Aftermath of Superstorm Sandy along the New Jersey Coast

Fossil Fuel Risk Bonds

Safeguarding public finances from product life cycle risks of oil, gas, and coal

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Center for Sustainable Economy

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Summary

- ✓ Governments at every level face burgeoning economic and financial risks from fossil fuel extraction, storage, refining, transport, and combustion – including risks associated with climate change.
- ✓ Sources of risk include explosions, spills, abandoned infrastructure and mines, extraction-related earthquakes, toxic contamination, climate-induced natural disasters, and the costs of climate adaptation.
- ✓ Insurance markets and existing financial assurance mechanisms, including "self-bonding," are inadequate for protecting public finances from these risks. Fossil fuel risk bond programs offer a solution.
- ✓ Fossil fuel risk bond programs are systematic efforts by state and local governments to evaluate and respond to the financial risks they face at each stage of the fossil fuel product life cycle in their jurisdictions.
- ✓ Fossil fuel risk bond programs embody two major approaches for internalizing risk. The first involves expanding the scale and scope of conventional financial assurance mechanisms to safeguard public finances against risks associated with extraction, refining, storage, and transport.
- ✓ The second approach includes surcharge-based trust funds that can be tapped to cover the costs of climate-related disasters, climate adaptation, air and water pollution, earthquakes, and other pervasive hazards associated with fossil fuels.
- ✓ Fossil fuel risk bond programs work in tandem with other market-based solutions for internalizing the social costs of carbon. But unlike other approaches, fossil fuel risk bond programs are directly targeted at public financial risks.

I: Governments at every level face substantial economic and financial risks from fossil fuels and climate change.

The motivation for fossil fuel risk bond programs is simple. The public now faces enormous economic and financial risks associated with extraction, storage, refining, transport, and combustion of fossil fuels, the impacts of climate change, and the costs of adapting to it. These risks are wholly externalized onto communities rather than incorporated into the costs of doing business. The *Stern Review on the Economics of Climate Change*, a 700-page report released for the British government in 2006 and authored by economist Nicholas Stern called climate change "the greatest market failure the world has ever seen."[1] A recent report by the International Monetary Fund (IMF) found that the externalized costs of pollution from coal, oil, and natural gas were "one of the largest externalized costs ever estimated," amounting to a staggering 6 percent of global GDP.

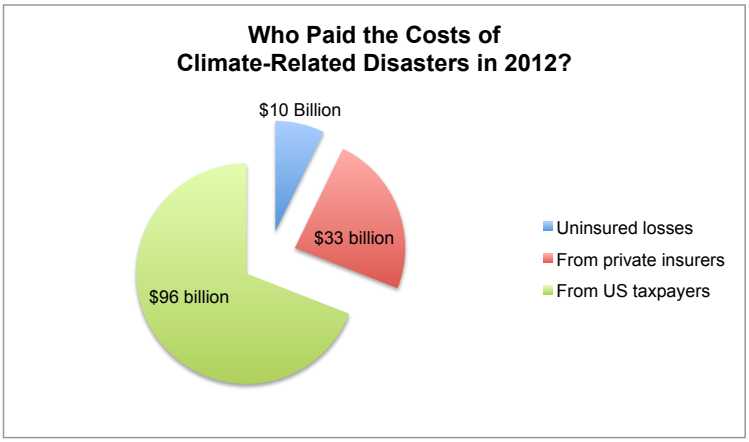

Figure 1: *Distribution of disaster-related costs in 2012. Source: Natural Resources Defense Council.*

Many of the externalized costs associated with fossil fuels are being now or will be borne by public agencies at every level of government. For example, the insurance industry estimates that 2012 was the second-costliest year in US history for climate-related disasters, with $110 billion in weather-related property claims.[2] Yet private insurers picked up only 25 percent of the tab, leaving the other 75 percent for US taxpayers to cover — a total of $96 billion, which amounted to more than the federal government spent on education or transportation in 2012 (Figure 1).[3]

In addition, taxpayers are now wholly responsible for the costs of climate change adaptation projects that will protect communities and public infrastructure from extreme weather events, collapse of ecosystems, public health threats and sea level rise. Recent reports suggest we may see as much as nine feet of sea level rise by 2050.[4] Protecting Miami will cost $4 billion for just one foot of sea level rise, and the city is expected to spend $300 to $400 million to upgrade infrastructure over just the next few years.[5] Globally, the cost of climate change adaptation has been forecast to range from $44 to $170 billion per year by 2030.[6] These are all big financial risks for federal, state, and local public agencies already being stressed by a culture of cutbacks.[7]

Other economic risks externalized onto communities by the fossil fuel industry include abandoned infrastructure, water pollution from spills and waste discharges, property damage associated with hydraulic fracturing–induced earthquakes, and the risk of catastrophic explosions, such as when mile-long oil trains derail and explode in communities across the country, as they are expected to continue to do with alarming regularity — perhaps 10 times per year over the next 20 years, at a cost of $4.5 billion.[8]

And while the US is slowly increasing grants and technical assistance to state, local, and tribal governments for climate adaptation, climate funding is prioritized elsewhere — mostly on research and clean energy. In 2014, less than 1 percent ($110 million) of the $21.4 billion budget authority for federal climate programs was earmarked for adaptation.[9] Moreover, many state and local officials are "dissuaded from applying to federal programs in the first place due to concerns about onerous reporting requirements and complicated paperwork."[10] As such, public finance officials at the state, county, and municipal levels need not wait for Congress to better fund federal programs or to streamline application procedures. Actions can be taken now to protect public coffers and create new sources of revenues for climate adaptation. But to understand this, we must first understand a bit more about the burgeoning sources of financial risk throughout the fossil fuel product life cycle.

II: Sources of financial risk can be inventoried at each stage of the fossil fuel product life cycle.

Fossil fuels create numerous sources of public financial risk. The fossil fuel product life cycle provides a convenient sequence to examine each source. There are five main stages to that life cycle, each of which poses its own distinct risks: (1) extraction; (2) transport; (3) refining; (4) storage; and (5) combustion.

Extraction

The extraction of oil, gas, or coal through either conventional or unconventional means exposes public agencies to a number of financial risks associated with abandoned wells, mines, and infrastructure, leaks, blowouts, water pollution, spills, earthquakes, overtaxed social services, employment volatility, and infrastructure stress. For example:

- Abandoned mines and wells are a growing source of risk as the transition away from fossil fuels accelerates. Since 1977, the federal Office of Surface Mining has spent over $4 billion to clean up dangerous abandoned mine sites.[11] In Pennsylvania, the cost of treating acid mine drainage from legacy coal mining has been estimated to be on the order of $15 billion.[12]

- Catastrophic well blowouts such as the BP Deepwater Horizon disaster in the Gulf of Mexico and the Porter Ranch methane leak in California pass significant costs onto taxpayers. Although BP settled out of court for $20.5 billion, it was able to claim a $5.35 billion tax write off and thereby shift this amount back onto taxpayers. The estimated legal costs of the Porter Ranch gas leak — which, having released roughly 97,100 metric tons of methane over 112 days, is the worst manmade methane leak in US history — have reached $665 million. Insurance is expected to cover $1 billion of the legal costs, but they could rise higher. However, the full costs of this enormous leak, which spewed out of control for four months and displaced thousands, will be paid by all of us in the form of further destabilization of the climate.[13]

- The "boom town" nature of volatile fossil fuel extraction activities stresses the capabilities of local governments to keep up with infrastructure and social service demands. In North

Dakota, the oil boom has severely taxed its roads and bridges (Figure 2). The crash in oil and gas prices in 2016 has jeopardized repayment of a $300 million debt the City of Williston took on to accommodate new roads, schools, and water treatment plants.[14]

Figure 2: *North Dakota's oil and gas boom has stressed its roads well beyond capacity.* Source: Minneapolis Star Tribune.

- Wastewater from hydraulic fracturing ("fracking") contains toxic chemicals that may reduce the quality of rivers and streams to the point where municipalities must invest in additional water treatment options in order to make the water safe to drink. New York's decision to ban high-volume fracking was put in place partly in response to the prospect of spending $10 billion or more to construct a filtration plant to maintain high-quality water for over nine million New York City residents.

Transport

Moving vast quantities of oil, coal, natural gas, and other fossil fuels by rail, pipeline, ship, and truck creates enormous financial risks for communities within transportation corridors. Catastrophic spills and explosions are rare, but when they do occur, public costs can be substantial. According to Sightline Institute, the Lac-Mégantic oil train disaster — which killed 47 people in a dramatic explosion — generated an estimated $2 billion in liabilities, with the cleanup alone projected at $200 million. The train's operator, MM&A, a short-line railroad transporting the crude from a Canadian Pacific (CP) yard to a refinery in New Brunswick, had just $25 million in liability insurance. Soon after the accident, MM&A filed for bankruptcy protection. So far, Canadian federal and provincial governments are paying the cleanup costs.[15] Following the 1989 Exxon Valdez oil spill, the US government's $1.1 billion settlement had an after-tax cost to Exxon of only $524 million. More than half of the $900 million in civil damages Exxon paid were tax-deductible.[16]

While these dramatic examples are alarming, a larger source of taxpayer risk may be thousands of smaller, more frequent, but still costly accidents. Highway crashes involving hazardous material shipments have a societal cost of more than $1 billion a year, according to a study published by the Federal Motor Carrier Safety Administration.[17] The exponential growth of natural gas pipelines in the US has created new sources of risks with which state and local

governments are just beginning to grapple. Hundreds of smaller-scale explosions, spills, and hazardous vapor releases occur along pipeline routes each year. Between 2002 and 2013, significant accidents involving pipelines resulted in over $5.6 billion in property damages.[18]

Refining and storage

Refining and storing large quantities of volatile petroleum products also presents a host of financial risks to local governments — including industrial disasters, pollution, and abandonment of toxic infrastructure. Recent history is full of deadly accidents.

- In 2005, a catastrophic vapor cloud explosion at the Texas City Refinery killed 15 workers, injured more than 150 others, and shattered windows nearly a mile away. For hours after the explosion, 75 local, regional and industrial emergency response units surrounded the site and battled the blaze, crowding the skies with helicopters to the point where the Federal Aviation Administration issued a no-fly zone 3000 feet high and 3 miles wide.[19]

- In 2013 a Williams Olefins petrochemical plant exploded in an industrial area southeast of Baton Rouge, Louisiana. The disaster killed two, injured 120, and was felt over five miles away. A shelter-in-place order was issued to residents and businesses within a two-mile radius. The Ascension Parish's emergency operations center was activated with police, fire, Homeland Security and other emergency officials on the scene.[20]

- In 2015, a blast at the ExxonMobil Torrance refinery in southern California left four workers injured, emitted a 200-foot tall column of smoke, and required partial shutdown of the plant. Wholesale gas prices rose 6 to 10 cents in California in response.

What these examples illustrate is that the public bears immediate and substantial costs associated with first responders, disruption of household and business activity, offsite damage repairs, investigations and consumer price effects – costs that are not fully compensated by subsequent fines or civil cases, most of which may not be settled for years afterwards.

Another major source of public financial risk associated with storage and refining facilities is the abandonment of sites before they are cleaned up and restored. The history of the federal Superfund toxic waste cleanup program is a sordid tale of taxpayers ultimately being forced to pay for polluters' carelessness. The program was created by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The law granted the federal government the authority to clean up pollution that threatened human health. It also allowed the Environmental Protection Agency to identify responsible parties and force them to pay for the cleanup; when responsible parties could not be found, the agency cleans the sites. Agency-funded cleanups were initially funded by a trust fund largely financed by a tax on energy companies. That tax lapsed in 1995 and the fund has dwindled, meaning most cleanup money now comes from general revenues paid by taxpayers. The EPA now spends roughly $1.2 billion on Superfund annually.[21]

Moreover, even when responsible parties are identified, bankruptcy laws often protect them. According to a 2007 investigation by the Center for Public Integrity, "[f]our companies connected by the Environmental Protection Agency to some of America's worst toxic waste sites have escaped more than half a billion dollars in pollution cleanup costs by declaring bankruptcy, potentially passing the tab onto taxpayers."[22]

Combustion and climate change

The combustion of fossil fuels in power plants, industrial facilities, and vehicles is the final stage in the fossil fuel product life cycle and perhaps the costliest for taxpayers. As climate change unfolds, many sectors of the economy are threatened with declining productivity, output, jobs, and income as the human and natural resources they rely upon are damaged or made scarcer. As these sectors contract, so too do tax revenues on which public agencies rely.

The EPA has synthesized anticipated economic costs incurred in six broad sectors – health, infrastructure, electricity, water resources, agriculture and forestry, and ecosystems. They have also examined costs that can be avoided if greenhouse gas (GHG) mitigation is successful at keeping global temperature increases below 2° C.[23] For example, without mitigation, EPA estimates that by 2100 water shortages could present an annual cost of up to $180 billion. Annual losses in labor productivity due to heat stress and other health impacts could approach $170 billion. All these effects will reduce public tax revenues and increase costs of providing a social safety net in the form of unemployment benefits, health care, and other social services for hard hit families. Taxpayers may also be asked to finance expensive interventions (like bailouts) to shore up ailing businesses and industries while they try to adapt.

Not only do public agencies and, ultimately, taxpayers bear the burden of climate change costs, but they also bear the costs of adapting to it. State by state, the costs of necessary adaptation expenditures are beginning to be evaluated and updated. In New York, for example, the state's Energy Research and Development Authority, in collaboration with a team from Rutgers University, has analyzed the costs and benefits of adaptation measures for water resources, coastal zones, ecosystems, agriculture, energy, transportation, communications, and public health. Minimum adaptation costs by mid-century are expected to be $560 million per year or more (Table 1). Potential financing strategies all involve traditional approaches, like municipal bonds, that are ultimately repaid by taxpayers.[24]

Table 1: New York State 2050 Climate Adaptation Cost Estimates By Major Sector[25]

Sector	Cause of adaptation response	Annual cost ($2016 millions)
Water resources	Flooding of wastewater treatment facilities	$51.31
Coastal zones	Property damages	$31.66
Ecosystems	Recreation, tourism, ecosystem service losses	$34.93
Agriculture	Dairy and crop losses	$85.15
Energy	Outages	$20.74
Transportation	Damage from severe weather events	$316.59
Communications	Damage from severe weather events	$13.10
Public health	Heat mortality and asthma hospitalization	$6.55
	Total annual adaptation cost:	$560.03

III: Insurance markets and existing financial assurance mechanisms are inadequate for protecting public finances from these risks.

Private insurance markets and financial assurance regulations provide at least a modicum of protection for public finances from some of these risks. Private insurance is regularly required for industrial facilities to cover the costs of accidents. Increasingly, environmental liability insurance is being used to cover the costs of pollution associated with these accidents or releases caused by severe weather.[26] Financial assurance instruments require potential polluters to demonstrate — before the fact — that they have financial resources adequate to compensate for environmental damages that may arise in the future.[27] (Specific types of financial assurance instruments available to companies will be discussed in the next section.) The federal government and most states require at least some form of financial assurance — most often in the form of surety bonds — to cover the costs of decommissioning and dismantling wells, pipelines, and drilling platforms, mine reclamation, and restoring sites to their natural condition. But these existing mechanisms are wholly inadequate to protect public finances from the litany of financial risks posed by the fossil fuel industry. The reality is that the fossil fuel industry commonly shifts most accident, closure, and post-closure liabilities onto federal, state, and local governments.[28] There are three main reasons for this: (1) lack of suitable mechanisms; (2) inadequate coverage; and (3) lack of political will or capacity.

Lack of suitable mechanisms

Insurance and financial assurance mechanisms have not been developed for many categories of fossil fuel–related risks because the nature of these risks is dispersed and therefore difficult or impossible to attribute to a particular facility owned and operated by a particular company. Every entity that participates in the fossil fuel life cycle is responsible for at least some portion of the financial risks associated with droughts, wildfires, sea level rise, floods, and other climate disasters as well as the socioeconomic costs of boom-and-bust cycles. But using conventional insurance and financial assurance mechanisms is not an option because when these disasters or socioeconomic ills manifest there is no single entity to blame.

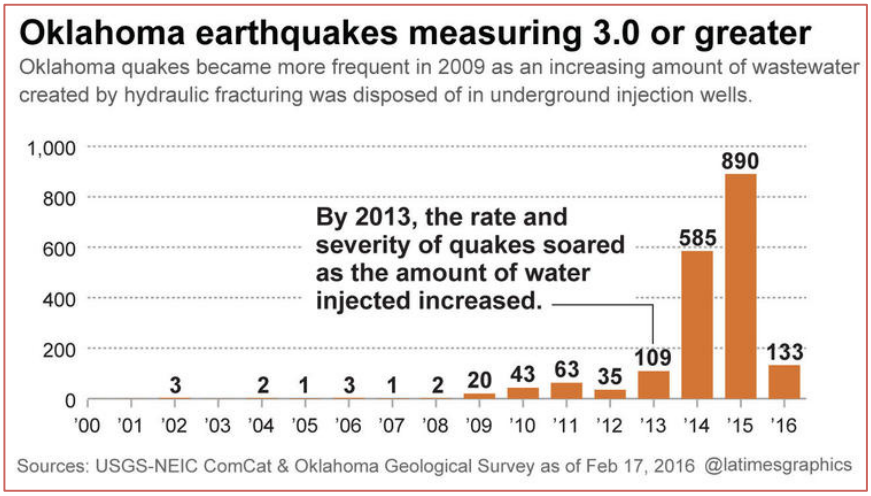

Figure 3: *Oklahoma earthquakes and fracking. Despite the correlation, there is no financial liability assigned for the damage. Source: LA Times.*

Nor can conventional approaches be used even when effects are more localized. For example, in Oklahoma, the relationship between the rate and severity of earthquakes and wastewater injection from fracking has

been well documented (Figure 3) — so much so that the State Corporation Commission has asked oil producers in the northwest part of the state to reduce injections by 40 percent.[29] But producers are not being held liable for earthquake damage because no one quake can be attributed to a single producer. Instead, public agencies must bear the full cost of earthquake damage to public buildings and infrastructure. According to the USGS, fracking-induced earthquakes "create seismic hazard to buildings, bridges, pipelines, and other important structures and are a concern for about 7.9 million people living in the vicinity of these events."[30]

Governments are not alone in bearing these externalized costs. Homeowners are forced to pay higher premiums. Recent studies from the Insurance Information Institute suggest demand for insurance premiums to cover quake-related damage to homes rose by 70 percent between 2010 and 2012.[31] While premiums may have increased, the damages covered by quakes are routinely denied. Nine out of 10 quake claims filed in 2014 were denied, according to Oklahoma Insurance Commissioner John Doak. Even when they were not denied, homeowners are expected to pay a high deductible toward the cost of repairs — up to as much as 10 percent of the value of the home.

Inadequate coverage

When they do exist, coverage amounts under these existing financial assurance mechanisms are often woefully inadequate. Insurance coverage for catastrophic explosions of refineries, oil trains, and export terminals is so low that it even calls into question the very applicability of the concept of private insurance for such disasters.[32] Bonding requirements for reclamation of oil, gas, and coal fields are well below the true cost of reclamation and so when mine or well owners go bankrupt or default for other reasons, taxpayers are likely to incur the remaining liability. A recent report by three conservation groups found that "coal companies have fallen far behind in reclaiming mines, and, with the coal industry on shaky financial ground, the public faces increasing liability for massive reclamation costs of more than $2 billion and damage to landscapes, wildlife and crucial water supplies."[33] According to the GAO, the Bureau of Land Management (BLM) holds nearly 4,000 bonds valued at $162 million, but bond amounts are based on regulatory minimums and not full reclamation costs.[34]

A 2013 report by CSE found that bonding covered just 25 to 50 percent of the full costs of removing oil platforms and pipelines in Alaska's Cook Inlet and restoring their footprints to a natural condition.[35] A recent GAO study found that as of October 2015, the federal government was potentially liable for about $2.3 billion in decommissioning costs for offshore oil and gas infrastructure in the Gulf of Mexico due to inadequate financial assurances.[36]

Exacerbating this bonding gap is overreliance on the practice of "self-bonding." A self-bond is backed only by a company's good name and overall financial health and not by any required sureties or specific pledges of collateral. Recently, the practice has come into focus with news of the bankruptcy declarations of several major coal producers and a growing chorus of alarm from state regulators.[37] It is estimated that the four largest coal companies in the U.S., Peabody (bankrupt]) Alpha, Arch Coal (bankrupt) and Cloud Peak Energy, have over 58% ($2.7 billion) of their reclamation obligations ($4.6 billion) "covered" by self-bonding, but audits of their financial data suggest that they will have inadequate funds to actually cover that cost.[38]

Lack of political will or capacity

Often, decision makers do not avail themselves of the financial assurance opportunities at their disposal or provide adequate enforcement — often due to the political influence wielded by fossil fuel interests or limited bureaucratic capacity. In Alaska, the oil and gas industry has fought vociferously to resist long-overdue upgrades to the state's bonding requirements for decommissioning, removal, and restoration of aging oil infrastructure sites. Few state and local governments require financial assurance to revitalize abandoned gas stations and other sites left behind by the fossil fuel industry beyond the removal of underground storage tanks.[39]

Use of environmental liability insurance is uncommon. Although such insurance has been available for over 25 years, "only a small portion of environmental risk is properly insured today."[40] Enforcement of existing mechanisms is often lax. According to the EPA, only 16 states require proof of financial responsibility for underground storage tanks on an annual basis, and 25 check owners' coverage less often or not at all.[41]

IV: Fossil fuel risk bond programs are a solution, and embody two major approaches depending on the nature of risk involved.

As proposed here, fossil fuel risk bond programs are systematic efforts by state and local governments to evaluate and respond to the financial risks they face at each stage of the fossil fuel lifecycle in their jurisdictions. The goal is to transfer financial risks back where it belongs in an efficient market economy – on the entities responsible for creating the hazards in the first place. Specific fossil fuel risk bond program instruments can be grouped into two broad categories. The first category of risk bonding for fossil fuels would consist of conventional financial assurance instruments that address discrete risks caused by particular entities in particular places – such as abandoned infrastructure, explosions, or localized pollution. Fossil fuel risk bond programs can expand the scale (i.e. required coverage amounts) and scope (i.e. types of hazards covered) of these conventional instruments. The second category of risk bonding for fossil fuels would consist of surcharge-based climate or natural hazard risk trust funds that deal with pervasive risks multiple entities contribute to – such as earthquake swarms, groundwater pollution, climate disasters, and adverse impacts on public health.

Approach 1: Expanding the scale and scope of conventional financial assurance instruments

Conventional financial assurance instruments come in a variety of forms. For example, Washington State's Department of Ecology has a useful online portal that explains the pros and cons of various existing financial assurance instruments including trust funds, letters of credit, insurance, financial tests, corporate guarantees, payment (surety) bonds, and performance bonds.[42] In Washington State, regulated entities are allowed to choose the most appropriate form of financial assurance with the most important distinction drawn between self-demonstrated and purchased assurances.

Self-demonstrated assurances (i.e., self-bonding) are simply agreements made by companies to follow through on their obligations to remedy environmental damages, clean up infrastructure, or respond to accidents. The agreements are backed by a company's own good

name and sometimes demonstrated with line items carried forward on internal balance sheets. Financial tests fall into this category, as do corporate guarantees. The financial test requires a company to meet very strict financial performance standards. If the company passes the test, they can use it to meet the legal requirements for financial assurance. In Washington, companies that use this option must submit a mandatory form along with a copy of their audited financial statements for the previous year and a special report from their accountants. Corporate guarantees are similar, but rely on the good faith and credit of parent companies if the regulated entity is a subsidiary.

Purchased assurances are provided by third parties. They include insurance, bonds, letters of credit, certificates of deposit, and trust funds that involve the services of third-party private financial providers, including insurers, sureties, banks, and lenders. In each case, companies pay premiums or fees to maintain a specified level of coverage that the third party pays out in the event of a claim or a default by the regulated entity. The insurance mechanism is generally relevant for accidents, such as a breach of a mine tailings pond and subsequent contamination of water supplies. Bonding mechanisms are generally relevant for performance-related obligations, such as the obligation to remove infrastructure and reclaim affected sites. Here, the regulated entity pays a bonding company an annual premium, and that company, in turn, agrees to reimburse the government for any unfulfilled obligations should the entity default. The amount of bonding required is typically set by regulation.

Letters of credit and certificates of deposit are services provided by banks. A letter of credit is a promise by the bank to pay the amount of the credit if asked to do so by the regulator. An annual fee is paid to maintain the letter of credit at the requisite level. Certificates of deposit (CDs) are issued when the regulated entity deposits funds sufficient to cover the full amount of the obligation. If the entity defaults, the regulating agency will draw on the CD to cover its costs. Trust funds are established voluntarily by the entity, but are managed by the bank under a trust agreement approved by the regulating agency. Like CDs, financial assurance trust funds typically require deposits of the full amount of the obligation, but unlike CDs, the bank actively manages them. As such, they can gain or lose money depending on how wisely they are invested.

Fossil fuel risk bond programs would involve several major tasks to ensure that these conventional instruments offer comprehensive coverage for all of the risks that arise in association with extraction, transport, storage, and refining. These tasks include:

- *Requiring financial assurances for infrastructure and risks not yet covered.* Financial assurance requirements have not kept pace with the proliferation of new oil and gas infrastructure in the United States. For example, few jurisdictions require assurances for intrastate natural gas distribution pipelines. State and local governments have broad authority to regulate these intrastate pipelines.[43] As part of this oversight, financial assurances should be required as a tool to reduce public financial risks from explosions, leaks, pollution, and abandonment.

- *Upgrading financial assurance mechanisms in place.* As discussed above, financial assurances now being used are often far from adequate to safeguard public finances. Required insurance and bonding coverage should reflect worst-case potential costs to the public.[44]

- *Eliminating self-demonstrated assurances.* The practice of self-insurance and self-bonding should be abandoned in favor of purchased assurances involving third parties. As the transition to renewable energy accelerates, the future financial solvency of fossil fuel companies is now uncertain enough to justify the use of more robust financial assurance mechanisms. Moreover, self-demonstrated assurances have proven very difficult for public agencies to monitor.[45]

- *Government-backed insurance for catastrophic events.* State and local governments can directly intervene in insurance markets to guarantee compensation for victims of catastrophic events and natural resource damages in a manner that minimizes public payouts.[46] For example, governments can provide such insurance directly and receive premiums from regulated entities to offset disaster costs. Or governments can share catastrophic risk with the private sector by acting as a reinsurer of last resort.

Approach 2: Establishing climate risk trust funds

Pervasive risks attributable to multiple entities involved in the fossil fuel product life cycle require a different approach. Climate risk trust funds (CRTFs) offer a solution. CRTFs can be established at any level of state or local government, and would be capitalized by a surcharge on all fossil fuel transactions in the jurisdiction. The surcharge rate can be based on a jurisdiction's expected costs associated with climate change, climate adaptation, and other pervasive risks such as earthquake swarms and pollution and be levied on each ton of carbon dioxide equivalent (CO2-e) embodied in fossil fuels extracted, transported, stored, distributed, and combusted (at least by industry and power plants) by any source in a given jurisdiction.

Table 2 illustrates how current climate change and adaptation costs for Alaska, Maryland, and Texas can be used as a basis for surcharges. (The figures for climate costs are approximate and incomplete and so this is a stylized illustration for demonstration purposes only.) The basic approach involves converting current cost estimates by mid-century (e.g., by mid-century Alaska will have spent at least $96 billion on adaptation and other climate costs) into annualized costs from the current time period forward and then calculating what surcharge would be necessary on each fossil fuel transaction in the economy to offset those costs.

Annualized costs include the opportunity costs of capital (OCC) to reflect that money tied up in adaptation projects will not be available for other uses. So in our stylized example, Alaska's CRTF would be capitalized through surcharges of $38.75 per metric ton CO2-e on all coal, oil, and gas transactions in the economy in order to offset expected annual climate change and adaptation costs of $9.06 billion. Figure 3 illustrates how these surcharges would stack up relative to retail prices using mean Table 2 surcharges across all three states and recent retail prices for gasoline and natural gas. In this example, the surcharges would raise the price of a gallon of gasoline by roughly 6 percent (15 cents) and the price of a thousand cubic feet of natural gas by 9 percent (91 cents).

	Alaska	Maryland	Texas
Climate cost projections through mid-century ($2016 billions)	$96.00	$23.70	$137.80
Annualized cost with 7% OCC ($ billions)	$9.06	$2.23	$13.00
Embodied carbon dioxide (metric tons CO2-e) in production and trade			
Annual production			
Coal	4,200,000	10,573,715	204,610,407
Oil	60,000,000	-	496,587,650
Natural gas	33,350,000	3,744,000	362,972,174
Annual trade			
Coal	4,620,000	17,368,125	225,071,448
Oil and petroleum products	90,000,000	40,162,000	546,246,415
Natural gas and liquids	41,687,500	11,723,400	399,269,392
Total embodied CO2 (metric tons)	233,857,500	143,571,240	2,234,757,486
Surcharge per metric ton CO2	$38.75	$15.58	$5.82
Surcharge plus equitable sharing premium	$48.44	$19.48	$7.28

Table 2: *Requisite surcharges to capitalize climate risk trust funds for statewide climate costs. Stylized calculations for Alaska, Maryland, and Texas.*

Surcharge rates can be adjusted as new or more accurate cost projections are made available. Money deposited into CRTFs can be managed by a third party, a quasi-public trustee with fiduciary responsibility to invest these funds wisely. Governments would have broad but not unlimited discretion to use the funds to offset public costs of climate-related natural disasters, to pay for the costs of climate adaptation, or to pay for economic damages associated with fossil fuel production and trade that are difficult to attribute to a single entity. For example, consider a county in which oil, gas, and coal extraction takes place that is also suffering the effects of a strengthening climate change signal in the form of regular 100-year floods. CRTFs maintained by that county could be used to (1) compensate homeowners for fracking-related earthquake damage; (2) pay for the costs of filtering water contaminated by tailing pond leaks; (3) pay for the increased public service cost burden associated with oil or gas boomtowns; and (4) relocate infrastructure from floodplains.

A transparent public process should inform rules for what constitutes a legitimate withdrawal from the CRTFs and to establish other important design features. A reimbursement mechanism is one design feature that could be used to incentivize early exit from fossil fuel markets. When payees into the CRTF cease fossil fuel extraction, transport, storage or combustion activities and comply with all postclosure cleanup and restoration activities, the amount they have paid into the fund would be refunded with interest minus a proportional share of the jurisdiction's payouts and money reserved for future adaptation expenses. The incentive also works in the other direction by motivating governments to invest in adaptation now rather than just sit on the funds until the adaptation projects becomes a last-minute, urgent imperative.

Another design feature could be equitable sharing premiums that allow state and local governments to participate in global efforts to promote climate justice. For example, a percentage of payouts from CRTFs could be earmarked for international assistance to nations, states, provinces, or cities that have little or no fossil fuel production or consumption but face enormous climate costs. Pacific island nations exemplify this situation. Surcharges could be modified upward to offset the fiscal impacts. The effect of a 25 percent equitable sharing premium is reflected on the last line of Table 2 — it would, for example, raise the Maryland surcharge from $15.58 to $19.58 per metric ton CO2-e. If these premiums were added as a design feature, a

portion of CRTF funds could be segregated as international grant or aid funds awarded through one of the emerging international mechanisms for North-South climate adaptation funding transfers such as the international Climate Adaptation Fund.[47]

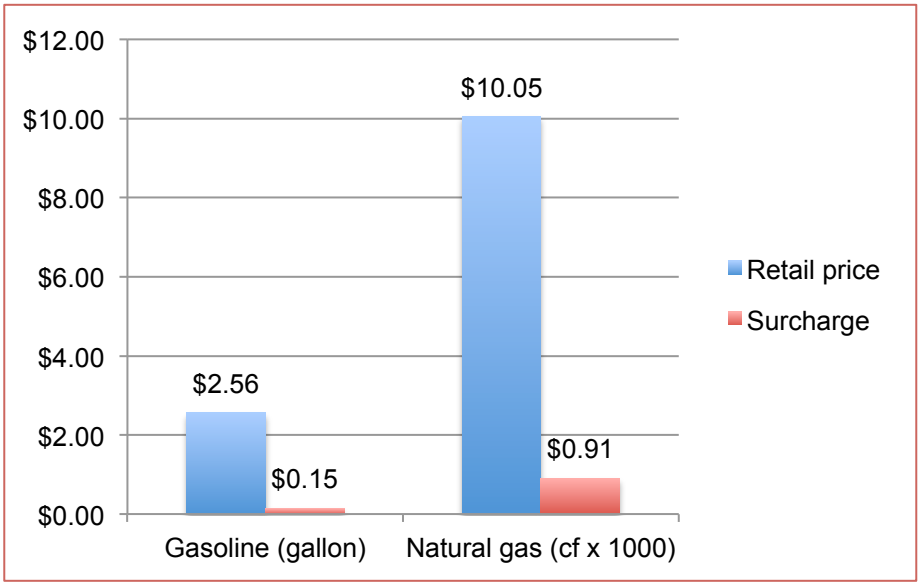

Figure 4: *Climate risk trust fund surcharges relative to retail price.*

The CRTFs are innovative, but they have precedent in the context of many existing state and local government programs. One example is an Oregon program administered by the Energy Facility Siting Council (EFSC). The EFSC provides energy facilities the option to pay into a climate trust fund at an "amount deemed sufficient to produce the reduction in greenhouse gas emissions necessary to meet the applicable carbon dioxide emissions standard."[48] The trust fund is administered by a nonprofit (The Climate Trust) and disbursements from the fund are used to offset GHG pollution from new energy projects to meet a carbon dioxide emissions standard that is 17 percent below the best-available technology.[49] Although CRTFs would not be established for offset purposes as they are understood under cap-and-trade mechanisms, what the Oregon example illustrates is a workable example of a state government establishing a quasi-public trust fund capitalized through fossil fuel charges and maintaining strong regulatory oversight over how that fund is managed.

State and local governments may have urgent climate costs to deal with and be unable to wait until CRTFs fully mature. In these cases, a hybrid approach involving green (environmentally oriented) municipal bonds and CRTFs together presents an important option to consider. As a future revenue stream, surcharges used to capitalize CRTFs can serve as collateral for issuance of green municipal revenue bonds earmarked for climate adaptation purposes. Revenue bonds are bonds issued by a jurisdiction that, in essence, borrow money against future revenue streams. In this case, CRTFs, which are based on surcharges on all fossil fuel transactions, would provide the backing for immediate issuance of green revenue bonds to provide a substantial short-term source of financing for climate adaptation or mitigation projects that would otherwise have to wait in a queue as CRTF funds are collected. Nearly all existing green bonds issued by cities and states are financed by taxpayers. In contrast, CRTFs provide an opportunity to shift the burden back onto polluters.

Implementation steps to get fossil fuel risk bond programs up and running

Each unit of state and local government in the US has the authority and economic incentive to get fossil fuel risk bond programs up and running as soon as possible. There are five major (concurrent) steps to consider:

1. *Risk assessment for infrastructure and trade.* It is important for state and local governments to inventory all fossil fuel infrastructure and the pattern of fossil fuel trade in their jurisdictions in order to evaluate the risks to public finance. In determining potential public financial liabilities, it is important to consider both the probabilities of various accident and abandonment scenarios and the economic damages that would occur. Although modeling various scenarios is important, including a worst-case scenario is critical since adequate financial protection against this scenario would, by definition, also guard against risks associated with less costly events. However, it is also important to consider the everyday risks (such as highway accidents involving hazardous materials or minor gas leaks) that add up to big taxpayer expenses over time. The end result of this exercise would be an expected financial cost stream that could be projected forward and rolled up into a single cost estimate at some future date such as those presented in Table 2.

2. *Climate change cost assessment.* Every state, county, and city should also have in hand at least an initial cost assessment that includes expected costs of climate change, climate adaptation, and implementation of climate action plans. The cost assessment should be extended several decades out into the future, as in Table 2. Surprisingly, only 14 states have finalized a climate adaptation strategy and few have yet to prepare cost assessments.[50]

3. *Inventory and upgrade of existing financial assurance instruments.* All existing financial assurance mechanisms applicable to fossil fuel infrastructure and the fossil fuel trade should be inventoried, evaluated, and upgraded to ensure that all significant potential public financial liabilities are covered. Where gaps exist, new financial assurance rules should be promulgated.

4. *Establish climate risk trust funds.* State and local governments that face significant public financial risks associated with climate change should consider establishing climate risk trust funds (CRTFs) capitalized by surcharges on all fossil fuel transactions in the local economy. Green revenue bonds backed by expected surcharge revenue streams could be issued to finance the most urgent adaptation needs while CRTFs accumulate. CRTF funds can be tapped to cover all climate-related costs a jurisdiction incurs, as well as the costs of establishing and operating fossil fuel risk bond programs.

5. *Updating cost and risk projections.* Projections of climate-related costs and financial risks associated with the fossil fuel trade will need to be updated on a regular basis to ensure that financial assurance instruments and CRTF surcharges are based on the best available models and data.

VI: Climate risk bond programs work in tandem with other market-based solutions for internalizing the social costs of carbon.

The most prominent market-based approaches for internalizing the costs of climate change are carbon taxes and cap and trade. Fossil fuel risk bond programs offer a third approach that can be implemented in tandem with either. The important distinction between them is that fossil fuel risk bond programs are targeted directly at minimizing the public's exposure to financial losses incurred as part of the fossil fuel industry's operations, while the other approaches are targeted at reducing GHG emissions.

The effects of either carbon taxes or cap and trade on public climate finance are murky, especially for revenue-neutral approaches that cut taxes elsewhere. In Washington State, for example, the most popular approach to a carbon tax (Measure 732) is one that is offset with reductions in the sales tax, reductions in a manufacturing tax, and an increase in tax credits available to low-income households.[51] Cap-and-trade programs do yield government revenues from allowance auctions, but generating revenue is not a primary goal.[52] Also, most of the emerging programs require that auction revenues be spent on GHG reductions — a good thing — but a restriction that still leaves the public paying numerous costs of fossil fuel extraction, transport, storage, and combustion.

Figure 5: *The Fort McMurray fire of 2016.*

Fossil fuel risk bond programs can thus be coupled with either of these approaches to ensure that the issue of public financial risk is not left out of the climate agenda. This is especially important for risks that cannot be addressed by the other approaches for legal or practical reasons. For example, states' ability to tax fossil fuels in transit on oil or coal trains is limited by the Commerce Clause of the US Constitution.

As this policy brief goes to press, an inferno is raging in the town of Fort McMurray, Alberta. Record-breaking heat and drought for early May has triggered an inferno. Forests have been incinerated, thousands of structures have burned to the ground, and 88,000 people have been evacuated. The toll on public finance will be considerable. Already, over 200 firefighters, 22 specialized tanker trucks, 10 helicopters, 17 air tankers, and a Hercules air transport plane have been deployed by federal, provincial, and municipal agencies. The irony, of course, is that Fort McMurray is at the epicenter of Canada's tar sands industry — producing some of the most carbon-intensive fossil fuels on earth.[53] That industry has no obligation to cover the costs of this disaster. Fossil fuel risk bond programs would help to correct this imbalance by shifting the bulk of financial responsibility onto greenhouse gas polluters as the tragic consequences of climate change continue to unfold.

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