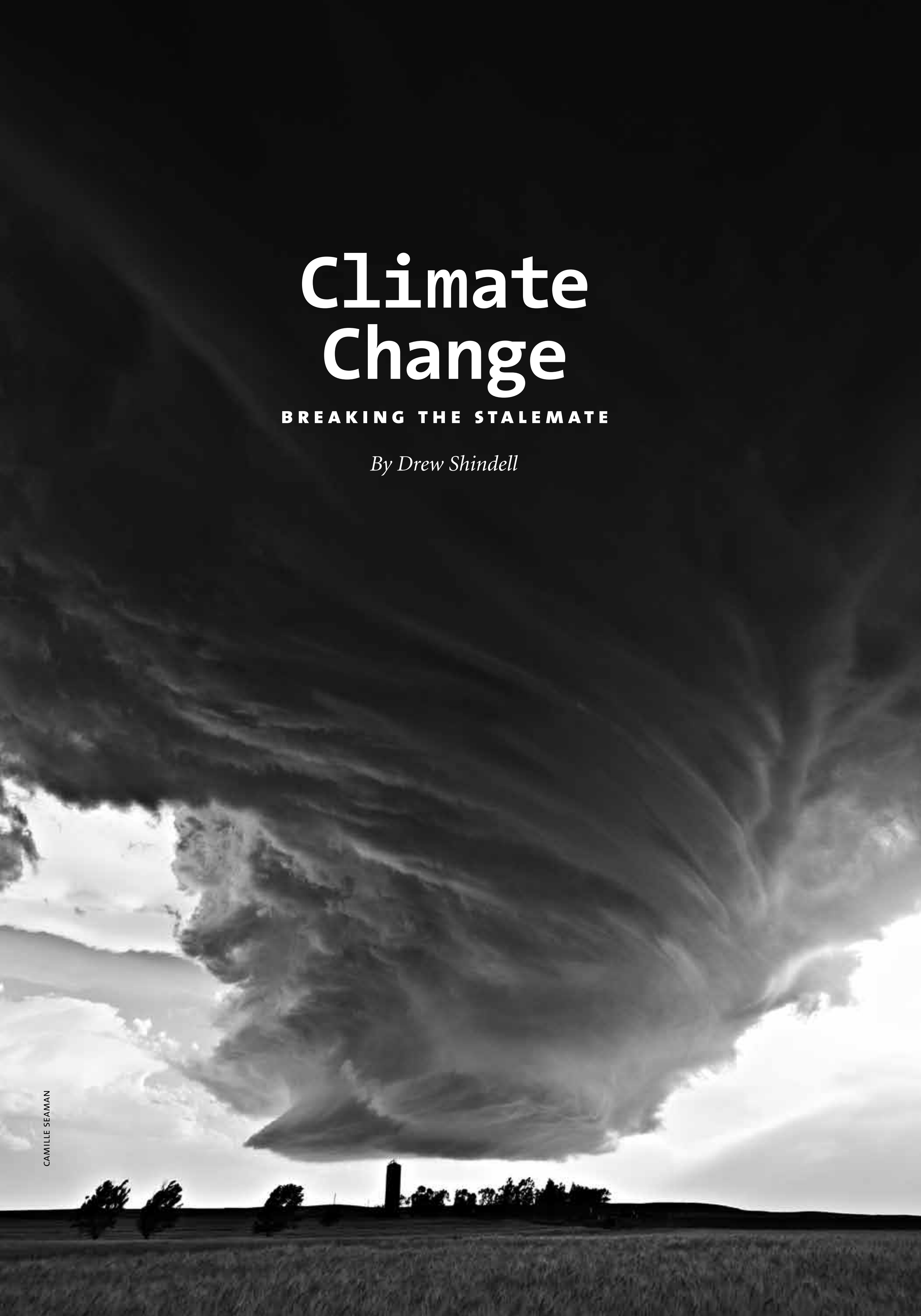

Climate Change

BREAKING THE STALEMATE

By Drew Shindell

CAMILLE SEAMAN

The key to containing human-induced climate change in the long run, everybody who's paying attention knows, is the reduction of carbon dioxide emissions. But policymakers face daunting political obstacles in asking people — and, probably more relevant, whole industries — to make sacrifices today in order to offer a better life to future generations.

That doesn't mean we can afford to ignore CO_2 emissions, but it does suggest the advantages of also focusing on emissions of other potent sources of warming, whose containment would yield a quicker payoff and face less opposition in both developed and developing countries. Indeed, once the differences between CO_2 containment and containment of other climate warmers are better understood by the public, the latter should prove much easier to sell.

WHERE WE STAND

While the worst effects of climate change may be many decades away, warming is a problem here and now. The area covered by snow during June in the Northern Hemisphere has decreased by about two-thirds since the early 1980s. The seasonal minimum Arctic sea-ice area has decreased by a third over this same period. Roughly a quarter of all land areas now routinely have summer mean temperatures that would have been in the top 2 percent before global warming.

Rainfall patterns are already changing, too, with both more heavy downpours and more droughts, as the greater energy powering the water cycle increases extremes at both ends. While we hear more about mean temperature changes, temperature and rainfall excursions have a more immediate effect on our ability to grow food, store fresh water and avoid flooding. Hence, the need to mitigate climate change over the next few decades, as well as over the longer term, during which average temperatures are projected to rise by considerably more.

THE CO_2 PARADOX

Limiting emissions of CO_2 is the primary way to limit long-term warming to less than the target of 2 degrees centigrade agreed to by virtually every nation on earth. But even the sunniest possibility, in which collective efforts to contain carbon are pursued aggressively, would not imply that large reductions in global emissions would happen quickly. Much of the infrastructure that emits CO_2 is in large capital investments like power plants, which have useful lives of many decades. Thus, emissions reductions are likely to be slow in rich nations, while in rapidly growing emerging-market countries like China, emissions are on track to rise sharply even if serious investments in containment are made.

There is a separate and quite troubling aspect of CO_2 emissions, which has yet to get much recognition outside the scientific community: once CO_2 is emitted, it takes an exceptionally long time to be recaptured from the atmosphere by natural processes. In fact, the combination of the long time frame for making serious headway on emissions rates and the slow response of total CO_2 in the atmosphere to emissions reduction means that the most optimistic scenarios produce nearly

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identical climate outcomes over the next 40 years as the pessimistic scenarios.

Thereafter, outcomes do diverge – so this conclusion in no way undermines the rationale for limiting CO_2 emissions now. But this sobering reality does have two key implications. First, to prevent extreme climate change far down the road, CO_2 reductions must proceed. Second, even if a serious effort is made soon, it will bring little benefit to those currently alive.

A SILVER LINING

This second conclusion does not imply, however, that there is no way to mitigate the effects of climate change in the near term. Pollutants other than CO_2 have a substantial role in climate change. What's more, some of these – methane, soot particles and ozone (in the lower atmosphere, where it is a component of smog, rather than stratospheric ozone that shields the earth from ultraviolet sunlight) – have much shorter lifetimes in the atmosphere than CO_2. Therefore, changes in emissions of these compounds – or in the case of ozone, which is not directly emitted, its precursors – lead to a climate response within days to years, rather than the decades associated with CO_2. Yet, taken together, the contribution of these three to global warming has to date been comparable to that of CO_2.

There is another key difference between these warmers and CO_2: they also degrade air quality. Methane is a main precursor of ozone in the lower atmosphere, and soot is one of the components of what researchers call fine particulate matter. These airborne particles are so small that, once inhaled, they can penetrate deeply into the most fragile areas of the lungs. Both fine particulates and ozone cause a variety of human health problems. These include cardiovascular disease and respiratory illness, with impacts that range from reduced cognitive functioning to premature death. Ozone is not only toxic to humans; it also damages plants when leaves are exposed to high concentrations, reducing crop yields and the growth of forests.

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Hence, reducing emissions of soot and methane could, in principle, lead to large, rapid benefits both by slowing near-term climate change and by improving local air quality. Recognition of the potential benefits from tackling non-CO_2 drivers of warming within the scientific community grew rapidly during the 2000s, while calls from civil society to take action reached all the way to the G8 leaders at

their 2009 summit meeting. But while the hypothetical impact of reductions was clear, many analysts pointed out that the practical consequences were unknown.

Would the impact of the kind of emissions reductions that we have the capacity to put into place be large enough to matter? Or worse, as soot is never emitted on its own but comes out in a plume of smoke that includes compounds that, ironically, lead to cooling, might there be no net benefit when soot was reduced in the real world?

In 2009, I was chairman of a group for the United Nations Environment Program to assess the impact of practical measures to reduce emissions of non-CO_2 warming agents. (The World Meteorological Organization, another part of the United Nations, later joined the assessment.) Completed in 2011, with peer-reviewed scientific papers published in 2012, we can now say with confidence that a strategy to target short-lived warmers would indeed provide multiple cost-effective benefits.

The group analyzed the potential impact of some 400 measures that could reduce short-term warmers. The data came from actual measurements using off-the-shelf emissions control technologies that have already been put in place in some parts of the world. While all of them improve air quality, a majority do not substantially reduce warming. Hence, emissions controls must be carefully targeted in order to simultaneously maximize air quality and climate benefits. Sixteen of them, accounting for roughly 90 percent of the total estimated climate benefits, seemed most promising.

Careful selection of measures is thus a key step toward providing guidance to policymakers. These 16 were therefore analyzed in detail using climate, air quality, health, agriculture and economic modeling tools. The computer models suggest that putting in place seven measures to reduce methane emissions and nine to reduce emissions of soot would decrease warming by about half over the next four decades, even as they prevent two million premature deaths from air pollution each year and increase the yield of several staple crops by about 50 million tons annually.

NUTS AND BOLTS

About two-thirds of the methane reduction could be achieved through tighter technical control of fossil fuel extraction and distribution. Methane reaches the atmosphere through leaky pipes and storage tanks, or through deliberate venting from coal mines and gas and oil drilling. The best practices in use by industry today could capture nearly all this methane – but they are not commonly employed in Russia, China, West Africa or the Middle East. The rest of the methane reduction would come from capturing or decreasing emissions from municipal waste, landfills, livestock manure and rice cultivation.

Methane has a lifetime in the atmosphere of about a decade, so that while the atmospheric stock of methane responds fairly rapidly to emissions changes and thus affects climate quickly, the time frame is still long compared with the time it takes for the wind to mix air throughout the lower atmosphere. Hence, the benefits of methane emissions reductions are largely felt globally rather than locally.

This can lead to the same sort of common goods problem seen with CO_2 reductions, where free riders get as much benefit as those who aggressively reduce their own emissions. That limits the incentive for any country to act on its own and instead encourages negotiators to try for agreements where others do the heavy lifting – as has been the norm in the UN-brokered climate talks focused on CO_2.

There is a distinct economic difference with methane, however: as the primary ingredient of natural gas, it's valuable. Reducing leakage from pipelines and storage facilities gives owners more fuel to sell, while capturing methane from landfills or from livestock manure can provide either income or a local source of energy. In fact, some methane reduction measures pay for themselves even without accounting for the climate benefits; this reality raises the question of why they haven't been pursued more aggressively in the marketplace.

Containment of soot and the compounds emitted along with it during inefficient burning is possible through a variety of measures, including lowering emissions from diesel vehicles, improving traditional stoves used for residential heating and cooking, and banning the burning of agricultural waste. Most of these measures apply primarily to the developing world, where vehicle emissions standards are not as stringent as in more industrialized nations (or simply don't exist), and where roughly three billion people still cook with primitive technology such as three-stone fires.

Unlike methane or CO_2, however, soot lasts for only a matter of days in the atmosphere, so it is not evenly distributed over the planet. Hence, the air-quality benefits of emissions reductions are felt largely locally, though the climate benefits from reduced

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warming are more broadly distributed.

But soot can also have a strong effect on regional rainfall and on the melting of snow and ice. Rainfall uncertainties are already a growing concern in South Asia, where agriculture depends heavily on the seasonal monsoon, and in sub-Saharan Africa, where drought can be devastating. Hence, for these measures, the places that take the most aggressive action stand to reap the greatest benefits in terms of public health, farm productivity and local environmental stability. This can be especially important in developing nations, where air quality is more problematic than in many developed countries, and where immediate health concerns generally trump worries about climate change – which is largely seen as a problem of someone else's making.

As with methane control measures, the economics of soot control are often quite favorable. Soot is produced when combustion is incomplete, so that many of the techniques for reducing emissions involve burning fuel more fully. This increased efficiency – for example, in residential stoves or in small-scale commercial brick kilns – lowers fuel costs, so it can provide net cost savings to households and businesses.

GETTY IMAGES

Reduced demand for biofuels protects against deforestation and resulting land erosion.

A measure like banning agricultural waste burning has little cost but requires government enforcement until the change becomes standard practice. Retrofitting older diesel vehicles with pollution controls can be expensive, but requiring new vehicles to have reduced emissions is typically cost-effective. Hence, overall, most of the soot measures are winners even without accounting for the health and climate benefits.

The UNEP analyses quantified the benefits in terms of reduced climate damage, improved human health and agricultural yields – albeit with substantial uncertainty. But there are additional societal benefits linked to reduced demand for fossil fuels that are more difficult to quantify. One is reduced dependence on imported fuel. Another is reduced demand for biofuels – trees, brushwood – that protect against deforestation and resulting land erosion.

Modern stoves with fans can increase efficiency sufficiently to halve fuel use and reduce emissions by about 75 percent, compared with traditional cook stoves. Stoves can also be changed from using biofuel or coal to

cleaner modern fuels. In Senegal, for example, a government program switched much of the nation to liquefied petroleum gas, thus reducing the need to gather firewood. Such measures, it's also worth remembering, free women and children from an onerous, time-consuming task and open the door to education or business enterprise.

There is another reason to focus on short-term warmers: slowing the rate of change reduces the total cost of adaptation. Coastal communities can adjust more efficiently to slower rates of sea-level rise, while farmers can adapt more readily to shifting rainfall patterns.

This holds for natural systems as well. The rate of change to which ecosystems have to adjust can be at least as important in determining their survival as the total amount of change. For example, trees are limited in the pace they can migrate as rainfall and temperature are altered.

WAIT, THERE'S MORE

In meeting the challenge of near-term climate change, it makes sense to consider one additional class of chemicals: hydrofluorocarbons, or HFCs. These compounds were developed to replace the more familiar chlorofluorocarbons (CFCs), which were used as refrigerant gases and solvents and were largely responsible for depleting the protective stratospheric ozone layer.

Unlike CFCs, many HFCs never reach the stratosphere, as they have been designed to break down in the lower atmosphere. This means that they are short-lived. What's more, they have no direct impact on the health of humans or ecosystems. Unfortunately, though, they are powerful greenhouse gases.

While production and thus emissions of HFCs are still relatively modest, the demand for refrigerant gases is growing rapidly. Hence, measures to reverse the trajectory could make a real difference, adding another 10 percent or so to the potential 50 percent near-term warming mitigation available through enhanced controls on methane and soot emissions.

MORE GOVERNMENT, PLEASE

As noted above, individuals, businesses and air-quality regulators already have incentives to reduce (or slow the rate of growth of) emissions of the short-lived greenhouse gases. But there are good economic and environmental reasons to speed the process above that dictated by the market and air-quality considerations. What would it take to amplify efforts to put the controls into place?

Some of the measures, such as particulate emissions standards for vehicles, prohibition of agricultural waste burning and regulation of methane leakage, require government action. These are all on government agendas in one form or another. But regulation is often compartmentalized in ways that do not encourage decision-making based on multiple impacts. For example, air quality, climate change and forestry may be under the purview of different agencies.

Better integration of environmental regulation would presumably facilitate coordinated action, especially when regulators are required to justify their rules with comparisons between total costs and benefits. But this is not easy to achieve where both interest-group politics and bureaucratic turf issues are in the way. The most realistic hope here is that raising public awareness of the importance of paring short-lived climate pollutants would make a difference.

Money matters, too. It's true that emissions containment that pays for itself in cash savings ought to happen without government intervention. But there are a host of reasons why it sometimes doesn't (especially in poor countries). These include everything from lack of information, to the lack of stable institutions such as contract enforcement, to the failure of financial markets to provide capital to small businesses on reasonable terms.

Most important here, even well-functioning private markets do not take account of the "external" benefits that accrue to localities in terms of air quality and to the world in terms of climate change. Hence, the strong economic logic for some public financing of emissions containment to speed the process.

The global nature of the benefits from methane reduction suggests the need for cross-border financing. And, in fact, the UN's Clean Development Mechanism, which encourages businesses to earn emission-containment credits at home by financing containment in developing countries, already supports methane reductions. It does not, however, take into account the potential added benefits to individual nations through air quality. More generally, the CDM has suffered from design and verification problems that have reduced its use even on very-high-value projects, suggesting that other approaches to financing methane containment would make economic as well as environmental sense.

The benefits of (and opportunities for) soot control measures vary greatly. Accordingly, financing should be designed to meet the needs of specific pollution sources and specific places, and may come from public or private sources. A good example of the latter is a small manufacturer of efficient stoves in Ghana that provides loans to purchasers. The stove itself comes with a small coin box attached; users deposit the money they save from the reduced outlays for fuel to pay back the company's loan.

THINKING GLOBAL

Initial progress occurred with the creation of the Climate and Clean Air Coalition under the aegis of Secretary of State Hillary Clinton last February. The coalition now has 18 nations and a host of NGOs aiming to provide technical and financial support for limiting short-term warmers. This effort also supports ongoing efforts like the Global Alliance for Clean Cookstoves, the Partnership for Clean Fuels and Vehicles, and the Global Methane Initiative.

These initiatives parallel efforts to reduce CO_2 emissions through international bodies like the United Nations Framework Convention on Climate Change, multinational arrangements like the European Union's and Australia's emissions trading system, and even sub-national efforts like California's new

greenhouse gas regulations. But there are solid reasons to keep them separate. For one thing, the political forces arrayed against CO_2 containment are quite powerful. For another, CO_2 emissions largely come from power plants and heavy industry, which are not major sources of methane or soot. Finally, since CO_2 and short-lived climate pollutants affect climate over very different time scales, emissions reductions cannot readily be traded against one another.

CLIMATE POLICY, SIMPLIFIED

The difference in the time frames over which short-lived climate pollutants and CO_2 affect climate raises the issue of intergenerational equity. Now, the question of how much people should sacrifice today in order to spare people the consequences of climate change tomorrow is hardly a new topic. But it has been discussed in the context of *how much* sacrifice rather than *what sort* of sacrifice. Clearly, some kinds of efforts bring benefits more directly to our children's generation, while others help our grandchildren's.

For better or worse, though, we don't need to ask how to apportion efforts between CO_2 and the short-term warmers because the politics of climate policy trump the ethics and the economics. Someday, some way, CO_2 emissions will have to be addressed if we are to save our grandchildren from the potentially dire consequences of global warming, and we must keep pushing for that day to be soon. But for the moment, we have a golden opportunity to move forward on an otherwise-stalemated issue by reducing emissions of methane, soot and HFCs wherever the societal benefits – including air quality and climate change – exceed the costs. M

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