves. For the most part, the reserves belong to governments rather than to private firms. Worldwide, roughly 90% of oil and gas reserves and two-thirds of coal reserves are state-owned.[6]

The market price of crude fuels is normally higher, often far higher, than the cost of extracting them from the ground. The difference is what economists call 'extractive rent.' Governments capture part or all of this rent by means of royalties, lease arrangements, signature bonuses on contracts, and taxes.

The World Bank has calculated the magnitude of fossil fuel rents by fuel type and by country. Extractive rents typically are higher for oil and natural gas than for coal. Worldwide, oil and gas account for about 90% of the total rent from fossil fuels (whereas they account for only 55% of the carbon dioxide emissions from fossil fuels).

[Table 2]

Predominantly Muslim countries receive about 65% of the world's total fossil fuel rents. The importance of these rents in an individual nation's economy can be gauged by comparing them to its GDP. By this measure, a number of countries are highly dependent. Topping the list are Kuwait and Iraq, where fossil fuel rents amount to about 52% and 43% of the country's GDPs, respectively.

[Table 3]

Governments use these rents in a variety of ways, some more beneficial to their people than others. One common use is the sale of fuel in domestic markets at highly subsidized prices, a practice that benefits individual members of the public in proportion to their fuel consumption.[7] For this reason, the subsidies benefit the rich more than the poor, at least in absolute terms, because they consume more, but at least some of the benefits 'trickle down' to the populace at large.[8] Other uses of extractive rents, including state expenditures on political repression and corruption, may make many of their people worse off rather than better off, a variant of the perverse phenomena known in the economics literature as the 'resource curse.'

The end of the fossil fuel era will bring an end to these rents. For countries that have been highly dependent on them, the adjustment may be neither smooth nor easy.

Fossil fuels: costs and victims

On the cost side of the scales, we can identify two broad categories of people who have been harmed by fossil fuels: first, the victims of relatively short-run adverse effects such as contamination of the air, land, and water and propagation of violent conflicts; and second, beginning more recently, casualties of climate damages such as more extreme heat waves and more intense cyclones. The latter group includes future generations, who will experience the suffer the environmental legacy of the fossil fuel era long after it has passed. These two categories differ in that the first is more proximate in time and space to the production and use of fossil fuels, whereas the second is more distant in both dimensions.

Proximate casualties: pollution and conflict

The extraction, processing and combustion of fossil fuels has many harmful environmental impacts apart from climate change. In and around sites of resource extraction, we find polluted waters and poisoned lands. Well-known examples include the contamination from oil spills in the Niger Delta in Africa and the headwaters of the Amazon in South America; and, in a case at the intersection of environmental degradation and violent conflict, the extraordinary 1991 oil fires in Kuwait.[9] In and around fuel processing sites, such as oil refineries, we find toxic air and soils poisoned by heavy metals.[10]

The combustion of fossil fuels releases not only carbon dioxide, the most important greenhouse gas, but also many other hazardous pollutants, including sulfur dioxide, nitrogen oxides, and particulate matter. The World Health Organization estimates that outdoor air pollution is responsible for roughly 3 million premature deaths annually worldwide, many of which can be traced to the use of fossil fuels. These adverse impacts can be mitigated, but not eliminated, by the use of pollution control technologies. Mortality rates from air pollution generally are highest in low and middle-income countries, but dirty air is a major killer even in upper-income countries.

[Table 4]

Within countries, low-income and minority communities often bear disproportionate risks from air pollution – a pattern known as environmental injustice. In Delhi, India, for example, the poor not only live in more polluted neighborhoods, but also spend more time working outdoors, including along arterial roadways where air pollution loads are most extreme. At the same time, they cannot afford to protect themselves with air conditioners or air purifiers.[11] And when they fall ill from respiratory and other diseases caused by pollution, they are less able to access health care. The relationship between minority status and pollution exposure in Delhi is not well-documented, but the poverty rate among Muslims in Delhi is almost double the city's average.[12]

Documenting the links between fossil fuels and violent conflict is less straightforward, and hence more controversial. A complex phenomenon like war can seldom be reduced to single causes. That said, it is plausible to suggest that the violent conflicts of recent decades in the Middle East, and their terrible human toll, are not wholly unrelated to the region's crucial role as a supplier of oil.[13]

Climate casualties

As the accumulation of greenhouse gases in the atmosphere begins to destabilize the Earth's climate, a new category of people harmed by fossil fuels is emerging: those who are vulnerable to phenomena such as sea-level rise, increased storm intensities, prolonged droughts, and heat waves.

In general, these impacts will be most severe in low-income countries, by virtue of both their locations and their limited adaptive and coping capacities. In a recent ranking of countries by overall risk from climate change, low-income nations in sub-Saharan Africa constitute 16 of the top 20.

[Figure 4]

The rankings change somewhat when adjusted for coping capacity: sub-Saharan African nations now make up 17 of the top 20, the other three at greatest risk being Bangladesh, Afghanistan, and Myanmar.[14]

[Figure 5]

Again, it is important to recognize the heterogeneity within countries: some people are more vulnerable than others. We saw this in the U.S. in 2005 when Hurricane Katrina hit New Orleans: low-income residents – in particular, African-Americans – accounted for most of the casualties, in part because they lacked the means to escape as the deadly storm approached.[15] Similarly, when a 2015 heat wave claimed more than 1,000 lives in and around Karachi, Pakistan, most of the dead were poor, elderly, or both.[16] These experiences illustrate the grim truth that vulnerability to disasters, however natural or unnatural their provenance, is highly correlated with social and economic status.[17]

The total magnitude of human costs that climate change will impose on future generations worldwide is a great unknown, not only due to the limits of present scientific knowledge but also to uncertainties as to how, and how quickly, the world will respond to this threat. Average surface temperatures today already are about 1 °C above pre-industrial levels.[18] The Intergovernmental Panel on Climate Change (IPCC) has issued projections that incorporate both scientific and policy uncertainty.

The IPCC scenarios – dubbed 'Representative Concentration Pathways' or RCPs – include one considered likely (albeit not certain) to hold the increase in global average surface temperature to 2 °C above its pre-industrial level, and another showing the impact of high emissions in the absence of serious mitigation policies. In the latter scenario, 'RCP8.5,' more memorably dubbed 'the Highway to Hell' by economist Frank Ackerman, the average temperature is expected increase by a further 3.7 °C by the end of this century.[19]

[Figure 6]

At first blush, a few degrees may not seem like all that much. After all, we regularly experience such temperature swings in the course of a single day. But it is important to realize just how finely tuned humans and other living things are to the average climate conditions that have prevailed not only in our own lifetimes but throughout the history of our species. A recent IPCC report concludes that with only 2 °C overall warming (that is, only 1 °C more than has already taken place), Karachi and parts of India could experience temperatures like those of deadly 2015 heatwaves every year.[20]

To put the IPCC scenarios in perspective, the last time the Earth experienced a global average surface temperature 3.5 °C above pre-industrial levels (that is, 2.5 °C above today's) was about 3.2 million years ago, in the mid-Pliocene epoch. There were large geographical variations in the extent of warming then as compared to now, with the difference being about three times bigger at high northern latitudes. Global sea level was at least 6 metres higher than today, and possibly 20 metres higher.[21]

Human societies evolved much later, within a relatively narrow and recent slice of time. The oldest cave paintings date from about 40,000 years ago. Agriculture originated about 10,000 years ago. Going back to the Pliocene is not an outcome that any reasonable person can contemplate with equanimity.

The clean energy revolution: mitigation

As the steep price of climate disruption becomes more visible and more widely understood, the balance of power that underpinned the fossil fuel era is starting to shift. In the past, the benefits of fossil fuels to consumers, producers, and rentiers – coupled with their power – were sufficient to outweigh their costs to the accompanying victims of pollution and violent conflict. But as climate casualties enter the picture, and as an ethic of responsibility to future generations becomes more widely shared, the scales are tipping. Today we stand at the threshold of the clean energy revolution. Indeed, I would venture to say that at this point the question is not whether the world will turn away from fossil fuels, but when, and how quickly, we will do so.

This revolution, like the Green Revolution analyzed by Keith Griffin, will be shaped profoundly by political economy. The distribution of its benefits and costs, and the relative power of those to whom they accrue, will affect both the pace and shape of the clean energy transition. Some features are predictable, but others still are very much up for grabs. The distribution of gains and losses will be determined by choices we make today and in coming years.

In looking ahead, it is useful to distinguish between the two realms that are called, in climate policy-speak, ‘mitigation’ and ‘adaptation.’ Mitigation refers to efforts to reduce the scale of climate disruption, above all by phasing out the use of fossil fuels. Adaptation refers to efforts to cope with the climate disruption that we have not headed off, not mitigated. In this final part of my talk, I will offer a few thoughts on both.

The political economy of mitigation is in some respects simply the inverse of the political economy of fossil fuels. Those who are harmed by fossil fuels, in the present as well as future generations, stand to benefit from mitigation. Those who gain from fossil fuels as consumers, producers and rentiers stand to lose those benefits. But the pattern and extent of these losses will depend on the design of mitigation policies.

A central political economy challenge in climate policy design is how to peel away some of the opposition to mitigation from beneficiaries of fossil fuels, by converting them instead into prospective beneficiaries of the clean energy transition. There are a variety of approaches to this problem, differing above all in which opposing interests they seek to convert. What all of these strategies have in common is the aim of shifting the balance of power between the winners and losers from mitigation, so as to tip the scales in favor of the former without waiting for the mounting costs of climate change eventually to do the job.

Cap-and-trade v carbon dividends

Consider, for example, two policies for curbing fossil fuel use that have been discussed in the United States: cap-and-trade and carbon dividends. Both policies would limit – put a cap – on the quantity of fossil carbon entering the nation’s economy, most of it from domestic production of coal, oil and natural gas. The cap would tighten every year, and annual carbon permits would be issued up to this limit. This would increase the price of fossil fuels, akin to what happened in the 1970s when OPEC cut the supply of oil.

In a cap-and-trade system, the carbon permits would be issued free-of-charge to corporations, allocated amongst them by a formula based on historical baselines. In this case, the recipients of the free permits would pocket the money paid in higher prices by consumers of fossil fuels, bringing them windfall profits.

In a carbon dividend system, permits would be auctioned rather than handed out for free (or, equivalently, carbon would be taxes at a rate keyed to emission targets). The cost of the permits would become part of the price of fossil fuels, so the extra money paid by consumers ends up as auction (or carbon tax) revenue. This money is then recycled as equal dividends to every person in the country. Because all receive the same dividend regardless of their own use of fossil fuels, everyone has an incentive to reduce carbon footprints. And because expenditures are skewed to upper tail of the distribution, the majority of households – including most low-income and middle-class households – would come out ahead in simple pocketbook terms, receiving more in dividends than they pay in higher fuel prices, a feature that could help build durable public support for the policy.[22]

The same political-economy logic applies in every country. Indeed, the positive net impact of a carbon dividend policy on the majority of consumers would be even stronger in countries like Indonesia, Bangladesh and Pakistan, where low-income families spend less on fossil fuels not only in absolute terms but also as a percentage of their incomes. In other words, national carbon dividend policies would turn the majority of consumers everywhere into financial winners from a policy that phases out fossil fuels, without even counting their benefits from a more stable climate.[23]

Back in 2009, when competing cap-and-trade and carbon dividend bills had been proposed by legislators in Washington, DC, I participated in a conference telephone call with policy advocates to debate their relative merits. Cap-and-trade proponents insisted that giveaways to the corporations were needed to win support from the fossil fuel lobby. 'What about support from the people?' I asked. In the weary tone of a political insider explaining the facts of life to an armchair academic, one of them replied that on Capitol Hill it is the corporate lobbyists who control votes, not the public. To this I responded, 'Let us assume a democracy.' This was met by hearty laughter from the others on the call.

Cap-and-trade proponents won the backing of the Democratic Party's leadership, but in the end their *realpolitik* calculations proved to be ill-founded. It was true, of course, that corporate lobbyists preferred the windfall profits of cap-and-trade to the egalitarian revenue distribution of carbon dividends. But better yet, in their eyes, would be no climate legislation at all. In the end, the cap-and-trade bill died in the Senate and they got their wish.

I tell this story to illustrate the broader point that the design of mitigation policies will matter greatly for the distribution of gains and losses in the clean energy transition. In my view, it makes more sense to allocate the revenue from carbon pricing so as to safeguard the household incomes of the majority of the population rather than trying to bribe fossil fuel corporations into supporting a policy that will consign their business to history's dustbin. The windfall profits the corporations would reap from cap-and-trade are not small potatoes, but against these they will weigh the value of assets that will be stranded, written down or written off, in the clean energy revolution. These include not only reserves left underground, but also capital sunk into the production, distribution and use of fossil fuels.[24]

For this reason, it will be difficult, if not impossible, to devise a mitigation policy that fossil fuel lobbyists will prefer to the no-mitigation alternative. It is straightforward, on the other hand, to design a policy that yields net monetary benefits for most consumers. Of course, we cannot simply 'assume a democracy.' But in the end, carbon dividends may prove to be a more feasible solution to the political economy of climate mitigation than cap-and-trade.

Goodbye to extractive rents

The loss of extractive rent from fossil fuels – and the value of carbon assets stranded underground – is more relevant to governments than to corporations because, as noted earlier, they hold most of the reserves. But unlike the fossil fuel corporations that wield a lot of influence in the corridors of power in major fossil fuel consuming countries like the U.S., and use that influence to try to defer mitigation policies, rentier governments have relatively little power to alter the pace of the world's clean energy transition. The phase-out of fossil fuels as a result of decisions taken in the major consuming countries will confront them with a *fait accompli*.

How the loss of extractive rent will be distributed across fuels, and across countries, will be an important issue in international political economy in the decades ahead. From the standpoint of efficiency – in a scenario in which the rates at which different fossil fuels are phased out are guided simply by their costs of production and the benefits of mitigation – it is estimated that limiting the increase in global temperature to 2 ℃ above the pre-industrial level will mean that about 88% of the world's coal reserves, 52% of the world's natural gas reserves, and 35% of the world's oil reserves are unburnable. In the cases of oil and gas, many of these reserves are located in the Middle East.[25]

[Table 5]

The magnitude of unburned reserves and their allocation across countries again will depend on policies, in this case on decisions reached by international negotiators and individual nations in coming years. However the details are resolved, the prospect of stranded reserves underscores the importance of economic diversification in countries that have relied heavily on fossil fuel rents.

A just transition for workers

One other group that should be considered in discussing the costs of mitigation is the labor force in the fossil fuel sector. Investments in energy efficiency and renewable energy generally are more labor-intensive than investments in fossil fuel production, as Robert Pollin and colleagues at the Political Economy Research Institute in Massachusetts have documented.[26] In the United States, solar power already employs more than twice as many people as coal production.[27]

[Table 6]

In fossil fuel-importing countries, the positive net impact of the clean energy transition on demand for labor is augmented by the fact that activities like insulating buildings and installing solar panels use a higher share of domestic labor as opposed to labor overseas. But the workers who obtain employment in the growing clean energy sector are not necessarily the same workers who lose jobs in the declining fossil fuel sector. Hence an important policy issue, from the standpoint of fairness as well as forging a winning coalition to support for climate mitigation, is how best to assist these workers by promoting what in the U.S. is nowadays termed a 'just transition.' Studies suggest that the costs of this transitional assistance will be modest, far below the costs of either climate disruption or clean energy investments.[28]

In fossil-fuel exporting countries, on the other hand, the clean energy transition could lead to net job losses. Losses in the energy sector itself could be exacerbated by the contraction of public spending and private consumption financed by fossil fuel rents. In countries that rely heavily on imported labor, the resulting employment impacts could spill across national borders. In the United Arab Emirates, for example, immigrants – mostly from India, Bangladesh and Pakistan – comprise as much as 90% of the private workforce.[29] It is time to think about what a 'just transition' would mean for them, too.

The clean energy revolution: adaptation

Adaptation has received less attention than mitigation in discussions of the political economy of climate policy. This is likely to change in coming decades, as the impacts of climate disruption ever more apparent and ever more painful.

One thing can be predicted with near certainty: the resources available for adaptation will fall short of needs. An early warning sign can be seen in the shortfalls in resources for the Green Climate Fund, established in the wake of the 2009 Copenhagen climate conference as a vehicle for international assistance to developing countries for adaptation and mitigation. At the time, industrialized nations pledged to provide $100 billion per year to the fund by the year 2020, but actual commitments to date amount to only $3.5 billion.[30]

Adaptation will raise profound questions not only of how to allocate scarce resources among competing ends, but also of how to allocate scarce resources among competing people. Policy makers will be forced by circumstances to decide on the criteria by which to make these choices.

The 'efficiency' criterion of neoclassical economics offers one prescription. Resources should be allocated to yield the biggest bang for the buck – the maximum net benefit – with the size of the 'bang' measured in monetary terms. The devil is in the latter detail, how benefits are to be measured. How should we weigh the value of protecting human lives against the value of protecting real estate? How should we weigh the value of lives in high-income countries against the value of lives in low-income countries?

The conventional practice in neoclassical economics is to use market valuations whenever available, and quasi-market valuations based on 'willingness to pay' when market prices do not exist. In the shadow markets of cost-benefit analysis, as in real-world markets, the wants of the rich carry more weight than the needs of the poor, for the simple reason that the rich have more money with which to back up their wants. They have greater willingness to pay, by virtue of their greater ability to pay. Their houses are worth more than the houses of the poor, so the efficiency criterion dictates that society should spend more to protect them. The same logic can be applied to human lives, an extension that provoked outrage in the 1990s when *The Economist* magazine leaked a memorandum signed by Lawrence Summers, then chief economist of the World Bank, claiming that 'the economic logic of dumping a load of toxic waste in the lowest-wage country is impeccable and we should face up to that.'[31] Climate disruption is simply a new type of toxic waste.

A very different criterion for the allocation of scarce adaptation resources is the protection of public health, based on the ethical principle that every person – rich and poor, man and woman, black, brown and white – has an equal right to a clean and safe environment. By this criterion, the lives of farmers in coastal Bangladesh are 'worth' as just much as those of people living on the coasts of North America, and just as deserving of protection from sea-level rise and storm surges.

What criterion will prevail in climate change adaptation – or the weights given to multiple criteria – has yet to be determined, or for that matter even widely debated.[32] The consequences of the choices we make will be profound, and for some could be deadly.

Concluding remarks

To recap, the fossil fuel era was underpinned by a political economy in which the benefits to consumers, producers, and rentiers, coupled with their power, were sufficient to prevail against the victims of fossil-fueled pollution and conflict and the casualties of long-run climate disruption.

Today, the balance of power is shifting against fossil fuels in favor of clean energy. This technological revolution is being propelled, above all, by growing realization of the threats posed by climate change, and by growing acceptance of the ethical principle that we have a duty to safeguard the world for our children, grandchildren, and those who follow.

Much will depend, however, on how quickly the world moves to phase out fossil fuels. Both the pace of the clean energy revolution and the distribution of its costs and benefits will be shaped by political economy. In this lecture, I have reviewed some of the key issues.

The pace of the clean energy revolution can be accelerated not only by continuing to build public awareness of the costs of climate disruption – a task in which nature itself will assist – but also by building political alliances with victims of the short-run environmental and social costs of fossil fuels. The fact that these costs are near-term and localized may help to surmount the myopia and international collective action difficulties that have impeded effective responses to the threat of global climate change.

Building durable public support for mitigation also will require careful attention to how its costs are distributed among consumers, producers, and rentiers. In the case of carbon pricing, which most economists agree must play a crucial role in advancing mitigation, I have suggested that carbon dividend policies that return most of the revenues to the public can be helpful in this respect. In every country of the world, national carbon dividend policies would ensure that the majority of consumers are net monetary winners from policies that restrict the supply of fossil fuels and thereby raise their price, quite apart from benefits to the environment.

It would be far-fetched, I believe, to imagine that an effective mitigation policy can be devised that will secure genuine backing from fossil fuel corporations and their lobbyists, compared to the alternatives of ineffective policies or none at all. The political challenge, in my view, is not to co-opt these parties but to defeat them.

For countries that depend heavily on fossil fuel rents, including many in the Middle East, the clean energy revolution will mean that they can no longer rely on extractive wealth. These countries will have little choice but to adapt to this new reality. Forward-looking leaders will do all they can to prepare for this day by investing their remaining extractive rents in ways that help diversify their economies and advance human well-being.

For countries that are most vulnerable to global climate change, including those at greatest risk from sea-level rise and storm surges, such as Bangladesh and Indonesia, and those at greatest risk from heat waves and drought, such as Pakistan and many African nations, a crucial question will be how to secure funds for adaptation investments and disaster response. Even as the attention of national and international policy makers focuses on the urgent task of mitigation, they need – we all need – to think seriously about how and for whose benefit adaptation resources will be allocated. Our moral obligations, I believe, extend not only to future generations but also to our fellow members of the present generation whose lives and livelihoods are today at greatest risk.

Thank you very much.

Notes

[1] Carbon Dioxide Information Analysis Center data, accessed 17 September 2018 at http://www.columbia.edu/~mhs119/CO2Emissions/Emis_moreFigs/. These numbers refer to gross emissions. If, instead, we were to measure emissions net of reabsorption by the Earth's carbon terrestrial and oceanic carbon sinks, allocating rights to the latter on the basis of population, the international picture would look even more unequal. See Anil Agarwal and Sunita Narain, *Global Warming in an Unequal World.* New Delhi: Centre for Science and Environment, 1991.

[2] Daniel Moran, Ali Hasanbeigi and Cecilia Springer, 'The Carbon Loophole in Climate Policy: Quantifying the Embodied Carbon in Traded Products,' Climate Works Foundation, August 2018. Accessed on 17 September 2018 at https://buyclean.org/media/2016/12/The-Carbon-Loophole-in-Climate-Policy-Final.pdf.

[3] Ranked by 2017 revenues. Source: http://fortune.com/global500/list/, accessed 19 September 2018.

[4] Bloomberg News, 'The Aramco Accounts: Inside the World's Most Profitable Company, 13 April 2018. Accessed on 19 September 2018 at https://www.bloomberg.com/news/articles/2018-04-13/the-aramco-accounts-inside-the-world-s-most-profitable-company.

[5] See, for example, Robert J. Brule, 'The Climate Lobby: A Sectoral Analysis of Lobbying Spending on Climate Change in the USA, 2000 to 2016,' *Climatic Change* (2018), 149:289-303; and Kathy Mulvey and Seth Shulman, 'The Climate Deception Dossiers: Internal Fossil Fuel Industry Memos Reveal Decades of Corporate Disinformation.' Union of Concerned Scientists, July 2015. Accessed on 19 September 2018 at https://www.ucsusa.org/sites/default/files/attach/2015/07/The-Climate-Deception-Dossiers.pdf.

[6] Carbon Tracker, 'Unburnable Carbon 2013: Wasted Capital and Stranded Assets,' London: Grantham Institute on Climate Change and the Environment, London School of Economics, 2013, p. 14. Accessed on 19 September 2018 at http://carbontracker.live.kiln.digital/Unburnable-Carbon-2-Web-Version.pdf.

[7] See, for example, Philip Bagnoli, Jean Château and Yong Gun Kim, 'The Incidence of Carbon Pricing: Norway, Russia and the Middle East,' *OECD Journal: Economic Studies*, 2008.

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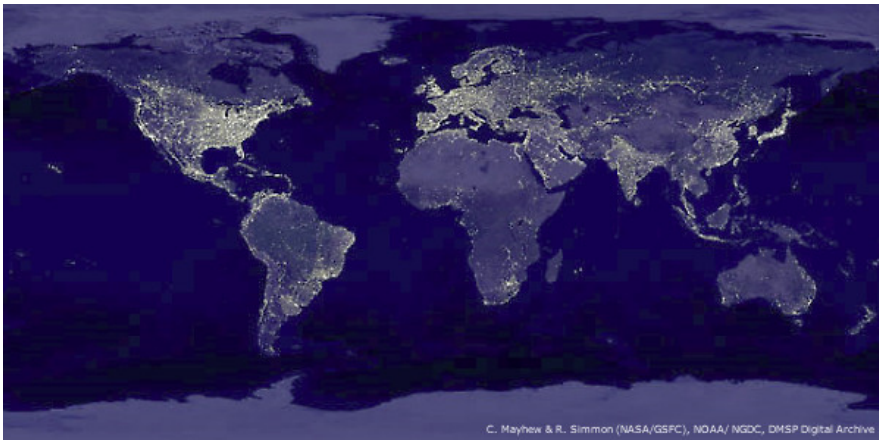
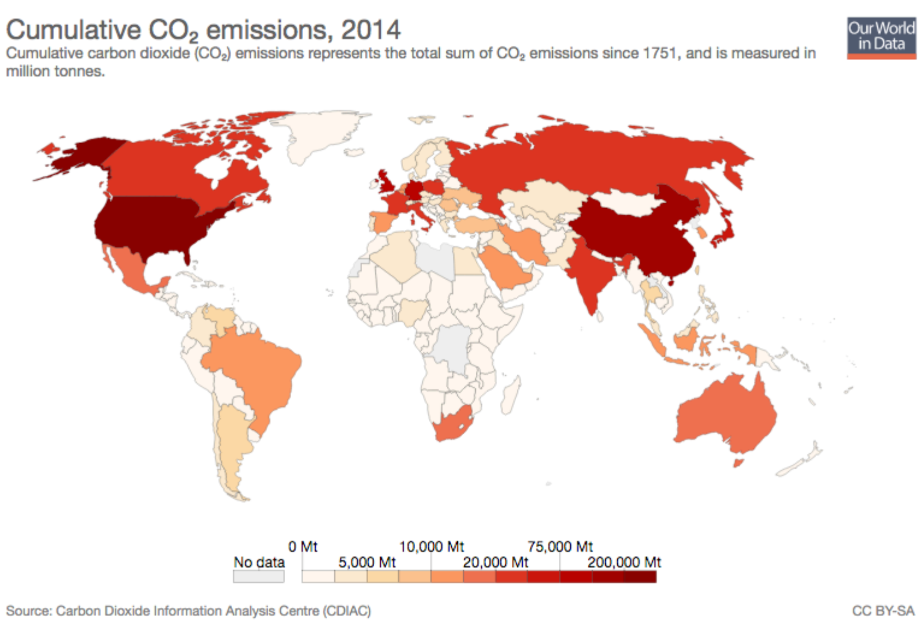
Figure 1. Earth at night



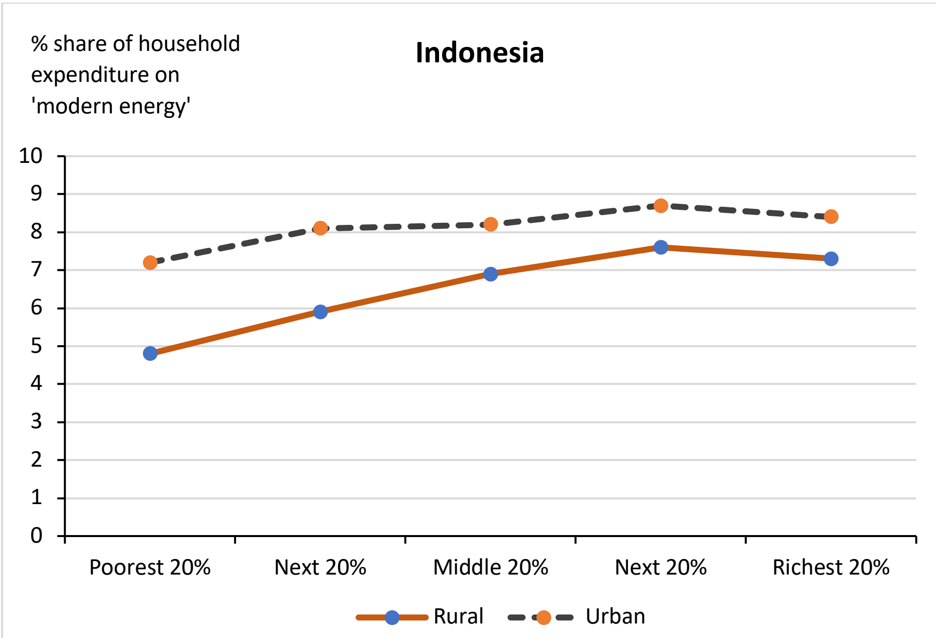
Source: NASA.

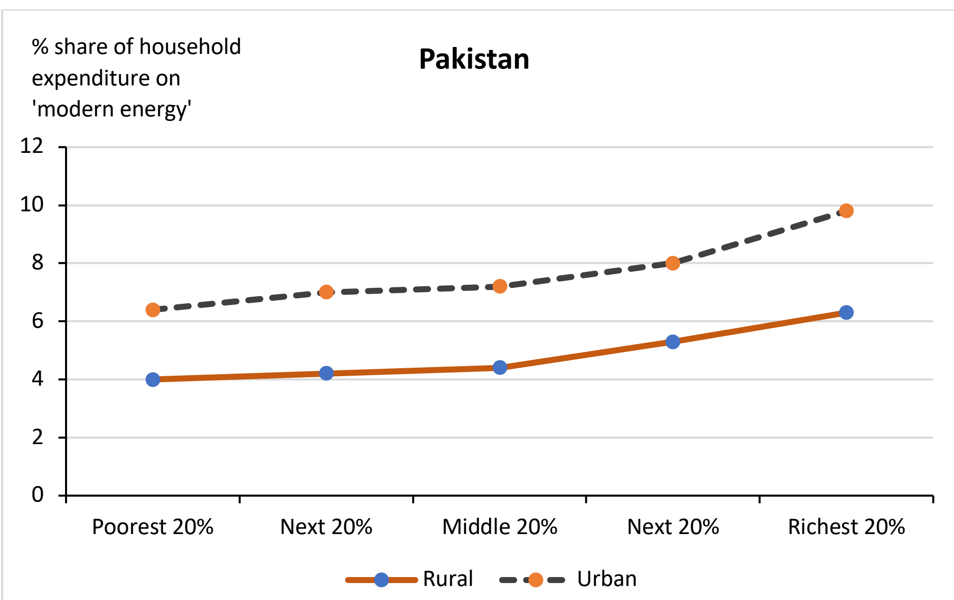
Figure 2. Cumulative CO2 emissions

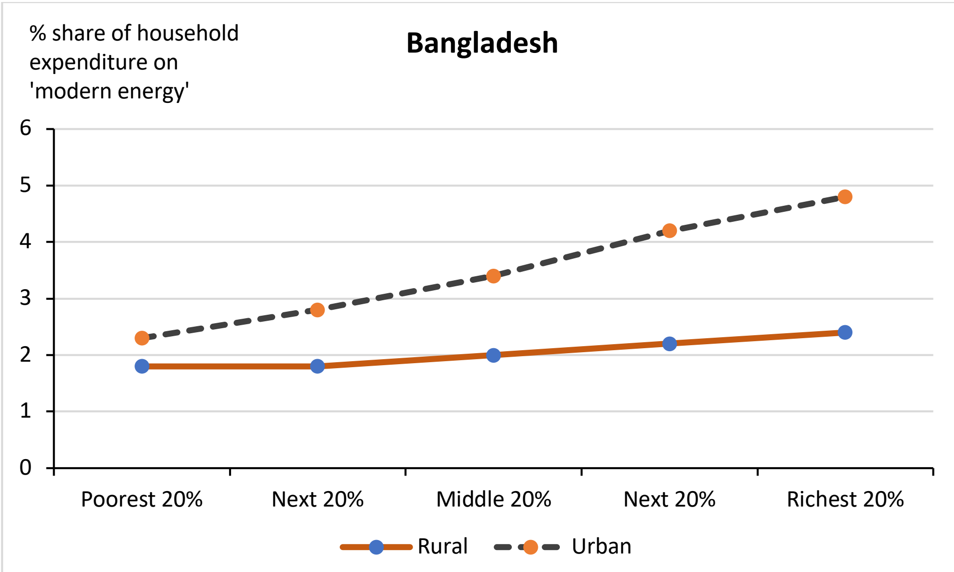


Source: Hannah Ritchie and Max Roser (2018) 'CO_2 and other Greenhouse Gas Emissions.' Published online at OurWorldInData.org.

Figure 3. Modern energy as percentage of household expenditures

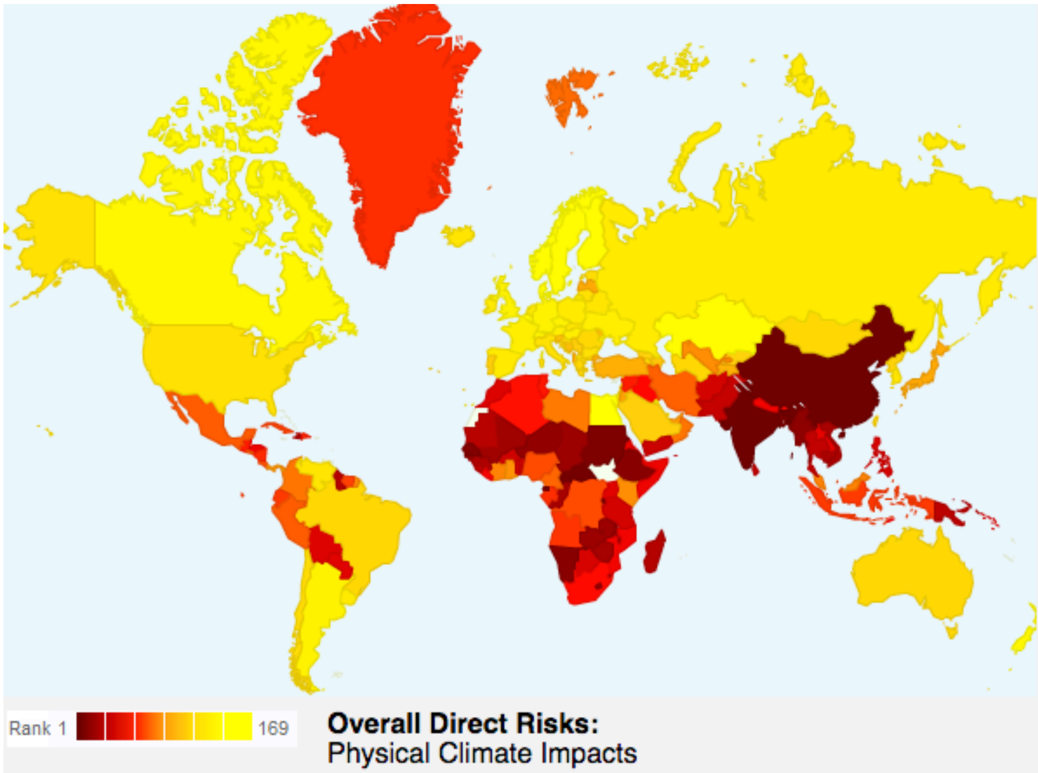






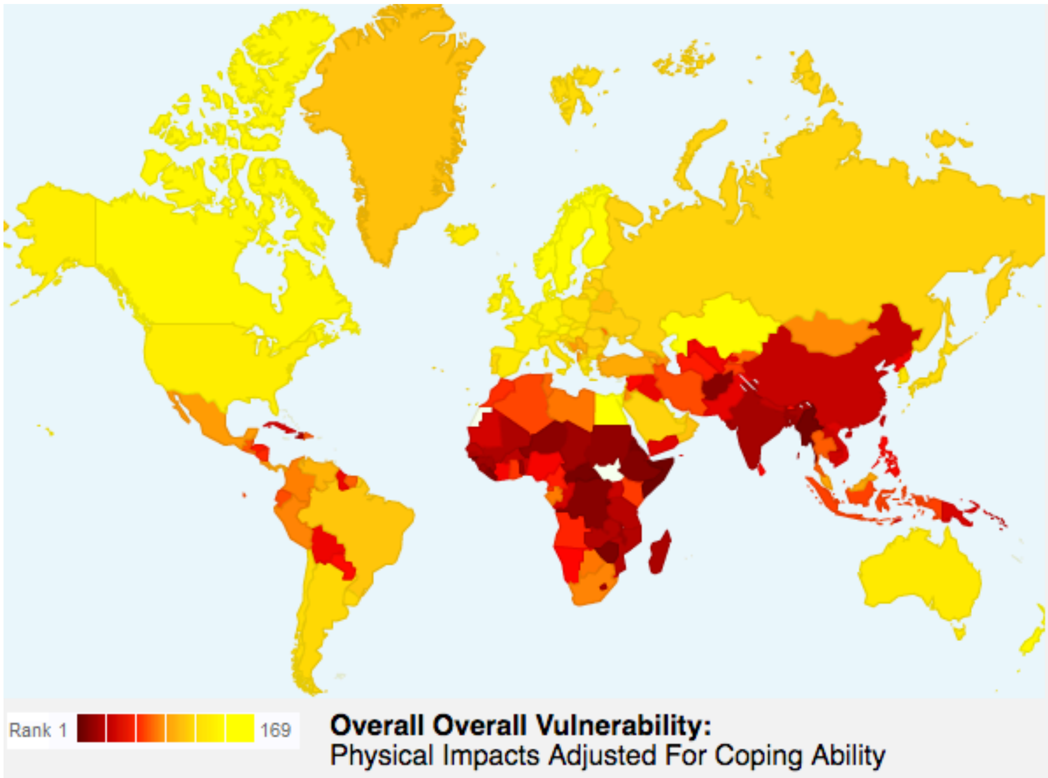
Source: Based on data in Robert Bacon, Soma Bhattacharya and Masami Kojima, *Expenditure of Low-Income Households on Energy.* World Bank, June 2010, Tables 3.5 & 3.6.

Figure 4. Climate Change Impacts by Country: Overall physical risks



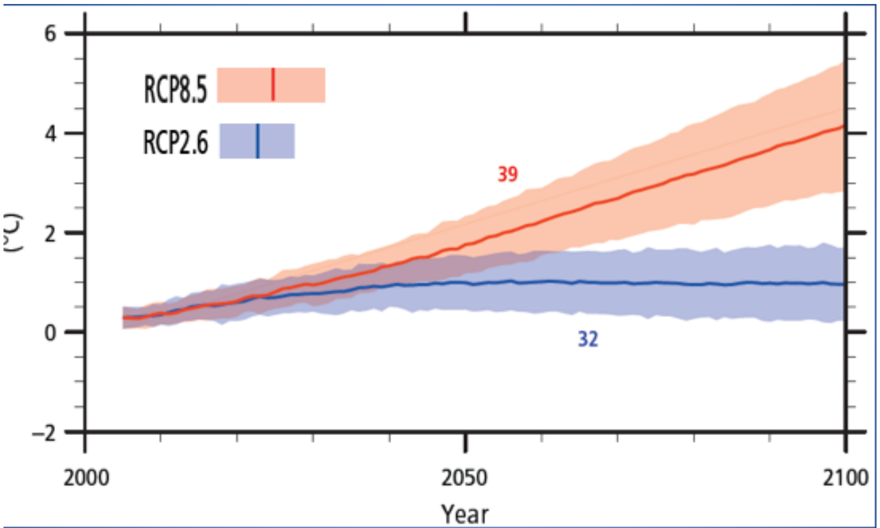
Source: Center for Global Development, 'Mapping the Impacts of Climate Change,' accessed 20 September 2018 at https://www.cgdev.org/page/mapping-impacts-climate-change.

Figure 5. Climate Change Impacts by Country: Overall vulnerability adjusted for coping capacity



Source: Center for Global Development, 'Mapping the Impacts of Climate Change,' accessed 20 September 2018 at https://www.cgdev.org/page/mapping-impacts-climate-change.

Figure 6. Global temperature increase scenarios



RCP8.5 = high 'baseline scenario.'
RCP2.6 = scenario aimed to hold 'likely' warming above pre-industrial level to 2 ℃.
Shaded area = 95% confidence interval.

Source: IPCC 2014 *Synthesis Report: Summary for Policy Makers,* p. 11.

Table 1. Shares of cumulative carbon dioxide and methane emissions, 1854-2010

Table 3 Top twenty investor- & state-owned entities and attributed CO_2 & CH_4 emissions

Entity	2010 emissions $MtCO_2e$	Cumulative 1854–2010 $MtCO_2e$	Percent of global 1751–2010
1. Chevron, USA	423	51,096	3.52 %
2. ExxonMobil, USA	655	46,672	3.22 %
3. Saudi Aramco, Saudi Arabia	1,550	46,033	3.17 %
4. BP, UK	554	35,837	2.47 %
5. Gazprom, Russian Federation	1,371	32,136	2.22 %
6. Royal Dutch/Shell, Netherlands	478	30,751	2.12 %
7. National Iranian Oil Company	867	29,084	2.01 %
8. Pemex, Mexico	602	20,025	1.38 %
9. ConocoPhillips, USA	359	16,866	1.16 %
10. Petroleos de Venezuela	485	16,157	1.11 %
11. Coal India	830	15,493	1.07 %
12. Peabody Energy, USA	519	12,432	0.86 %
13. Total, France	398	11,911	0.82 %
14. PetroChina, China	614	10,564	0.73 %
15. Kuwait Petroleum Corp.	323	10,503	0.73 %
16. Abu Dhabi NOC, UAE	387	9,672	0.67 %
17. Sonatrach, Algeria	386	9,263	0.64 %
18. Consol Energy, Inc., USA	160	9,096	0.63 %
19. BHP-Billiton, Australia	320	7,606	0.52 %
20. Anglo American, United Kingdom	242	7,242	0.50 %
Top 20 IOCs & SOEs	11,523	428,439	29.54 %
Top 40 IOCs & SOEs		546,767	37.70 %
All 81 IOCs & SOEs	18,524	602,491	41.54 %
Total 90 carbon majors	27,946	914,251	63.04 %
Total global emissions	36,026	1,450,332	100.00 %

Source: Richard Heede, 'Tracing Anthropogenic Carbon Dioxide and Methane Emissions to Fossil Fuel and Cement Producers, 1854-2010,' *Climatic Change* (2014) 112:229-241.

Table 2. Rents by fossil fuel type

FUEL	RENT		EMISSIONS	
	US$ billion	%	billion mt CO_2	%
Oil	720.6	77.7	11.2	34.8
Natural gas	106.5	11.5	6.4	20.0
Coal	100.6	10.8	14.5	45.2

Sources: Rent (2016) from World Bank, *World Development* Indicators; emissions (2015) from International Energy Agency, *CO_2 Emissions from Fuel Combustion*, 2017, pp. 94-103.

Table 3. Fossil fuel rents as share of GDP: top 20 countries (2010-2016 average)

Rank	Country	%
1	Kuwait	51.8
2	Iraq	43.0
3	Saudi Arabia	39.2
4	Congo, Rep.	39.1
5	Oman	37.7
6	Qatar	30.2
7	Angola	29.9
8	Equatorial Guinea	28.4
9	Turkmenistan	27.3
10	Gabon	26.1
11	Azerbaijan	25.6
12	South Sudan	22.7
13	United Arab Emirates	21.8
14	Iran, Islamic Rep.	20.0
15	Algeria	18.7
16	Chad	18.1
17	Brunei Darussalam	17.7
18	Kazakhstan	15.5
19	Libya	14.6
20	Trinidad and Tobago	13.6

Source: Calculated from data from World Bank, World Development Indicators.

Table 4. Premature Deaths from Outdoor Air Pollution, 2012

	Premature deaths	Death rate (per 100,000)
China	1,033,000	76
India	621,000	49
Russia	141,000	98
Indonesia	62,000	25
Pakistan	59,000	33
Ukraine	55,000	120
Nigeria	47,000	28
Egypt	44,000	51
United States	38,000	12
Bangladesh	37,000	24
Turkey	34,000	44
Japan	31,000	24

Source: World Health Organization, *Ambient Air Pollution: A Global Assessment of Exposure and the Burden of Disease.* Geneva: WHO, 2016, Annex 2.

Table 5. Geographical distribution of unburnable reserves

	World		**Top regions**		
Oil	449	38%	Middle East	264	38%
(billion barrels)			C & S America	63	42%
Natural gas	100	52%	Middle East	47	61%
(trillion cubic metres)			Former Soviet Union	36	59%
Coal	887	88%	USA	245	95%
(gigatons)			Former Soviet Union	209	97%

Source: McGlade & Ekins *Nature* 2015.

Table 6. Job gains from investing in clean energy

	Jobs per $1 million investment		Net gains from investing 1.5% of GDP in clean energy	
	Clean energy	Fossil fuels	Jobs	Share of labor force
Brazil	37.1	21.2	395,000	0.4%
China	133.1	74.4	6,400,000	0.6%
South Africa	70.6	33.1	126,000	0.7%
United States	8.7	3.7	650,000	0.5%

Source: Robert Pollin, *Greening the Global Economy,* Cambridge, MA: MIT Press, 2015. Tables 6.1 and 6.2.