BEFORE THE SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING UNITED STATES HOUSE OF REPRESENTATIVES

REDUCING BLACK CARBON OFFERS IMMEDIATE OPPORTUNITY FOR CLIMATE AND PUBLIC HEALTH BENEFITS

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Summary of Testimony

Mr. Chairman, members of the Select Committee, good morning. My name is Conrad Schneider, and I am the Advocacy Director of the Clean Air Task Force. I want to thank you for the leadership that you and this Committee have shown on the issue of climate change and for the work that went into passage of the Waxman-Markey climate bill. I appreciate the opportunity to speak with you today regarding policy options for reducing black carbon emissions. The Waxman-Markey bill made an excellent start in dealing with this issue and we appreciate you revisiting it today because it represents a promising approach that deserves immediate attention both in the climate bill and in other legislation that is before Congress. At the outset of today's hearing I want to make one thing very clear: addressing black carbon and the other short-lived climate forcing pollutants such as methane and ozone is not a substitute for enacting comprehensive climate change legislation to deal with carbon dioxide emissions. We are going to need both and then some in order to address the climate crisis.

So please let me thank you for shining the spotlight today on black carbon as a critical part of the solution. Adopting policies to reduce black carbon offers us a "no regrets" strategy. Leading experts say that addressing black carbon emissions globally can deliver between 1 and 2 Socolow climate mitigation "wedges", each wedge equivalent to a cumulative reduction of 25 billion carbon equivalent tons over 50 years, and representing the major steps required to reverse the growth of greenhouse gases in the atmosphere. A global black carbon reduction strategy could also avoid hundreds of thousands of premature deaths from exposure to particulate matter. That's a "win-win" for climate and public health.

To avoid the worst impacts of global warming, many scientists say we must guard against two related but different risks on different timescales: (1) we need to counter the cumulative warming due to increasing concentrations of greenhouse gases in the atmosphere; and (2) we need to counter the threat of near-term effects of climate change and feedbacks from such changes, which could plunge the earth into a cycle of rising seas and an abrupt shift to a much warmer climate regime.

While the focus of mitigation to date has been on limiting emissions of carbon dioxide (CO_2) and other greenhouse gases into the atmosphere, even rapid action on this front may not be fast enough to avoid dangerous changes. Some climate scientists argue that even if we are able institute policies which will return CO_2 concentration to 350 parts per million by 2100, irreversible changes and feedback loops such as melting of Arctic summer ice and collapse of ice sheets may still occur during this century. An ice-free and therefore darker Arctic Ocean will absorb and trap more heat. Melting permafrost could release millennial stores of methane and carbon dioxide. These developments ultimately could contribute to the disintegration of the Greenland ice sheet triggering rapid and catastrophic sea level rise.

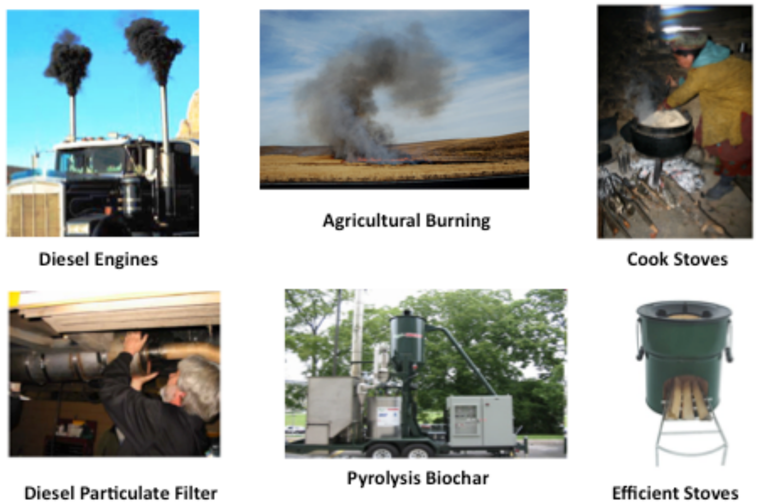
So not only must we take action to reduce global greenhouse gas (GHG) emissions significantly by mid-century, we must quickly reduce several short-lived pollutants, such as black carbon, which can have an immediate impact and slow the rate of warming.

Black carbon is an important component of airborne particulate matter, and not only represents a potent climate-forcing agent, but also is a deadly air pollutant. In the U.S., the Clean Air Task Force, using U.S. EPA methodology approved by the National Academy of Sciences, has estimated that diesel particulate emissions will cause over 21,000 premature deaths this year. Globally, the World Health Organization estimates that ambient particulate matter is responsible for 865,000 premature deaths each year. A recent *Lancet* article finds that over 2 million deaths can be avoided over a ten-year period through reductions in exposure to pollutants from cook stoves.

The previous panelists have identified diesel engines, cook stoves, and agricultural burning as the major controllable sources of black carbon, so my testimony will focus on domestic and international policies to deal with them. Programs to address these pollution sources have been underway for years, mainly to reduce health impacts and deforestation. Only recently have these strategies been understood to offer climate benefits as well. Last year, due in part to the leadership of Rep. Inslee, Congress directed U.S. EPA to study the issue of black carbon and report back early next year. The study requires EPA to inventory major sources of black carbon, assess its impacts on global and regional climate, assess potential metrics and approaches for quantifying the climatic effects, identify the most cost-effective approaches for reductions, and analyze the climatic effects and other environmental and public health benefits from the identified approaches.

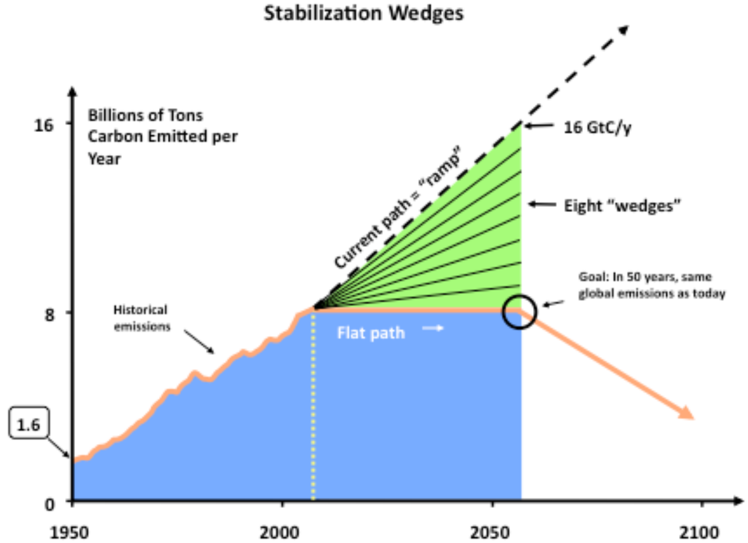
At one level, the solutions for each of these source categories are simple. For diesel engines, filters that are available today can trap up to 90 percent of the black carbon emissions. For cook stoves, the key is replacing existing, smoking stoves with clean, efficient stoves. For agricultural burning, it involves shifting the burning away from the spring season and using pyrolysis to turn waste into “biochar” that sequesters carbon and increases agricultural productivity. However, all of this is easier said than done. There are over 11 million diesel engines in the U.S. without filters, tens of millions globally. Half the people on earth rely on inefficient cook stoves. And unnecessary agricultural burning occurs in virtually every country on earth.

Black Carbon Sources and Solutions



For diesels, the needed policies boil down to mandates and money. The U.S. and European Union have adopted emissions standards for new engines that, in essence, require filters on all new engines and that eventually will reduce particulate matter (and black carbon) emissions by 90 percent. Michael Walsh, board chair of the International Council on Clean Transportation (ICCT), estimates that adoption of these standards in China, India, and Brazil with lesser standards elsewhere could deliver between 1 and 1 ½ Socolow climate stabilization "wedges". However, because diesels are so durable, it will take decades before the fleet turns over completely to these new, cleaner engines. In the meantime, the focus must be on retrofitting existing engines and accelerating fleet turnover.

Stabilization Wedges



Domestically, the Clean Air Act gives U.S EPA the authority to regulate only 1 million of the 11 million diesel engines in use today. An analysis by M.J. Bradley & Associates estimated that targeting this fleet for retrofit could achieve the same climate benefits as removing 21 million cars from the road and would save approximately 7500 lives through reduced particulate matter pollution. The Waxman-Markey bill directed EPA to exercise this authority, but it did not expand that authority to reach the other 10 million engines. We were pleased that, in addition, the Kerry-Boxer bill that passed the Senate Environment and Public Works Committee devoted a significant portion of the bill's allowance auction proceeds to fund the Diesel Emissions Reduction Act (DERA).

In 2005, Congress passed DERA, which authorized $1 billion over five years to a grant and loan program for diesel clean up. However, DERA has been chronically underfunded. Although the American Reinvestment and Recovery Act (ARRA) did provide $300 million for DERA, EPA has received $2 billion in project applications and so is sitting on $1.7 billion in unfunded project applications that could cut black carbon significantly. Additional funding for DERA should be included in any "Jobs Bill" Congress passes this year. DERA expires next year, so it should be reauthorized and fully funded. Language in the Waxman-Markey bill reauthorized DERA but did not fund it.

In addition, the upcoming Transportation Bill offers the opportunity to reduce black carbon from diesel construction equipment. We believe that work on federally funded transportation infrastructure projects should be accomplished with clean diesel equipment paid for through transportation funds and the Associated General Contractors (AGC), which represents the construction firms that own the equipment, agrees. Last year, the Clean Air Task Force negotiated a set of joint "clean construction" legislative principles with AGC. Now, Rep. Hall, with the support of several members of this Committee, is championing the effort to see that these principles are included in the Transportation bill reauthorization.

For cook stoves, the Waxman-Markey bill calls for providing assistance to foreign countries to reduce, mitigate, and otherwise abate black carbon emissions, and specifically outlines action to provide affordable stoves, fuels, or both stoves and fuels to residents of developing countries. Notably, the bill also prescribes a set of environmental performance standards for stoves including: reduces fuel by more than fifty percent, reduces black carbon by more than sixty percent, and reduces childhood pneumonia by more than thirty percent. However, the bill did not allocate any allowances or auction proceeds for this program.

The U.S. should lead in the creation of jointly funded international programs in the public, private, and non-profit sectors that will develop regionally appropriate strategies to deploy cleaner cook stoves globally. These programs should include financing plans, identification of local manufacturers and service providers, and training and testing. As part of the black carbon study, EPA is charged with investigating the question of whether projects such as stove replacement programs should qualify for "offsets" under cap and trade and, if so, what credit they should be given. But, we face many other challenges as well, including cultural acceptance of these stoves in developing countries, the need for on-site verification of mitigation, and cheap stoves that can be produced at scale.

Similarly, stemming agricultural fires in spring, when arctic ice and snow is most affected by black carbon, requires overcoming cultural resistance to changing long held practices. Black carbon emissions from spring agricultural burning in northern latitudes are highest in areas across Eurasia—from Eastern Europe, through southern and Siberian Russia, into Northeastern China—and in the northern part of North America's grain belt. Black carbon emissions can transport directly from these areas to the Arctic, and when they do they can be deposited on ice and snow, darkening the cover and absorbing more solar radiation. Accordingly, fires in these countries present a clear target for mitigation. However, change will require education, engagement by the international community, and enforcement of existing no-burn laws by these countries.

Pyrolysis, which involves turning agricultural waste into "biochar", similar to charcoal, holds out the promise of a more productive use of this waste. Biochar is a soil amendment that can increase productivity while sequestering the carbon from the plant waste – another "win-win" strategy. The challenge is developing and providing low-cost pyrolysis units to the farmers burning crop wastes and the education necessary for them to understand the economic, as well as environmental, advantages of biochar. A program to produce and deploy this technology should be a priority.

In conclusion, policies targeting black carbon emissions offer a viable climate strategy that can be implemented without delay and will deliver immediate climate benefits using technology available today. Moreover, black carbon reduction policies can deliver important public health protection from particulate matter pollution, one of the most potent and widespread air pollution-related public health threats. Winning these policies domestically and globally will be challenging, but their significant health benefits make them extremely cost-beneficial and they may constitute our best hedge against near-term climate impacts.

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THE CLIMATE CHALLENGE

To avoid the worst impacts of global warming, many scientists say we must guard against two related but different risks on different timescales: (1) we need to counter the cumulative warming due to increasing concentrations of greenhouse gases in the atmosphere; and (2) we need to counter the threat of near-term effects of climate change, which could plunge the earth into a cycle of rising seas, feedbacks from such changes, and an abrupt shift to a much warmer climate regime.

While the focus of mitigation to date has been on limiting emissions of carbon dioxide (CO_2) and other greenhouse gases into the atmosphere, even rapid action on this front may not be fast enough to avoid dangerous changes. Some climate scientists argue that even if we are able institute policies which will return the CO_2 concentration to 350 parts per million by 2100, irreversible changes and feedback loops such as melting of Arctic summer ice and collapse of ice sheets may still occur during this century.[1] An ice-free and therefore darker Arctic Ocean will absorb and trap more heat. Melting permafrost could release millennial stores of methane and carbon dioxide.[2] These developments ultimately could contribute to the disintegration of the Greenland ice sheet and trigger rapid sea level rise.[3]

Not only must we take action to reduce global greenhouse gas (GHG) emissions significantly by mid-century, we must quickly reduce several short-lived pollutants, such as black carbon, which can have an immediate impact and slow the rate of warming.

A FOCUS ON SHORT-LIVED CLIMATE FORCING AGENTS CAN HELP BUY TIME FOR FURTHER CLIMATE MITIGATION MEASURES TO BE EFFECTIVE

A key mitigation strategy with a fast climate response is reducing short-lived climate forcing agents such as black carbon, tropospheric ozone, and methane. While carbon dioxide emissions persist in the atmosphere for centuries or even millennia, black carbon and ozone reside in the atmosphere for days or weeks and methane persists for just a decade. Their relatively short atmospheric lifetimes mean that reductions in these

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[1] Solomon, S, G. Plattner, R. Knutti, and P. Friedlingstein (2009) Irreversible climate change due to carbon dioxide emissions, *Proc. Natl. Acad. Sci.*, 106, 1704–1709. Available at: http://www.pnas.org/content/106/6/1704.abstract

[2] Quinn, P.K, T.S. Bates, E. Baum, N. Doubleday, A.M. Fiore, M. Flanner, A. Fridlind, T.J. Garrett, D. Koch, S. Menon, D. Shindell, A. Stohl, and S.G. Warren (2008) Short lived pollutants in the Arctic: their climate impact and possible mitigation strategies, *Atmos. Chem. Phys.,* 8, 1723-1735. Available at: http://www.atmos-chem-phys.net/8/1723/2008/

[3] Lenton, T., H. Held, E. Kriegler, J. Hall, W. Lucht, S. Rahmstorf, and H. Schellnhuber (2008) Tipping elements in the Earth's climate system, *Proc. Natl. Acad. Sci.,* 105, 1786-1793. Available at: http://www.pnas.org/content/105/6/1786.abstract

pollutants could result in rapid reduction in their atmospheric concentrations and therefore their radiative forcing.[4]

One of these pollutants, black carbon, has been estimated to be responsible for up to 50 percent of the anthropogenic warming experienced to date.[5] Because of its dark color, black carbon contributes to global warming by absorption of sunlight, in two distinct ways: First, it absorbs light in the atmosphere and then radiates it as heat, thereby warming the surrounding air. Second, the black particles deposit on and darken the surfaces of snow, ice, and glaciers, accelerating their melting. Over a 20-year period, pound for pound, black carbon may trap 2000 times more heat than carbon dioxide.[6]

Globally, the major anthropogenic sources of black carbon include agricultural burning, biomass and coal burning for residential cooking and heating, diesel engines, brick kilns, and coke ovens.[7]

Black carbon is an important component of airborne particulate matter, and not only represents a potent climate-forcing agent, but also is a deadly air pollutant. In the U.S., the Clean Air Task Force, using U.S. EPA methodology approved by the National Academy of Sciences, has estimated that diesel particulate emissions will cause over 21,000 premature deaths in 2010.[8] Globally, the World Health Organization estimates that outdoor particulate matter is responsible for 865,000 premature deaths each year.[9] A recent *Lancet* article found that over 2 million deaths could be avoided over a ten-year period through reductions in exposure from pollutants from cook stoves.[10]

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[4] Jacobson, M. (2002) Control of fossil-fuel particulate black carbon plus organic matter, possibly the most effective method of slowing global warming. *J. Geophys. Res.*, 107, 4410.

[5] Ramanathan, V. and Y. Feng (2008) On avoiding dangerous interference with the climate system: Formidable challenges ahead. *Proc. Natl. Acad. Sci.,* 105, 14245-14250. Available at: http://www.pnas.org/content/105/38/14245.abstract

[6] Bond, T.C. (2007) Can warming particles enter global climate discussions? *Environ. Res. Lett.* 2 045030. Available at: http://www.iop.org/EJ/article/-search=68386981.1/1748-9326/2/4/045030/erl7_4_045030.html; Bond, T.C. and H. Sun (2005). Can reducing black carbon emissions counteract global warming? *Environ. Sci. Technol.* 39, 5921-5926; Hansen, J., M. Sato, P. Kharecha, G. Russell, D.W. Lea, and M. Sidall (2007). Climate change and trace gases. *Phil. Trans. R. Soc. A*, 365, 1925-1954, Available at: http://rsta.royalsocietypublishing.org/content/365/1856/1925.abstract; Jacobson, M. (2001). Strong radiative heating due to the mixing state of black carbon in atmospheric aerosols. *Nature*, 409, 695-697.

[7] Bond, T.C, D.G. Streets, K.F. Yarber, S.M. Nelson, J.H. Woo, and Z. Klimont (2004) A technology-based global inventory of black and organic carbon emissions from combustion. *J. Geophys. Res.,* 109, p. D14203.

[8] Clean Air Task Force (2005) Diesel and Health in America, the Lingering Threat. Available at: http://www.catf.us/publications/reports/Diesel_Health_in_America.pdf

[9] See: http://www.who.int/entity/quantifying_ehimpacts/countryprofilesebd.xls

[10] Wilkinson, P., K.R. Smith, M. Davies, H. Adair, B.G. Armstrong, M. Barrett, N. Bruce, A. Haines, I. Hamilton, T. Oreszczyn, I. Ridley, C. Tonne, Z. Chalabi (2009) Public health benefits of strategies to reduce greenhouse-gas emissions: Household energy. *Lancet*, 374, 1917-1929.

Sources and Policy Responses

Drs. Bond, Ramanathan, and Shindell have described sources that are rich in black carbon emissions and what we understand about how controlling these sources could benefit climate. I will focus my testimony on the relevant emissions control strategies, the domestic and international black carbon abatement efforts that are underway, and what additional policies should be pursued.

It is important to note that the U.S. Congress recently directed U.S. EPA to study the sources of black carbon and provide recommendations for action by early next year.[11] The study requires EPA to inventory major sources of black carbon, assess the impacts of on global and regional climate, assess potential metrics and approaches for quantifying the climatic effects, identify the most cost-effective approaches for reductions, and analyze the climatic effects and other environmental and public health benefits from the identified approaches.

Transportation

On- and off-road diesel engines represent one of the largest sources of black carbon[12] and offer one of the greatest opportunities for controlling the climate impact of black carbon. In the U.S. and European Union (EU) nearly 60 percent of the black carbon emissions come from diesels.[13] U.S. per capita emissions of black carbon are higher than those from other regions of the world, including Asia.[14] In the developing world, diesel emissions likely represent the fastest growing source of black carbon.[15]

Control options

One promising strategy for reducing black carbon emissions involves fitting as many diesel engines as possible with diesel particulate filters (DPFs). DPFs, which physically trap black carbon particles, can reduce black carbon emissions by more than 90 percent relative to an uncontrolled engine.[16] Requiring DPFs on new diesel engines and requiring, and funding, filter retrofits on existing in-use diesel engines represent key black carbon control strategies.

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[11] SA 2505, Senate Report 111-058 – Black Carbon Research Bill to accompany S. 849 (July 22, 2009).
[12] Bond, T.C., et al. (2004) Op.Cit.
[13] Ibid.
[14] See: http://www.yaleclimatemediaforum.org/2009/07/black-carbon-and-global-warming/
[15] Streets, D. G., T. C. Bond, T. Lee, and C. Jang (2004) On the future of carbonaceous aerosol emissions, *J. Geophys. Res.*, 109, D2421, doi:10.1029/2004JD004902
[16] Frank, B., S. Tang, T. Lanni, G. Rideout, C. Beregszaszy, N. Meyer, S. Chatterjee, R. Conway, H. Windawi, D. Lowell, C. Bush, J. Evans (2004) *A Study of the Effects of Fuel Type and Emission Control Systems on Regulated Gaseous Emissions from Heavy-Duty Diesel Engines*. SAE paper 2004-01-1085, 18p.

Domestic Policies

The U.S. has adopted standards for new engines that the U.S. EPA estimates will reduce particulate matter and black carbon emissions from diesel 90 percent by the year 2030.[17] However, the current economic downturn has brought the rate of fleet turnover to a standstill and, even if the economy comes roaring back, two decades may be too late to avoid triggering dramatic near-term climate impacts. Both to protect the climate and to continue our leadership in reducing health impacts from particulate matter, the U.S. should expeditiously address emissions from our in-use diesel fleet. In the U.S. and the EU, the best opportunity to reduce diesel black carbon reductions consists of retrofitting existing diesel engines with DPFs and adopting policies to accelerate fleet turnover to new engines already fitted with filter technology.

The State of California, through the California Air Resources Board, has led the way in this regard, setting emissions standards and timetables that are targeted to achieve a 85 percent reduction in diesel particulate emissions by 2020 in that state.[18] At the federal level, U.S. EPA so far has declined to exercise its existing regulatory authority under the Clean Air Act to require filters on all on-road diesel engines whenever they are rebuilt. Under the Bush Administration, EPA preferred a "voluntary" approach funded largely through the Diesel Emission Reduction Act (DERA), which authorized $1 billion over five years to subsidize a variety of diesel clean up measures. In assessing its benefits, the EPA has estimated that for every dollar spent in the DERA program, more than $13 of economic and health benefits are generated.[19] However, because the program has never been fully funded,[20] diesel particulate filters have barely penetrated the existing fleet and therefore represent an immediate opportunity to address positive climate forcing with available technology.

The U.S. can lead by adopting a suite of policies to deal with the problem of in-use diesel black carbon emissions including:

1. U.S. EPA issuing a "Engine Rebuild" rule under its existing Clean Air Act authority governing rebuilt engines
2. Expanding EPA's regulatory authority and providing funding for diesel retrofits in the Climate Bill
3. Requiring and funding clean construction equipment on all federal transportation infrastructure projects in the reauthorization of the Transportation Bill
4. Reauthorizing and fully funding DERA.

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[17] EPA (2004) *Final Regulatory Analysis: Control of Emissions from Nonroad Diesel Engines*, EPA420-R-04-007; EPA (2000) *Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements*, EPA420-R-00-026.

[18] California Air Resources Board (2000) *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*. The CARB website lists CARB diesel regulations, at: http://www.arb.ca.gov/diesel/mobile.htm.

[19] Lisa P. Jackson, EPA Administrator, remarks on Ohio Recovery Act DERA Grant, June 3, 2009.

[20] http://www.epa.gov/diesel/grantfund.htm.

1. U.S. EPA Engine Rebuild Rule

EPA should exercise its existing regulatory authority under the Clean Air Act and issue a rule requiring all Class 8 trucks built between 1998 and 2006 (after which the new engine standards took effect) to meet emissions standards commensurate with the installation of a filter whenever their engines are rebuilt.[21] Class 8 trucks, which comprise long-haul tractor-trailer trucks, dump trucks, and transit buses, consume nearly 75 percent of the diesel fuel used by on-road trucks in the U.S. and thus are responsible for a commensurate share of black carbon emissions. M.J. Bradley & Associates has estimated that targeting this fleet of approximately 1 million engines for retrofit could achieve the same climate benefits as removing 21 million cars from the road and would save approximately 7500 lives through reduced particulate matter.[22] Incentives from the Diesel Emission Reduction Act, Transportation bill, and other sources could facilitate and accelerated compliance with such a regulation. See discussion infra.

2. U.S. Climate Legislation Should Expand EPA Authority Over and Fund Retrofits on Existing Diesel Engines

In the current session, the U.S. Congress has taken up the issue of climate legislation in earnest. The U.S. House of Representatives passed the American Clean Energy and Security Act of 2009, which directs U.S. EPA to use its existing regulatory authority to cut black carbon emissions (i.e., to issue a rebuild rule), but it did not expand EPA's authority to cover the other 10 million engines in use today.[23] It should. In addition, the bill orders U.S. EPA to study the options for reducing black carbon both domestically and internationally and to report a set of recommended policy actions to Congress.[24] The Clean Energy Jobs and Power Act (Kerry-Boxer bill) that passed the Senate Environment and Pubic Works Committee included all of those provisions, but took the significant additional step of allocating a percentage of the proceeds from the auction of allowances to fund diesel retrofits targeted at reducing black carbon.[25] To do the job, final comprehensive climate legislation should devote at least 1 percent of allowances of any economy wide cap and trade bill to fund diesel retrofits for the first 10 years with a sustained but lesser amount thereafter. Because diesel particulate filters confer no economic benefit on fleet owners (such as fuel economy savings), to ensure their use, regulatory mandates will be needed and should be part of any final climate legislation.

3. Transportation Bill Reauthorization Presents An Opportunity for Cleaning Up Construction Equipment

According to the U.S. EPA's Clean Air Act Advisory Committee (CAAAC), off-road

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[21] Clean Air Act Sec. 202(a)(3)(D) [42 U.S.C. Sec. 7521(a)(3)(D)].
[22] See CATF Report: *The Carbon Dioxide-Equivalent Benefits of Reducing Black Carbon Emissions from U.S. Class 8 Class 8 Trucks Using Diesel Particulate Filters: A Preliminary Analysis*. http://www.catf.us/projects/diesel/
[23] H.R. 2454 Sec. 851 (2009).
[24] H.R. 2454 Sec. 333 (2009).
[25] S. 1733 Secs. 201(g) and 771(b)(3) (2009).

construction equipment is responsible for 37 percent of land-based particulate matter emissions in the U.S.[26] However, U.S. EPA lacks the regulatory authority under the Clean Air Act to require emission reductions from in-use equipment. To help address the emissions from this sector, Congress in the Transportation Bill reauthorization should require and fund the use of "clean construction" equipment on all federally funded transportation infrastructure projects. The Associated General Contractors agrees. The Clean Air Task Force negotiated a set of joint "clean construction" legislative principles with AGC[27] and Rep. Hall, with the support of several members of this Committee, is championing the effort to see that this policy is included in the Transportation bill reauthorization.[28] Optimally, this would involve prioritizing the use of diesel particulate filters where possible.

4. Fully Funding the Diesel Emission Reduction Act

The Diesel Emission Reduction Act (DERA), which authorized $1 billion for a variety of diesel clean up strategies over 5 years beginning in 2008, expires in 2011.[29] Language in the Waxman-Markey bill reauthorized DERA but did not fund it. Congress should reauthorize DERA, increase the authorized funding amount, and commit to fully fund the program each year. U.S. EPA received applications totaling requests for over $2 billion in funding for the $300 million appropriated to DERA as part of the U.S. American Recovery and Reinvestment Act, so the demand for the program is well-established.[30] Additional funding for DERA should be included in any "Jobs Bill" that Congress passes this year. KeyBridge Research, a reputable economics consulting firm, found that a $1 billion investment in DERA would generate 19,000 jobs.[31]

International Policies

The European Union has adopted the EURO VI particulate matter emission standards for new on-road heavy-duty diesel engines and Stage III and IV standards for new non-road diesel engines, which will drive similar market penetration of the DPF technology in the EU as the EPA new engine standards will in the U.S.[32] Globally, adoption of these new

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[26] U.S. Clean Air Act Advisory Committee (2006) *Recommendations for Reducing Emissions from the Legacy Diesel Fleet: A Report from the Clean Air Act Advisory Committee* p. 48.

[27] http://www.catf.us/projects/diesel/20090929-AGC_CATF_Principles.pdf

[28] Letter from 55 Members of the House of Representatives to Reps. Oberstar, DeFazio, Mica, and Duncan dated August 10 2009.

[29] Subtitle G of Title VII of the Energy Policy Act of 2005 (42 U.S.C. 16131 et seq.)

[30] Public Law 111-05 - American Recovery and Reinvestment Act of 2009.

[31] KeyBridge Research (2008).

[32] Regulation (EC) No 595/2009 of the European Parliament and of the Council of 18 June 2009 on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI); and Directive 2004/26/EC of the European Parliament and of the Council of 21 April 2004 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed on mobile non-road machinery. Directive 2005/55/EC introduced by Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6).

vehicle and engine particulate and/or black carbon emission standards holds great potential to achieve meaningful near-term climate benefits. A preliminary estimate by Michael Walsh, an internationally recognized transportation expert and the current board chair of the International Council on Clean Transportation (ICCT), found that extending by 2015 the EURO 6 and VI particulate standards for new engines to China, India, and Brazil plus adoption of less stringent EURO 4 standards in the rest of Latin America and the Middle East and EURO 3 in Africa by the year 2015, could achieve an additional 38 billion CO_2-equivalent tons reduction by 2050.[33] This level of reduction constitutes nearly 20 percent of the Princeton Carbon Mitigation Initiative's 200 billion-ton goal i.e., the equivalent of about one and a half Pacala and Socolow "wedges."[34]

A crucial and challenging precondition for widespread use of DPFs involves reducing sulfur content in diesel fuel to very low levels - at a minimum to levels below 50 ppm, with levels as low as 10 ppm preferred, especially in cold climates. Low fuel sulfur levels are required to ensure that these devices can regenerate passively, and to preclude the production of sulfate particulate.[35] As part of its new engine standards, the U.S., for example, has adopted 15 ppm sulfur in fuel standards that should be available nationwide for on- and off-road use during 2010.[36]

Another strategy is to retire older diesel engines. In 2009, China retrofitted 8000 vehicles, scrapped 104,000 light and heavy duty vehicles in, and is aiming to scrap 40,000 more by May 2010. China's Ministry of Environmental Protection of the People's Republic has stated that it wants to scrap all pre Euro III diesels by 2015.[37]

Marine Shipping

Closely related to diesel, international shipping is a significant emitter of black carbon,

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[33] Walsh, Michael, Presentation: "What is the World Doing to Reduce Black Carbon?" Briefing for European Commission staff, Brussels (October 7, 2009).

[34] http://cmi.princeton.edu. Pacala and Socolow identified an overall carbon emissions reduction stabilization target of 200 billion tons divided into 8 "wedges" each representing 25 billion tons of carbon emissions that could avoided by 2050 through implementation of different reduction technologies. See Pacala, S. and R. Socolow (2004) Stabilization wedges: Solving the climate problem for the next 50 years with current technologies, *Science,* 305, 968-972. See also: Grieshop, A.P, C.C.O. Reynolds, M. Kandlikar and H. Dowlatabadi (2009) A black-carbon mitigation wedge, *Nature Geoscience* 2, 533–534.

[35] USDOE, NREL (2002) *Diesel Emission Control – Sulfur Effects Project (DECSE), Summary of Reports*, NREL/TP-540-31600. Available at: http://www.nrel.gov/docs/fy02osti/31600.pdf Manufacturers of Emissions Controls Association (2000). *Catalyst-Based Diesel Particulate Filters and NOx Adsorbers: A Summary of the Technologies and the Effects of Fuel Sulfur*. Available at: http://www.meca.org/galleries/default-file/cbdpf-noxadwp.pdf

[36] EPA (2001), "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Sulfur Control Requirements," 66 Fed. Reg. 5002 (January 18, 2001). EPA (2004), "Control of Emission of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule," 69 Fed. Reg. 38957 (June 29, 2004).

[37] Walsh, Michael, Presentation: "Clean Diesels: An Important Strategy to Reduce Black Carbon," Arctic Council Meeting, San Francisco (February, 2010).

emitting between 71,000 and 160,000 metric tons annually,[38,39] and constituting between 5 percent and 15 percent of world shipping emissions of particulate matter.[40] Currently marine vessels emit an estimated 2 percent of total global black carbon (and about 3 percent of CO_2). An estimated 85 percent of shipping emissions occur in the northern hemisphere, and the release of black carbon emissions in northern shipping routes close to the Arctic is particularly damaging to that region. Furthermore, as sea ice melts, more Arctic sea lanes will open up. Although shipping emissions of black carbon in the Arctic region are relatively small at present, some estimates project they will increase by two to three times the global rate between now and year 2050. International shipping is a larger relative source of black carbon emissions – by more than 50 percent – north of 40° latitude, where most international shipping traffic occurs and emissions are more likely to reach the Arctic.[41]

As a product of incomplete combustion, black carbon emissions from marine engines vary, depending on engine type and combustion efficiency. A recent study found that medium speed marine engines typically used on tugboats, fishing vessels and ferries emit black carbon at more than twice the rate of slow speed engines used on large ocean-going ships (excepting containerships) and high speed engines used on passenger ships.[42]

<u>Control options</u>

- In-engine measures to reduce smoke include improved fuel injection systems (e.g., common rail) and modified turbochargers.
- Diesel particulate filters (DPF) are after-treatment devices that are effective at controlling black carbon, reducing emissions by up to 95 percent (with 70-95 percent reductions in total particulate matter).[43] This technology is suitable only use with for high grade (ideally ultra-low sulfur fuel) distillate fuels and cannot be used with residual/bunker fuels.
- Water mixing and injection technologies, where water is emulsified into the fuel or separately injected into the fuel-air mixture, have been shown to reduce particulate matter (PM) and black carbon emissions by over 50 percent. Water injection also

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[38] Green, E., J. Winebrake, and J. Corbett (2007) Opportunities for reducing greenhouse gas emissions from ships, annex to document MEPC 58/INF.21.
[39] Lack, D., B. Lerner, C. Granier, T. Baynard, E. Lovejoy, P. Massoli, A.R. Ravishankara, and E. Williams (2008) Light absorbing carbon emissions from commercial shipping. *Geophys. Res. Lett*., 35, L13815.
[40] Lack, D., *et al*. (2009) Particulate emissions from commercial shipping; Chemical, physical and optical properties. *J. Geophys. Res.,* 114, D00F04, doi:10.1029/2008JD011300.

[41] Preliminary calculations by Corbett and Koch for Clean Air Task Force, 2009.
[42] Lack, D. *et al.* (2009) Op.Cit. Although higher black carbon emissions were found in ships burning lower sulfur fuel, these ships had predominantly medium speed engines, and the engines rather than the fuel likely produced the higher black carbon emission rates.
[43] See, e.g., annex to document MEPC 58/INF.21. Other technologies such as oxidation catalysts reduce some PM constituents, but do not reduce black carbon.

reduces emissions of nitrogen oxides (NOx).[44]

- Slide valves produce more complete combustion than conventional valves, reducing PM and black carbon by 25 percent or more. NOx is also reduced, by about 10-25 percent. Slide valve replacement is extremely cost-effective, having a total incremental installation cost of less than $700 per valve.[45] Slide valves cannot be used on all engines.

Domestic/international Policies

Air emissions from ships sailing in international waters are subject to international regulations set by the International Maritime Organization (IMO).[46] On January 15, 2010, Norway, Sweden, and the U.S. filed a joint paper to the Marine Environment Protection Committee (MEPC) of the IMO requesting that "the Committee discuss how to address [black carbon] by examining potential measures to be recommended or required to significantly reduce black carbon emissions from shipping having an impact in the Arctic."[47] A companion submission describes a recent report and analysis of inventories of emissions of black carbon, organic carbon, and sulfur dioxide emissions from international shipping activity in the Arctic (north of 60 degrees North latitude) for the years 2004, 2020, and 2030.[48]

Solid Fuel Stoves

Use of inefficient cookstoves in the developing world contributes to a range of serious health and environmental problems that dramatically reduce the life span of millions of women and children,[49] threaten the security of women as they forage for fuel, exacerbate global climate change through inefficient burning and production of black carbon,[50] and degrade forests and ecosystems. Globally, there are 500 million biomass-fueled cook stoves in use, supporting more than three billion people, or nearly half of the world's population. Worldwide, cookstoves are the second largest source of human generated black carbon emissions.[51]

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[44] Winebrake, J., J. Corbett, and E. Green (2009) *Black carbon control costs in shipping*, prepared for ClimateWorks Foundation.

[45] Entec UK Ltd. (2005) *Final Report for European Commission Directorate-General-Environment, "Service Contract of Ship Emissions: Assignment, Abatement and Market-based Instruments."* Available at: http://ec.europa.eu/environment/air/pdf/task2_nox.pdf

[46] Any country has jurisdiction to regulate harmful emissions from ships sailing to their ports within their waters, subject to any applicable international right of innocent passage.

[47] Marine Environment Protection Committee, 60th session, Agenda item 4, Prevention Of Air Pollution From Ships, "Reduction of emissions of black carbon from shipping in the Arctic," Submitted by Norway, Sweden and the United States.

[48] Marine Environment Protection Committee, 60th session, Agenda item 4, Prevention Of Air Pollution From Ships, "New Inventory of short-lived climate forcing aerosols from international shipping activity in the Arctic."

[49] Wilkinson, P. *et al.* (2009), Op.Cit.

[50] Venkataraman, C., G. Habib, A. Eiguren-Fernandez, A.H. Miguel, and S.K. Friedlander (2005) Residential biofuels in South Asia: Carbonaceous aerosol emissions and climate impacts, *Science*, 307, 1454-1456.

[51] Bond, T.C. *et al.* (2004), Op.Cit.

Control options

The dominant black carbon control option is stove replacement to more efficient and cleaner burning stoves. The first priority of stove improvements is better health, but several stove designs have been advanced which, at least in tests, reduce black carbon emissions and increase fuel efficiency (decreasing CO_2 emission) in addition to dramatic decreases in total PM. Confirming these reduced emissions requires careful sampling of emissions of black carbon and other pollutants from improved and traditional stoves, both in the laboratory and in the homes where the stoves are to be used. Stove replacement efforts include many critical steps – financing mechanisms, distribution, program coordination, performance methodologies, and scrappage of the stoves being replaced – and all are important to achieve goals related to health, climate, sustainability, or security. However, to understand (and claim) climate benefits from improved stoves, standards and field and lab testing are particularly essential elements.

Domestic Policies

The U.S. should lead in the creation of jointly funded international programs in the public, private, and non-profit sectors that will develop regionally appropriate strategies to deploy cleaner cook stoves globally. These programs should include financing plans, identification of local manufacturers and service providers, training, and testing. As part of the black carbon study, EPA is charged with investigating the question of whether projects such as cook stove replacement programs should qualify for "offsets" under cap and trade and, if so, what credit they should be given. However, there are many other challenges, including cultural acceptance of these stoves in developing countries the need for on-site verification of mitigation and cheap stoves that can be produced at scale.

Provisions in H.R. 2454: American Clean Energy and Security Act of 2009[52] call for providing assistance to foreign countries to reduce, mitigate, and otherwise abate black carbon emissions, and specifically outlines action to provide affordable stoves, fuels, or both stoves and fuels to residents of developing countries. Notably, the bill also prescribes a set of environmental performance standards for stoves including: reduces fuel by more than fifty percent, reduces black carbon by more than sixty percent, and reduces childhood pneumonia by more than thirty percent. However, the bill failed to allocate any allowances or auction proceeds for this program. The Kerry-Boxer bill does not contain similar cook stove provisions, but does include language requiring EPA to report on cost-effective opportunities for reducing black carbon domestically and internationally.

International Policies

While myriad international and country-specific programs exist to promote the use of cleaner cookstoves, few have reached the commercial scale needed to meaningfully address the nature of this global problem, and many projects fail to achieve measurable

[52] H.R. 2454 Sec. 851 (2009).

improvements in health and safety, combustion efficiency, or reduced emissions of black carbon and other pollutants.

That said, some specific program initiatives include:

- The UN Foundation seeks to build a Global Alliance for Clean Cookstoves with the United Nations, the U.S. Government, and other international private sector, non-profit, foundation, and government partners to develop an effective program that would dramatically scale up the development, distribution, and utilization of clean cookstoves, with the goal of deploying millions of stoves in target countries by 2015.
- EPA's Partnership for Clean Indoor Air (PCIA) has over 330 partners operating in 115 countries and is growing.
- In December 2009, India announced a major national initiative on biomass cookstoves, with a goal of scaling up to replacing over 150 million cookstoves.

Successful programs will likely combine strong bottom-up policies and actions that include stove and program development; protocols design, testing and dissemination with top down strategies that engage governments and donors at the highest level.

Agricultural Burning

Agricultural fires are used to remove crop residues, prepare fields for planting, and clear brush for grazing. Emissions from these fires, especially when they occur in the spring, can result in transport and deposition of black carbon to the Arctic during the most vulnerable period for ice and snow melt.[53] Moreover, field burning frequently ignites larger forest fires, which, in addition to increasing burn area and emissions, cause property and health damage.[54] Black carbon emissions from spring agricultural burning in northern latitudes are highest in areas across Eurasia – from Eastern Europe, through southern and Siberian Russia, into Northeastern China – and in the northern part of North America's grain belt. Accordingly, these fires present a clear target for mitigation.[55]

<u>Control Options</u>
Like the issue of cook stove replacement, stemming spring agricultural fires will include overcoming cultural resistance to changing long-held practices. Change will require education, engagement by the international community, and better enforcement of existing and future regulations and laws.

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53 Warneke, C., K.D. Froyd, J. Brioude, R. Bahreini, C.A. Brock, J. Cozic, J.A. de Gouw, D.W. Fahey, R. Ferrare, J.S. Holloway, A.M. Middlebrook, L. Miller, S. Montzka, J.P. Schwarz, H. Sodemann, J.R. Spackman, A. Stohl (2010) An important contribution to springtime Arctic aerosol from biomass burning in Russia, *Geophys. Res. Lett*., 37, L01801.
54 Warneke, C., R. Bahreini, J. Brioude, C.A. Brock, J.A. de Gouw, D.W. Fahey, K.D. Froyd, J.S. Holloway, A. Middlebrook, L. Miller, S. Montzka, D.M. Murphy, J. Peischl, T.B Ryerson, J.P. Schwarz, J.R. Spackman, and P. Veres (2009) Biomass burning in Siberia and Kazakhstan as an important source for haze over the Alaskan Arctic in April 2008, *Geophys. Res. Lett*., 36, L02813.
55 Pettus, A. (2009) *Agricultural Fires and Arctic Climate Change*, Report for the Clean Air Task Force, available at: http://www.catf.us/publications/view/99

These include:

1. banning spring time burning
2. expanding uses for crop waste, including biochar production *via* pyrolysis.
3. timing and permitting fires, based on meteorological conditions and forecasts to avoid transport of black carbon to the Arctic

<u>Domestic policies</u>

In the United States, field burning is regulated at the state level, with requirements varying by state. Many states require permits for open-field burning, and state officials post "no-burn" periods during exceptionally dry conditions. Both U.S. EPA and USDA collect fire data, although there is no standard database of fire events or area burned for any year.[56] Federal fire statistics in the U.S. have limited spatial accuracy, tend to be aggregated at the county level, and may exclude fires outside of public lands.[57]

<u>Selected International Policies</u>

Russia is the largest contributor of emissions to the Arctic from springtime agricultural burning, with fires representing over 80 percent of the springtime black carbon emissions that reach the Arctic, followed by Kazakhstan, China, and the U.S.[58] Since the collapse of the USSR, Russia's centralized fire management system has steadily weakened. This has diminished the government's once strong capacity to detect, monitor and fight fires, allowing increasingly severe blazes to burn unchecked.[59] Our understanding is that while broad laws generally ban agricultural burning in Russia, this law is not enforced, nor are penalties or jurisdictions spelled out to enable enforcement.[60,61]

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[56] For instance, to estimate forest and wildfire emissions for the 1999 emissions year, the EPA used fire activity data for the years 1985-1998 obtained from the U.S. Department of Interior and the USFS for Non-Grand Canyon States. After the emissions estimates were produced, they were often distributed from an aggregated state level to a county level using data from a prior year(s). This often led to large errors and inaccuracies when comparing where emissions were shown to occur and where actual biomass burning occurred. Recently, in a large part as a result of this work, the EPA had begun to include satellite data in the National Emissions Inventory (Soja et al. 2009)

[57] Soja, A.J., J.A. Al-Saadi, L. Giglio, D. Randall, C. Kittaka, G.A. Pouliot, J.J. Kordzi, S.M. Raffuse, T.G. Pace, T. Pierce, T. Moore, B. Roy, B. Pierce, J.J. Szykman (2009) Assessing satellite-based fire data for use in the National Emissions Inventory, *J. Appl. Remote Sens.,* 3, 031504.

[58] Pettus, A. (2009), Op. Cit.

[59] Ibid.

[60] According to Burenin Nikolaj Sergeevich, paragraph 327, section X of the Russian Federation Prevention of Fire Regulation 01-03, states that: "the burning of stub land and crop residues, as well as bonfires in the fields, are prohibited" (personal communication). Mr. Sergeevich identifies himself as "head of the department for scientific-metholodological grounds in the field of environmental impact, transboundary transfer, and state accounting."

[61] Evdokimova, N. and E. Kobets (2009) *Legal regulation on air protection connected with waste burning and transport pollution in Russia*, Report for Bellona Foundation.

Agricultural fires have been suggested as a topic for inclusion in the Clinton-Lavrov bi-lateral commission, dedicated to pursuing joint projects that strengthen strategic stability, international security, economic well being, and the development of ties between the Russian and American people.

Although China's government officially prohibits open-field burning (and has even used satellite technology to monitor burning in rural areas), public compliance has been weak.[62]

Agricultural burning has been significantly reduced in recent decades in Europe, suggesting that mitigation efforts can greatly reduce this important source of black carbon, which particularly affects the Arctic.

Pyrolysis, which involves turning agricultural waste into biochar, similar to charcoal, holds out the promise of a productive use of field wastes that are often burned off. Biochar is a soil amendment that can increase productivity while sequestering the carbon from the plant waste – another "win-win" strategy. The challenge is to provide low-cost pyrolysis units in areas where agricultural burning occurs and to inform farmers of the advantages of biochar.[63] A program to produce and deploy this technology should be a priority.

Industrial Sources

Industrial sources are estimated to produce a significant fraction, 18 percent, of global black carbon emissions. Brick making is the largest single industrial source of black carbon, followed by coke ovens and commercial boilers.[64]

Brick kilns

Bricks are one of the oldest and most important building materials in the world. Over 98 percent of bricks are made in developing countries, using very basic tools and techniques. The majority – 55 percent – are produced in China, followed by India – 11 percent. The balance is made in thousands of small brickworks scattered throughout Southeast Asia and, to a lesser extent, Africa and South America. Primitive brick kilns have been recognized in several developing countries as having large environmental, health, and a range of social problems.[65]

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[62] Cao, G.L., X.Y. Zhang, Y.Q. Wang, F.C. Zheng (2008) Estimation of emissions from field burning of crop straw in China, *Chin. Sci. Bull.* 53, 784-790. Available at: http://www.springerlink.com/content/x545112257l13um1/fulltext.pdf

[63] For more information, see: http://www.biochar-international.org/

[64] Bond, T.C. *et al.* (2004), Op.Cit.

[65] Heierli, U., and S. Maithel, (2008) *Brick by brick: the Herculean task of cleaning up the Asian brick industry*. Swiss Agency for Development and Cooperation, Natural Resources and Environment Division. Available at: http://www.poverty.ch/asian-brick-industry.html.

Control options

Improved kiln designs, which have been widely adopted in some regions, offer substantial improvements over primitive designs in energy efficiency and air pollution. Although systematic measurements of black carbon from the various kilns have not been made, improved kiln designs very likely offer an opportunity to reduce black carbon pollution (improved kilns almost certainly produce less air pollution in general, improving human health). Additionally, anecdotal observations indicate that primitive kilns produce substantial black smoke plumes, which disappear with some improved kiln designs. This is corroborated by measurements of total particulate emissions, which decrease from more primitive to the more advanced kilns.[66]

In most cases, replacing relatively primitive with more modern brick kilns will have considerable co-benefits – substantially lower operating costs, fuel consumption, emissions of harmful pollutants (particulates, SO_2 and NO_X), and CO_2 emissions, and improved brick quality.

There are potentially four ways to reduce black carbon emissions from brick kilns:

1. use more energy efficient kilns
2. install pollution control technologies on existing kilns
3. use cleaner fuels
4. switch to making hollow bricks

Measurement of climate-relevant emissions is needed to quantify the climate mitigation opportunity from improving brick kilns.

International Policy

Low fuel efficiency, high polluting continuous kilns have been banned by law in China since at least the mid 1990's because of their low fuel efficiency.[67] We have no information regarding the level of enforcement of this ban.

Some highly polluting kiln designs, while widely used in South Asia, have been banned in India since 2002[68] and in Nepal, in the Kathmandu Valley, since 2004.[69] In January 2009, the Environmental Protection Agency of Pakistan (Pak-EPA) ordered brick makers in and around the capital to close their operation or switch to alternative technology

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[66] Co, H.X., N.T. Dung, H.A. Le, D.D. An, K.V. Chinh, and N.T.K. Oanh (2009) Integrated management strategies for brick kiln emission reduction in Vietnam: a case stud. *Int. J. Environ. Stud.* 66, 113-124.
[67] Zhang, Z. (1996) Energy efficiency and environmental pollution of brickmaking in China. *Energy,* 22, 33-42.
[68] Damle Clay Structurals, Ltd. "Indian Clay Brick Industry – On the Threshold of Mechanisation," Available at: http://www.damleclaystructurals.com/Article6.htm Accessed 12 February 2010.
[69] Nepal Ministry of Environment, Science and Technology (2007) *Ambient Air Quality of Kathmandu Valley 2007*. Kathmandu, Nepal.

because of the high level of pollution produced by primitive kilns.[70] We have no additional information on the success of this order.

<u>Coke Production</u>

Coke production is concentrated in a relatively small number of coke making facilities (about 1500 worldwide) and is dominated by China, which produced 60 percent of global coke in 2008 and accounted for 96 percent of global production growth since 2000.[71]

A coke making technology is comprised of coke ovens, auxiliary equipment, and by-product recovery system. Three major types of coke ovens dominate current coke production.[72]

- **Beehive** – "Primitive" technology in limited use – probably primarily in China. Emissions from this technology are high – with black plumes suggesting large black carbon emissions. These ovens are also called "pile" or "kiln" ovens and in China they are called "indigenous" or "modified indigenous" ovens.
- **"Slot Oven"** – Modern technology ovens that recover a wide range of chemicals from coke oven gas. These coke ovens have many potential air emissions points. With proper maintenance practices and appropriate air emissions controls, black carbon emissions can potentially be reduced to very low levels. These ovens are also called "recovery" or "machinery" ovens.
- **"Non-recovery"** – Modern technology ovens that combust coke oven gas and may recover heat but not chemicals. These coke ovens have fewer potential air emissions points and thus tend to have lower air emissions than recovery ovens. These ovens are also called "heat-recovery" ovens.

Air pollution emissions vary by major coke oven type and appear high for the more primitive coke ovens – with black plumes often reported. Except in the non-recovery coke ovens, air pollution is very high compared with production of other commodities.[73]

<u>Control Options</u>

Upgrading from the more primitive coke ovens and installing appropriate emissions control technology can potentially reduce black carbon emissions to very low levels. A wide range of emissions capture technologies and equipment maintenance measures can be employed at different processing stages, which should yield particulate matter

[70] Rehman, F. (2009) 12 brick kilns directed to stop functioning. *The Nation (Pakistan)*. March 18, 2009.

[71] Polenske, K.R., Ed. (2006) *The Technology-Energy-Environment-Health (TEEH) chain in China: A case study of cokemaking*, Dordrecht, Netherlands: Springer.

[72] Ibid.

[73] Polenske, K.R, X. Zhang, S. Li, J. Li, and H. Liu (2009) *Cokemaking Report to the Clean Air Task Force*.

reductions and will likely result in reductions in black carbon. Modern coke ovens also have a combustion stack, which allows installation of pollution control technologies.[74]

Again, as with brick kilns, the lack of measurements of climate-relevant emissions constrain efforts to advocate for upgrading facilities, which likely can improve climate and air quality by reducing global coke oven black carbon emissions to much lower levels over one or two decades. Field measurements will be necessary to determine which actions reduce black carbon emissions and by how much.

Domestic Policy

The U.S. coke industry has been subjected to technology-based regulation of fugitive emissions for over 30 years. U.S. and European environmental regulation has demonstrated that air emissions – likely including black carbon emissions – can be reduced to very low levels through proper maintenance practices and installation of appropriate air emissions control technology. But, even in the U.S., the emissions from one coke oven are largely responsible for the surrounding area failing to meet national ambient air quality standards for particulate matter.[75]

International Policy

A significant fraction of China's primitive coke ovens have been phased out, with current estimates of such production ranging from ~5 percent to 20 percent of the total. Elimination of nearly all primitive coke oven production in China and replacement with modern kilns may occur within the next several years.[76]

Funding Options for International Black Carbon Reductions

The major obstacle to widespread replacement of cook stoves and availability of mobile pyrolysis units is money. Several funding options, probably implemented in combination, will be needed to help make the needed equipment available. These could include:

1. Set aside of carbon allowances or use of auction proceeds under the Climate Bill

In the Waxman-Markey bill, various climate mitigation technologies and programs are funded via the set aside of allowance value or through the use of auction proceeds. The Kerry-Boxer bill devoted a portion of the auction proceeds under the bill to fund diesel black carbon reductions, but nothing to international black carbon projects. Domestic and international programs to reduce black carbon emissions could receive allowance set asides and/or auction proceeds because they offer significant, immediate climate mitigation benefits.

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[74] Ibid.

[75] Weitkamp, E.A, E.M. Lipsky, P.J. Pancras, J.M. Ondov, A. Polidori, B.J. Turpin and A.L. Robinson (2005) Fine particulate emission profile for a large coke production facility based on highly time-resolved fence line measurements, *Atmos. Environ.* 39, 6719-6733.

[76] Polenske, K.R. *et al*. (2009), Op.Cit.

2. Offsets

A climate bill could recognize black carbon reductions as eligible for international offsets under a cap and trade program. Doing so, however, would not be as straightforward for projects that reduce the suite of six recognized greenhouse gases, which have an internationally accepted carbon dioxide equivalency factor. As part of the black carbon study, EPA is charged with investigating the question of whether projects such as cook stove replacement programs should qualify for "offsets" under a cap and trade program and, if so, what credit they should be given.

3. Global black carbon mitigation fund

One possibility for international black carbon reductions would be a financial mechanism that would provide "black carbon credits" funded via public or private participation. Current international climate negotiations in the "Bali track" encourage voluntary mitigation actions with near-term impacts; and black carbon provides one means to do this that has a significant health and environmental co-benefits. Interested countries could agree to pay for black carbon reductions at a fixed price. Moreover, since some of these black carbon reductions projects might arise via investments that provide other carbon and development benefits (such as vehicle filters reducing PM, agricultural burning reducing CO2, and displacement of high carbon and black carbon cook stoves with captured methane-fueled stoves), these separate revenue streams could backstop and be leveraged by a black carbon fund's base price guarantee.

International and National Venues for Black Carbon Mitigation

In the past two years, there have been a number of venues committed to: 1) better understanding the role of black carbon; and 2) recommending and developing abatement strategies. These include:

The Arctic Council was the first to consider early mitigation actions through its Arctic Monitoring and Assessment Program in September 2008. The eight Arctic Foreign Ministers issued the Tromsø Declaration of the Arctic Council during their April 2009 meeting, in which they highlighted the role of "short-lived climate forcers" such as black carbon, methane, and tropospheric ozone in Arctic climate change. They stated that reducing emissions of these forcers has "*the potential to slow the rate of Arctic snow, sea ice and sheet ice melting in the near-term.*" The Arctic Council has created two internal task forces to solidify the science and draft policy action steps to report out in 2011.

***The UN Convention on Long Range Transboundary Pollution (CLRTAP*)**, a "decision-making" body aimed at creating or revising binding international agreements**,** has been ratified by the EU, the U.S., Canada, and Russia. The convention establishes binding authority to impose specific pollution reduction measures on treaty signatories. In part in response to the Arctic Council's action, at its December 2009 meeting, the Executive Body of Convention decided to take up short-lived climate forcing pollution by establishing an ad hoc Expert Group on Black Carbon, with the mandate of completing its work and providing a report for consideration by the Executive Body at its twenty-eighth session in December 2010. The report is expected to identify options for potential revisions to the Gothenburg Protocol, which would enable the Parties to mitigate black carbon as a component of PM for health purposes while also achieving climate co-benefits.

The United Nations Environment Programme (UNEP) is undertaking a black carbon and tropospheric ozone assessment, addressing the climate change, public health and ecosystem impacts of measures to decrease concentrations of black carbon and tropospheric ozone. A final report to the UNEP Governing Council is anticipated in early 2011 and is expected to summarize the state of science and identify technological and policy options for different regions of the world, including mechanisms for international action.

US Strategic Initiative was announced at COP-15 by the U.S. State Department and signaled the Administration's intention to commit $5 million towards international cooperation to reduce black carbon emissions in and around the Arctic. This effort will seek to fill information gaps and develop and implement mitigation efforts that could help reduce Arctic warming while yielding significant direct public health and ecosystem benefits. The U.S. anticipates these funds will be matched by other nations. Federal agencies currently are submitting proposals for spending these funds.

United Nations Framework Convention on Climate Change (UNFCCC) At COP-15, treaty language requesting governments and the UNFCCC to begin taking into account the impact of short-lived climate forcers was successfully negotiated and agreed to in one of the texts, the "LCA" (Long-term Cooperative Action) or "Bali track" text. The section refers to the need to address near-term and mid-term climate change and was spearheaded by Micronesia, actively supported by Norway, the EU and the U.S. Although this section is now non-bracketed or "agreed to", the status of the LCA text in relation to the Copenhagen Accord remains unclear, and it will be important to track this issue closely in the upcoming negotiating sessions. The Accord contains no such reference.

The Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010 directed the EPA Administrator to carry out and submit to Congress the results of a study on domestic and international black carbon emissions. The report, due in April 2011, will inventory major sources of black carbon, assess the impacts of on global and regional climate, assess potential metrics and approaches for quantifying the climatic effects, identify the most cost-effective approaches for reductions, and analyze the climatic effects and other environmental and public health benefits to the identified approaches.

Bounding the Role of Black Carbon in Climate. This scientific assessment, sponsored by National Oceanographic and Atmospheric Administration's (NOAA) Atmospheric Chemistry and Climate Initiative[77] draws on over 30 authors worldwide with deep black carbon scientific expertise. The team will address a broad suite of critical questions

[77] See: http://www.igac.noaa.gov/ACandC.php

associated with sources, climate responses and key uncertainties of black carbon. A final paper, slated for completion in June 2010 for submission to a peer-refereed journal, will derive the best estimate for radiative forcing from black carbon.

CONCLUSION

Policies targeting black carbon emissions offer a viable climate strategy that can be implemented without delay and will deliver immediate climate benefits using technology available today. Moreover, black carbon reduction policies can deliver important public health protection from particulate matter pollution, one of the most potent and widespread air pollution-related public health threats. Winning these policies domestically and globally will be challenging, but their significant health benefits make them extremely cost-beneficial and they may constitute our best hedge against near-term climate impacts.