Risk, Reward & Revolution

Why globalizing the natural gas revolution is smart environmental and economic policy for Louisiana

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1. Summary

Louisiana faces a unique suite of environmental risks– land subsidence, sea-level rise, wetland loss, coastal storms, and ocean acidification – that climate change is likely to compound and worsen. Beyond that vulnerability, climate policy is also highly relevant to Louisiana because of the state's strategic importance to the American natural gas revolution and the prospects for its globalization. This paper examines the environmental challenges Louisiana faces and considers the prospects for Louisiana to offer solutions to the country and the world.

Compared to coal, electricity generated from natural gas emits much less heat-trapping, greenhouse-gas pollution. Consequently, the new abundance of American natural gas is already delivering substantial emission reductions in the United States. Exporting U.S. natural gas (and American fracking expertise) could achieve the dual benefits of global climate-change mitigation and local/national economic development. Louisiana is poised to host much of the nation's natural gas export capacity, but several of these major investments are waiting on approval from the Obama administration, which is dithering to deem new export capacity in the "public interest." Because of Louisiana's resource endowment and trade infrastructure, the state stands to benefit economically from taking a more engaged leadership role in reorienting the U.S. climate change debate around the promise of natural gas and the power of free markets.

2. Introduction

Fossil-fuel production and the environment are both highly important issues for Louisianans, though they are often presented as discrete issues competing for priority status. The politics of energy and the environment long have been characterized by perceived trade-offs between the economic benefits and environmental risks caused by fossil-fuel consumption. But the discovery of abundant stores of natural gas in the United States has seen it displace higher-emissions fossil fuels (i.e. coal) and drive down U.S. greenhouse gas emissions to levels we have not seen since the mid-1990s. Globalizing the U.S. natural gas revolution through exports of liquefied natural gas and American fracking expertise would be an economic boon for America, especially Louisiana, as well as a prudent and "no regrets" component to American climate-change policy.

Largely due to lingering and anachronistic perceptions of trade-offs, climate change remains a controversial topic. Conservatives rightly have taken to task those who use apocalyptic climate change scenarios to drum up support for big-government programs and regulations. Yet the fact remains that most Americans – including 62% of Republicans – believe America should take steps to lessen the risks of climate change. In key swing states, approval ratings for President Obama's EPA regulations to control greenhouse gases are currently in the mid-50s to low-60s, even though the president's approval ratings are in the low 40s. These regulations are the least-efficient mechanism available to mitigate climate risks, but they will be the law of the land until Americans demand effective, pro-growth alternatives. Given

its resource endowment and trade infrastructure, Louisiana is poised to play a major role in reorienting American climate and energy politics away from the costly and futile and toward the prudent and effective.

Better public education about the risks of climate change and the opportunities to mitigate its effects – especially locally – represents a step in the direction of pragmatic decision-making on climate issues. To that end, we aim in this paper to outline:

1. The environmental risks endemic to Louisiana
2. The potential impact of climate change on those risks
3. The economic and environmental benefits of the natural gas revolution
4. What globalizing that revolution would mean for Louisiana

3. Louisiana's environmental vulnerabilities

Due to a confluence of interconnected threats, Louisiana is uniquely vulnerable among the Lower 48 states. With 397 miles of coastline fronting the Gulf of Mexico, and an economy intimately tied to the sea, Louisiana is directly at risk from climate and environmental change. Greater storm intensity (and possibly greater storm frequency) combined with higher sea levels are the most apparent, most potentially damaging, and least understood climate risks facing Louisiana. Hurricanes Katrina and Rita showed how these massive storms can destroy lives, property, and economic activity. Even 2012's Hurricane Isaac, a relatively small (category 1) storm caused great flooding and damage when it made landfall in Louisiana. In addition to acute risks related to extreme weather, more chronic risks exacerbated by a changing climate – like land subsidence, wetlands loss and ocean acidification – carry potentially large costs for Louisiana's economy, property, and environment.

Though no credible person or study can predict specific future events such as hurricanes or floods, there is well-established science to ascertain the odds of future events under different emissions scenarios. Extrapolation of current trends, combined with the high likelihood of additional warming, could well make Louisiana a direct target of climate change. Any standard of reasonable risk management would suggest serious consideration of measures to protect property, infrastructure, and economic activity from the risks of these impacts. We briefly discuss five of these environmental risks which may be exacerbated by climate change.

3.1. Land subsidence

For millennia, silt flowing down the Mississippi River shaped Louisiana's coast. The shifting river deposited layers of sediment from America's heartland. Land subsidence is typical of delta regions, because rapid accumulation of sediment also traps a great deal of water. Over time, as new layers of sediment are deposited, water is squeezed out of the underlying deposits, causing compaction and the land

surface to sink. However, today, the Mississippi has been tamed and its flow directed through protected channels. This allows assured navigation of the river and protects investments from flooding, but it also directs the sediment away from compacting land. As a result, the lands around the Mississippi's delta are no longer being replenished at the rate needed to fight back the tides.

In addition to natural process of land subsidence, accelerated by the channeling of the Mississippi, the toll of decades of oil extraction from far beneath Louisiana's surface has also added to the problems of land subsidence, as petroleum extraction has literally caused the ground above it to drop.

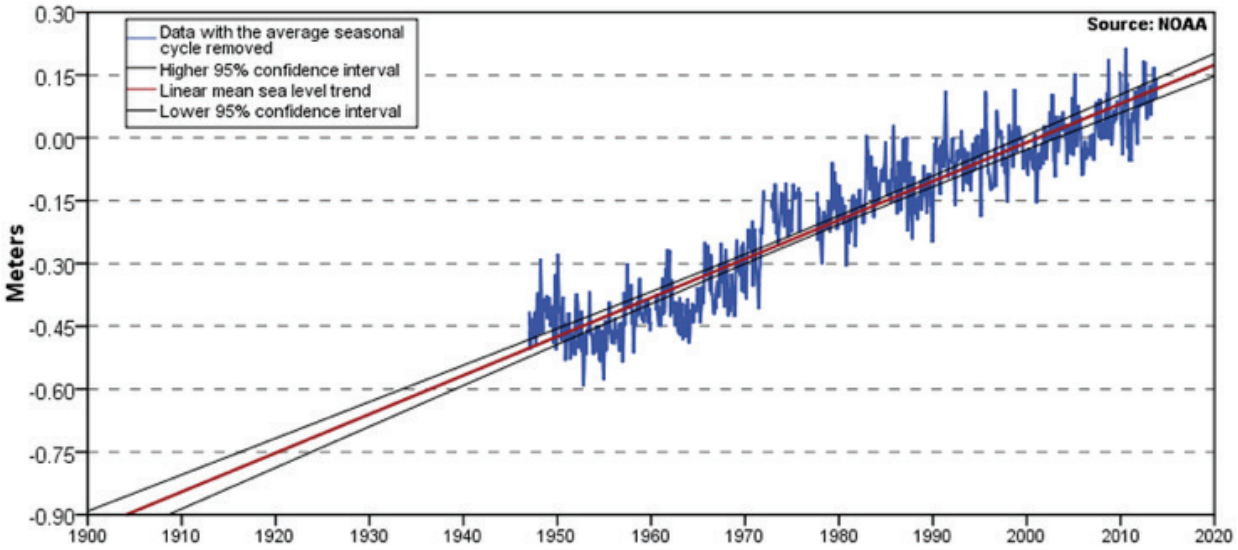
The problem of land subsidence has little relation to the amount of greenhouse gasses in the air, but when combined with the problems of sea level rise and coastal storms, it acts as a "force multiplier" that serves to increase loss and damage from other environmental threats.

3.2. Sea level rise

Like other bodies of water around the world, the sea level of the Gulf of Mexico is rising. Scientists are confident that global ocean levels rose by about 19 centimeters (7.5 inches) in the last century. They are also confident that the rate of increase has sped up; since 1993, the average rate has nearly doubled, from 1.7 mm (.07 inches) per year to about 3.2 mm (.13 inches) per year.

There are two drivers of global sea level rise. First, warmer water has a higher volume than cooler water, due to a process called "thermal expansion." Second, far from America's Gulf Coast, ice is melting faster than at any time in human history. The ice caps of Greenland, Antarctica, and on glaciers around the world are melting into the sea.

Figure 1: **Mean Sea Level Trend at Grand Isle, Louisiana**



Source: NOAA, "Sea Level Trends," http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8761724

We know that sea level rise is a problem for Louisiana already, even before future climate change is factored in. Since 1947, when records were first kept, the sea level at Grand Island has gone up by almost two feet, at a rate of one-third of an inch per year. Figure 1, from the National Oceanic and Atmospheric Organization, shows the sea level at Grand Isle over the last 66 years.

3.3. Wetlands loss

The combined result of a rising sea level and sinking land is that Coastal Louisiana is rapidly sinking into the Gulf of Mexico. Already, more than 1,880 square miles of Louisiana's wetlands have been lost since the 1930s and just as much could be lost, again, during this century.

Coastal wetlands are prime spawning grounds for many of Louisiana's fisheries. In addition, swamps and mangroves provide buffers to storm surge that beaches or seawalls alone cannot match.

3.4. Coastal storms

With dwindling wetlands and rising seas, Louisiana will increasingly lack natural buffers against storms. Without changes in these trends, the people of Louisiana will be ever more unprotected from the hurricanes and tropical storms that have struck throughout its history. While there is a tremendous amount of variability in every storm season, even over decade-long time scales, there is emerging consensus among scientists that a warming climate will make storms more powerful. We simply do not know whether it will also make them more likely.

3.5. Ocean acidification

Oceans absorb atmospheric carbon causing chemical reactions that make ocean water more acidic. Current scientific evidence shows that about a quarter of the carbon dioxide released into the atmosphere is absorbed into the ocean, where it forms carbonic acid.

Since the beginning of the Industrial Revolution, the pH (a measure of a liquid's acidity) of surface ocean waters has fallen (i.e. become more acidic) by 0.1 pH units. This represents a 30% increase in ocean acidity compared to pre-industrial time.

For Louisiana, an acidified ocean means that shellfish – including crucial stores of crawfish, shrimp and oysters – are less able to build their hard shells. Acidic waters also hinder the survival of plankton, which is perhaps even more threatening to ocean life and Louisiana's economy, because plankton (a small invertebrate) forms the base of the food chain for almost all aquatic animals.

4. Effects of climate change on Louisiana's environmental risks

Any assessment of risk has to weigh two components: the likelihood of events and how severe any potential losses from those events might be. In a changing climate, the probability and severity of many environmental risks are compounding and/or increasing in Louisiana. Because sea-level rise in the Gulf of Mexico is compounded by land subsidence around Louisiana, there may be no place on earth that faces faster encroaching seas than Louisiana.

Louisianans have already seen these effects up close. In the last two centuries, New Orleans has sunk well below the levels of both Lake Pontchartrain and the Mississippi River. As New Orleanians know, in much of the French Quarter, you actually have to look up to see the level of the Mississippi River. Even if climate change had zero effect on storm intensity, Louisiana's vulnerability to storm surges is getting worse.

Hurricane Katrina was only the most visible environmental disaster to hit Louisiana. Some environmental activists are very quick to label Katrina as "caused" by climate change. Very few scientists would venture such an audacious link to a singular weather event. Indeed, there is a scientific debate about the extent to which climate change has influenced extreme weather events to date. However, scientists on both sides of this dispute do, with few exceptions, agree that our hot days will become hotter and warming oceans will host ever-greater energy and therefore could be expected to drive more intense hurricanes.

Whatever the compounding risks of climate change, the risk of a catastrophic hurricane strike on New Orleans is ever present. The federal government has reinforced the storm barriers and levees, but flooding remains a threat. Past disasters have taught that predictions only last until the storm reaches shore. We may have protected against the last storm, but we cannot predict the next storm. Subsiding

land and dissolving coastal wetlands only make New Orleans and surrounding parishes more vulnerable. Louisianans should insist upon proper study and integrated management of all the major risk factors which threaten resilience to monster storms.

4.1. The other side of the equation: potential losses

In addition to assessing the probability of climate change impacts, including the incidence of acute weather events, understanding risk requires an assessment of the severity of potential losses. After all, when a hurricane hits a coast with no people or infrastructure, its size and power does not matter. On the other hand, the underprepared, high-value coast of Louisiana has a great deal at risk. The National Oceanic and Atmospheric Administration (NOAA) estimates that Hurricane Katrina was the costliest storm in U.S. history, costing $125 billion in 2005; but it was far from the most powerful storm to hit the United States. It was the combination of vulnerability and what was at risk.

These risk equations must include Louisiana's important waterfront industries. Part of the reason the state has so much at risk is because it extracts so much value from its waterfront. Louisiana's seafood industry, for example, is responsible for one in seventy jobs in the state, with annual retail sales of more than $2 billion.

Louisiana is home to four of the top ten largest ports in the country, measured by volume handled (i.e. Port of South Louisiana, Port of New Orleans, Baton Rouge, and Port of Plaquemines). These ports and the Mississippi River waterway are among the most important for trade and economic development in the country. The mouth of the river is the world's busiest waterway, with more than 5,000 oceangoing vessels annually, over 1,800 of which call at the Port of New Orleans. The port estimates maritime activity is responsible for about 160,500 jobs statewide, $17 billion in spending and $800 million in taxes.

Additionally, Louisiana's energy industry is critically vulnerable to rising seas and storm surges. There are more than 100 major energy facilities, including oil, natural gas, and electricity production sites within one foot or lower of the sea level, more than all other states combined. A report from the Entergy Corp. on the vulnerability of U.S. Gulf Coast energy infrastructure to sea level rise and coastal storms projects that, by 2030, there will be nearly $1 trillion in energy assets at potential risk from rising sea levels and hurricanes. By 2030, Entergy estimates the Gulf Coast energy sector – of which Louisiana is a central player – will face an average annual loss from extreme weather of $8 billion.

The concentration of energy infrastructure is a threat not just to Louisiana, but to the whole country, because of the sheer concentration of infrastructure on the Gulf Coast. Americans felt how deeply our energy economy hinges on Louisiana when Hurricane Katrina crippled supply infrastructure and sent natural gas prices through the roof, up about $5 to more than $12 per thousand cubic feet in 2005. The shale revolution has ameliorated the risk of massive volatility, but Louisiana is still the heart of America's gas market and storm-induced supply constraints are still a real risk.

Similarly, Hurricane Katrina caused a spike in gasoline prices for consumers, as U.S. gas prices jumped by nearly 20% in less than a week, with some areas of the Southeast seeing prices more than double. The concentration of oil refining, production and transport infrastructure along the Gulf Coast, much of which is at or near sea level, ensures that this is a concern for the whole nation.

Responsible measures to adapt to a changing climate, combined with prudent market-based measures to reduce emissions, will help Louisiana. Fortunately, Louisiana is poised to be a leader on both of these, with potentially dramatic benefits for the state and the country.

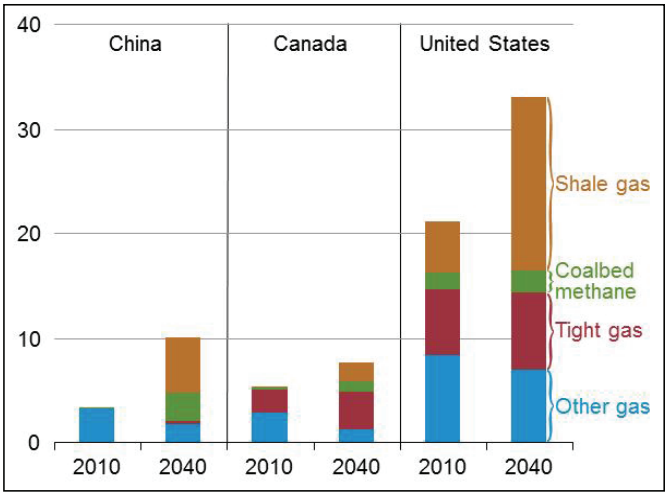
5. Economic and environmental benefits of the U.S. natural gas revolution

5.1. History and revolution

Louisiana has a long history of producing and trading natural gas. For much of the 20th century, the state was a leader in conventional gas production. Today, Louisiana's four natural gas market centers form the heart of the nation's gas industry. Particularly important is the Henry Hub, North America's marquee market center, connecting nine interstate and four intrastate pipelines. State production of natural gas peaked in 1970 and offshore production from the Outer Continental Shelf peaked in the early 2000s. With rising demand and falling but volatile supply, natural gas prices were high and volatile. Lower prices abroad created demand for imports of liquefied natural gas (LNG). The arbitrage opportunities were so great that companies began spending billions of dollars on infrastructure to import and re-gasify African and Middle Eastern LNG. By the early 2000s, at least 47 regasification terminals were issued construction permits. Louisiana hosts four LNG import terminals, more than any other state.

But then the whole energy paradigm reversed. Advancements in horizontal drilling, hydraulic fracturing and multi-seismology for underground mapping have unlocked vast supplies of natural gas trapped in shale formations. In 2003, America was building LNG import terminals and the National Petroleum Council estimated total U.S. recoverable shale gas at about 38 trillion cubic feet (TCF). A decade hence, America is building LNG export terminals and the Potential Gas Committee estimates 1,073 TCF of recoverable U.S. shale gas, representing 48% of total estimated recoverable gas. America is now the leading producer of natural gas in the world, recently overtaking Russia, and the shale-gas revolution is expected to drive increased production for decades (see Figure 2).

Figure 2: **Natural gas production in China, Canada and the United States, 2010 and 2040 (trillion cubic feet)**



Source: U.S. EIA, International Energy Outlook 2013

5.2. Renaissance in production and manufacturing

For Louisiana and the country, the economic consequences of America's shale-gas revolution are substantial. As you can see in Figure 3, in Louisiana, natural gas prices have plummeted and production and proven reserves have soared over the past six years. Louisiana's production could further boom when and if the massive, 2.6 million-acre Tuscaloosa Marine Shale formation is responsibly drilled.

The nation has benefited from our new abundance of natural gas. Every year since 2009, the U.S. economy has reaped in excess of $100 billion from lower energy costs.

Abundant natural gas supply has also catalyzed a manufacturing renaissance, especially on the Gulf Coast. Cheaper natural gas means lower energy costs for energy-intensive manufacturing. There is also a massive double dividend for chemical manufacturers that rely on natural gas "feedstocks" in the production of various upstream compounds required to make plastic products, paints, detergents, adhesives, fertilizers and many other products. Ethane, a natural gas liquid, is a widely used feedstock. As the shale revolution has progressed, ethane prices have dropped precipitously, from their high of 93 cents per gallon in 2008, down to an average of 41 cents per gallon in 2012, and an average of 27 cents per gallon during the first half of 2013. A very different story is playing out abroad, where chemical manufacturers rely on oil-based feedstocks like naphtha – the price of which has soared in recent years with the price of the oil. The result is a tremendous competitive advantage for American firms.

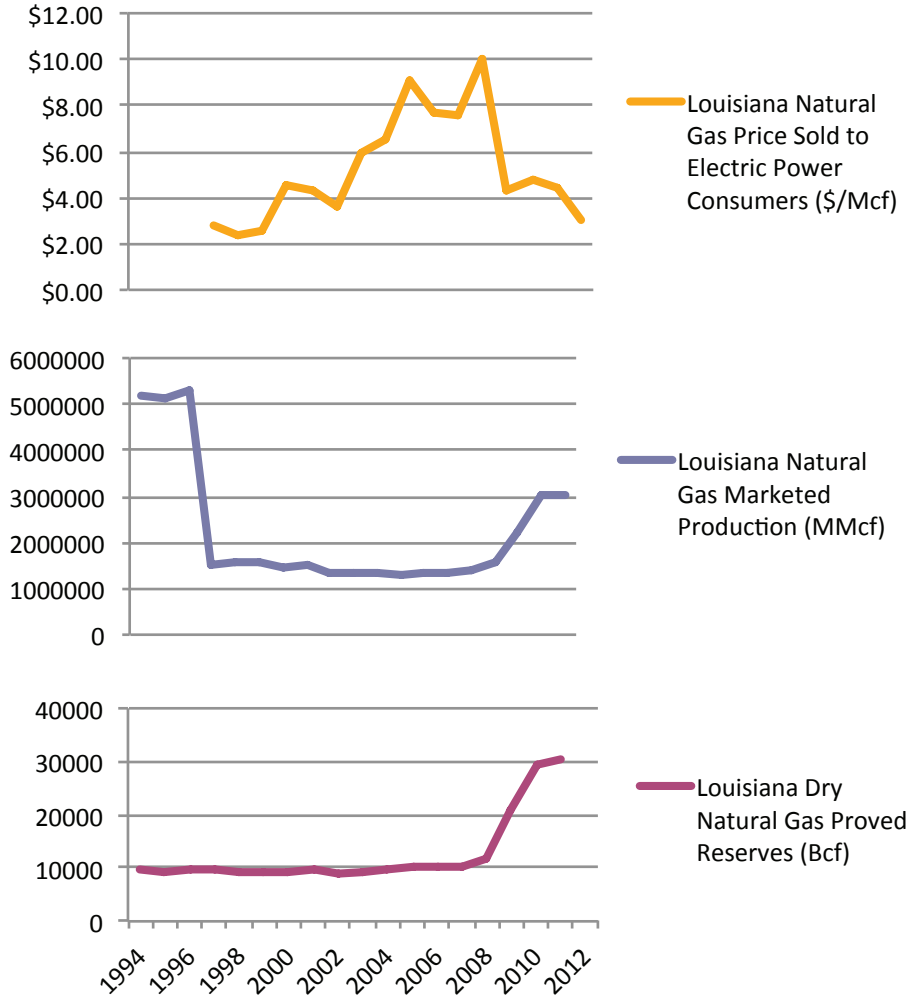
For these reasons, foreign companies have flocked to the United States and account for more than half of the new investments in shale-advantaged U.S. manufacturing. The American Chemistry Council (ACC) reported in May 2013 that 97 capital investments in the U.S. chemical industry have been announced since the shale boom began, totaling potentially $71.7 billion in investment, 485,000 direct job-years and 46,000 permanent direct jobs. Roughly 78% of the investments are planned for the Gulf Coast (where the most capacity exists for separating, or "cracking," the methane and liquids in natural gas). Recently, the ACC's chief economist reported that their list has grown quickly and now they are tracking 134 shale-advantaged major investments totaling $89.3 billion in capital investment.

Over the course of a few short years, new extraction technologies have fundamentally changed the American energy economy, creating wealth from new production, saving $100 billion per year in energy costs and spawning a manufacturing renaissance. And, though it would have sounded impossible just a decade ago, this U.S. natural gas revolution has become the most promising opportunity for the meaningful and near-term mitigation of climate change risks.

5.3. The critical importance of natural gas for climate change mitigation

The gas boom is a hugely important development for climate-change mitigation for two principal reasons. First, natural gas-fired electrical generation displaces dirtier, higher-emissions, coal-fired power. Second, gas-fired generation softens intermittency problems with renewables, thereby making it possible to ramp-up renewable generation.

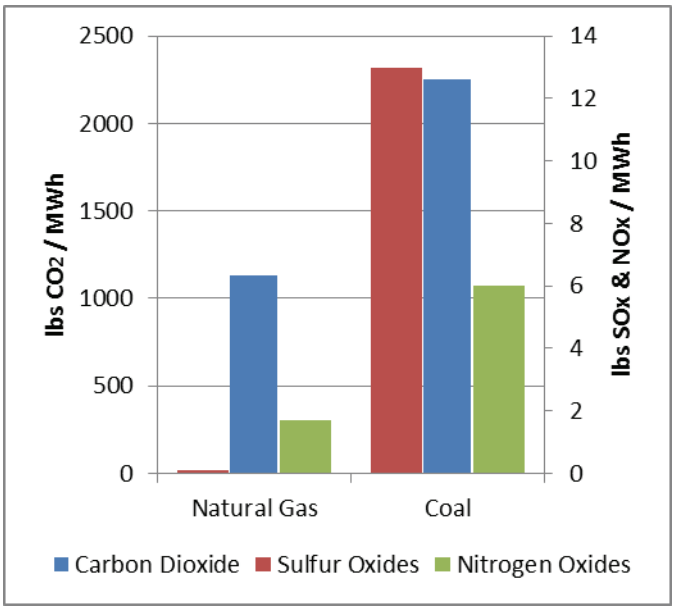
Figure 3: **Louisiana Gas: Price, Production, & Proven Reserves, 1994-2012**



Source: Data from U.S. EIA, "Natural Gas Summary" http://www.eia.gov/dnav/ng/ng_sum_lsum_dcu_sla_a.htm

Compared to coal-fired power plants, gas-fired plants emit about half the level of greenhouse gases. As Figure 4 shows, natural gas also creates fewer toxic terrestrial pollutants. The United States has captured these benefits as low natural gas prices have driven rapid fuel switching from coal to gas. In 2007, coal-fired electricity supplied 48.5% of U.S. electricity consumption. Coal-fired electricity now accounts for 39.0% total electrical generation (a 22% drop over just six years). Studies are finding that the natural gas revolution is likely cutting U.S. emissions by 300-500 million metric tons of CO2 per year; - which

Figure 4: **U.S. Average Natural Gas vs. Coal Power Plant Emissions**



Source: Chart adapted with data from U.S. EPA, "Air Emissions," http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html

is in the ballpark of total annual emissions from Mexico, Saudi Arabia, Australia, Brazil or Spain. There is a need for better data on fugitive emissions of methane during fracking, which can undermine some of the greenhouse-gas benefit to natural gas production, but the common practices of flaring and reduced-emission completions limit the greenhouse gas impact. Unlike most 'tragedy of the commons' pollution, leaked methane is lost money for producers. In this case (and for the whole natural gas revolution), a profit motive aligns with an environmental challenge.

Complementarity with renewables is the second reason natural gas is vital to mitigation efforts. Commercially available renewable-energy technologies tend to have intermittency problems, because sometimes the sun does not shine and the wind does not blow. Deploying utility-scale renewable energy is typically only possible if renewables are paired with reliable power sources that can ramp up or ramp down quickly and efficiently depending on demand and the rate of renewables production (at least until large-scale electricity storage becomes commercially viable). America's coal-fired power plants are not flexible (and nuclear even less so). Ramping up or down a coal plant's output is slow, and marginal emissions rise when coal plants run underutilized. As a result, renewables do not yet displace coal. Counterintuitively this means that fuel-switching from coal to gas has delivered more greenhouse gas reductions than renewables. A Breakthrough Institute study estimated that fuel switching has been responsible for between three and ten times more emission cuts than non-hydro renewables. Renewables are much better suited for deployment with gas-fired plants, which are more flexible. New natural gas combined cycle (NGCC) technology ramps quickly and efficiently and is specifically designed to integrate with intermittent renewables. For these reasons, natural gas has often been labeled a "bridge fuel."

Climate change mitigation in the medium term hinges largely on how successfully current and future coal power is displaced by gas-fired power plants and paired renewable generation. Playing on the "bridge fuel" concept, some environmentalists call natural gas a "bridge to nowhere" because, they fear, ample supplies will lock-in gas-fired electricity and crowd-out renewables in the long term. This view neglects to consider the ample opportunities for renewables to compete in a rapidly expanding market.

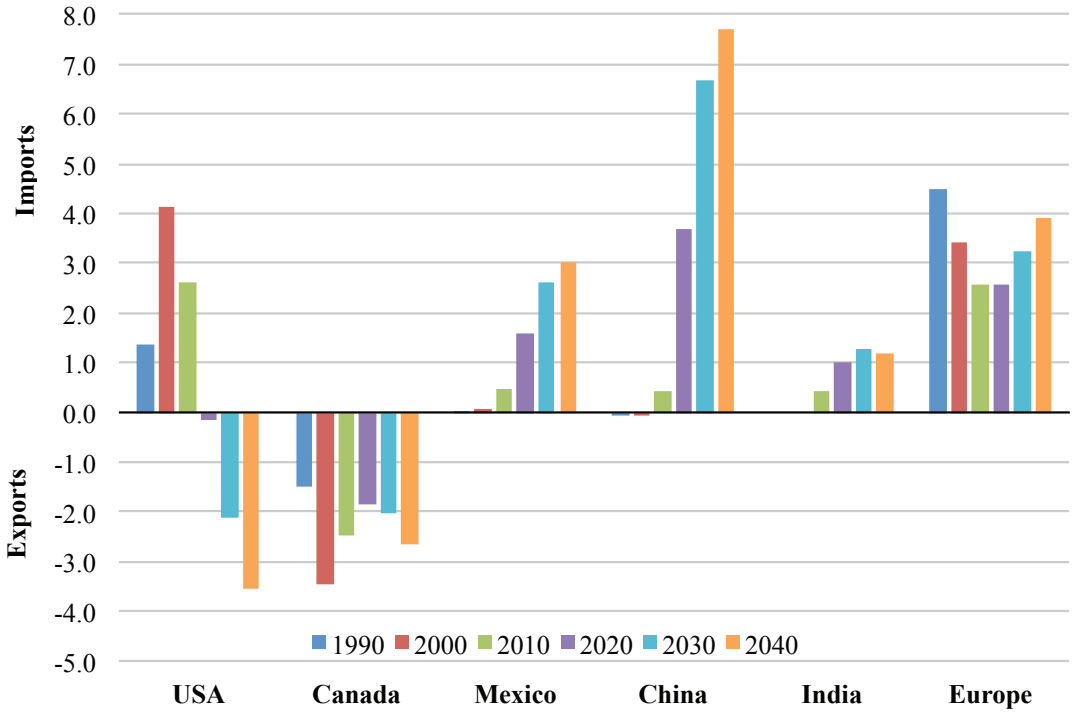
The world economy is hungry for energy. Emerging economies will drive up global energy consumption by an estimated 56% by 2040. The U.S. Energy Information Administration (EIA) projects that fossil

energy will still make up 80% of the global energy mix through 2040. Which fossil fuels is the most important question for those vulnerable to climate risks. Current EIA estimates peg natural gas consumption rising at 1.7% per year through 2040, mostly accounted for by an 80% rise in gas-fired electrical generation and a 58% rise in non-combusted industrial gas consumption. At the margins of this reality is where pragmatic climate-risk mitigation should occur. Climate risk mitigation over the long term may require the development and large-scale deployment of zero-carbon fuels. In the near and medium term, our best option is exploiting and globalizing the American natural gas revolution.

5.4. LNG exports: Globalizing the U.S. natural gas revolution

Louisiana has much at stake in supplying global markets with American natural gas. A few years ago, Louisiana's four LNG import-and-regasification terminals brought foreign gas to U.S. consumers. Today, Louisiana has a remarkable opportunity to deliver U.S. natural gas to foreign consumers. Figure 5 depicts this reversal in American fortunes, as well as the appetite for imported LNG across major markets with which the United State does not currently have free trade agreements (FTAs). The economic, geopolitical and climate benefits are real, as are the bureaucratic obstacles to realizing them.

Figure 5: **Projected Net Natural Gas Trade: 1990-2040 (trillion cubic feet)**



Source: Data from U.S. EIA, International Energy Outlook 2013

As of Dec. 6, 2013, there is a queue of 23 proposed liquefaction-and-export terminals waiting for the U.S. Department of Energy (DOE) to deem them in the "public interest." The Natural Gas Act requires exporters to get licenses from DOE, which must stipulate a maximum export volume for each terminal. DOE is tasked with determining whether or not LNG exports in a specific volume from a specific terminal will service the "public interest." DOE has told applicants that the public-interest consideration is based on the cumulative impact that the applicant and all expected exports will have on U.S. gas needs, energy security, Gross Domestic Product, consumers, industry, job creation, balance of trade, and international considerations. Applications to export to countries with which the U.S. has an FTA are, by law, automatically deemed in the public interest. But since South Korea is our only FTA ally that imports significant amounts of LNG, most of the approved export volume for FTA countries will not materialize. The major opportunities are for exports to non-FTA countries like Japan, India and the nations of Europe.

Each proposed terminal would mean very substantial infrastructure investments, with growth effects felt locally and by suppliers across the country. Louisiana is in the lead, so far, with two approved export terminals (and four pending). The first-ever approved LNG export terminal is Sabine Pass in Cameron Parish, Louisiana. There, Cheniere will spend $2.4 billion in initial capital investment. Between its two approved and four pending LNG export applications, Louisiana hosts 34% of the nation's planned and proposed LNG-export capacity (see Table 1).

A chorus of independent macroeconomic analyses have quantified the economic impacts of various LNG-export scenarios and found all plausible scenarios to have net economic benefits. Included in this chorus is the study commissioned by the Department of Energy to inform its process of determining whether individual LNG-export terminals are in the public interest (see Box 1).

Box 1: Conclusions of the study commissioned by DOE to inform its public-interest determinations for granting LNG-export licenses

For every one of the market scenarios examined, net economic benefits increased as the level of LNG exports increased. In particular, scenarios with unlimited exports always had higher net economic benefits than corresponding cases with limited exports. In all of these cases, benefits that come from export expansion more than outweigh the losses from reduced capital and wage income to U.S. consumers, and hence LNG exports have net economic benefits in spite of higher domestic natural gas prices. This is exactly the outcome that economic theory describes when barriers to trade are removed.

NERA Economic Consulting, "Macroeconomic Impacts of LNG Exports from the United States," Department of Energy: December 12, 2012. http://energy.gov/sites/prod/files/2013/04/f0/nera_lng_report.pdf

Table 1: **Louisiana Applications for LNG Exports to non-FTA Countries: Approved & Under DOE Review (as of 12/6/2013)**

Terminal	Location	Capacity	Date filed	Date approved
Sabine Pass Liquefaction	Cameron Parish	2.2 Bcf/d	9/7/2010	5/20/2011
		0.28 Bcf/d	2/27/13	Under Review
		0.24 Bcf/d	4/2/13	Under Review
Economic benefits • $1.6B capital investment (first four trains), plus $800m for two trains under review • 3,000 jobs through construction ($1B in wages); 150-250 permanent jobs				
Lake Charles Exports	Lake Charles	2.0 Bcf/d	5/6/2011	8/7/2013
Trunkline LNG Export[34]			1/10/2013	Under Review
Economic benefits per train • $600m investment • 350 construction-management jobs and supporting jobs ($240m in wages); 4.5m construction-man hours ($120m in wages); 60-80 permanent jobs				
Cameron LNG	Hackberry	1.7 Bcf/d	12/21/2011	Under Review
Economic benefits • $4B initial capital investment; $336B total increase in US output over 20 years • 1,300 construction/engineering jobs (2,900 during year of peak construction) • 4,600 jobs in natural gas production/exploration				
CE FLNG	Plaquemines Parish	1.07 Bcf/d	9/21/2012	Under Review
Economic benefits • 750-1000 construction jobs; 200 permanent jobs				
Freeport-McMoRan Energy (Main Pass)	Offshore	3.22 Bcf/d	2/22/2013	Under Review
Economic benefits • 20,140 direct jobs ($51/hr); 33,820 industry-support jobs ($35.15/hr) • 3,000-4,000 construction jobs (5 years); 250-500 permanent jobs				
Magnolia LNG	Lake Charles	1.08 Bcf/d	10/15/2013	Under Review
Economic benefits • $3.7 billion total investment (four trains) • 1,000 construction jobs (two trains); 55-60 (175) permanent direct (indirect) jobs				
Total non-FTA LNG export applications:		**11.79 Bcf/d**		
LA's share of US LNG export applications		**33.6%**		

When broken down by state, a 2013 study by ICF International finds net positive or net negligible economic impact across every state in the union. ICF estimates that LNG exports will add $115 billion net GDP per year by 2035, with states like Louisiana (and other producers like Texas and Pennsylvania) seeing state income increase by $10 to $31 billion annually. Of the 665,000 net job gains ICF estimates by 2035, vgas-producing states, including Louisiana, are each expected to add 60,000-155,000 jobs.

It is clear that quite a bit of American wealth creation is tied up just waiting for export licenses. As we wait, competition mounts from new LNG liquefaction-and-export terminals under construction in Australia, Africa, and Canada. Why has it taken years, not months or weeks, for DOE to determine that these economic opportunities are in the public interest?

There are powerful opponents to LNG exports, including U.S. chemical manufacturers, who are worried that their energy and feedstock prices will balloon to undermine their competitive edge. It is true that natural gas prices would rise domestically. But the benefits of exporting gas simply overwhelm the small welfare losses expected from modest increases in the domestic price of natural gas. It is hard to blame the chemicals industry for lobbying for artificial trade barriers to earn a de-facto subsidy. Delaying LNG exports is a subsidy.

Also opposed to LNG exports are many environmentalists, who are worried that LNG exports will lead to more fracking. That is probably true (at least initially), but it is something anyone who cares deeply about climate change should celebrate.

A report from the Brookings Institution offers a compelling solution for allaying the uncertainties and costs of delays to LNG export licensing. They suggest that the Department of Energy automatically deem export applications as in the public interest if they meet a few basic criteria to quantify the seriousness of the applications (i.e. the likelihood that the proposed terminal capacity will actually be built). Criteria could include completing the pre-filing process with the Federal Energy Regulatory Commission (FERC) and securing contracts for a certain percentage of the proposed capacity. Such a policy change would remove a major source of regulatory uncertainty and delay without adding to supply uncertainty (which could be exacerbated if DOE granted unconditional approvals that attracted a slew of proposals that are unlikely to progress).

Confronted with the big winners, modest losers and net positive benefits from LNG exports, John Medlock, an energy economist at Rice University, gave the following good advice to the Obama administration:

> The bottom line is that gains from trade are real. And, if they are present, any constraint on their realization is net welfare reducing...Industry should be given the right to allocate its capital in the best manner it sees appropriate.

5.4.1. Beyond LNG exports

Cutting red tape alone would not be sufficient to globalize the natural gas revolution. China, Algeria, Argentina and others are sitting on shale-gas deposits larger than America's – but they have unique geologies and little technical experience with advanced drilling and hydraulic fracturing. Nearly anyone who has run a successful fracturing process lives in America. The global shale gas revolution would foment much more quickly with American assistance, technology and suppliers. It's important that we incorporate the climate benefits of natural gas production into the equation when considering technology-transfer opportunities. Selling America's technology abroad is another form of export; we can export our knowledge and expertise around the world, for the benefit of both the environment and the bottom line.

6. Conclusion

Louisiana is vulnerable to several environmental risks which may become worse in a changing climate. Louisiana also stands to benefit tremendously from the revolution which has made American natural gas one of the world's most promising resources for greenhouse-gas emission reductions. Over the near and medium terms, natural gas resolves the commonly perceived trade-offs between fossil-fuel consumption and climate change. Simply allowing the market to grow without federal impediment is both prudent economic and climate policy. But long delays to federal approvals of LNG-export terminals constrain natural gas demand in order to ensure a cheap-gas subsidy for certain industries and consumers. These delays are costly and are not good climate policy. All demonstrably serious applications for LNG export licenses should be quickly approved.

Policymakers seeking to mitigate the risks of climate change should make intelligent use of markets. It's incredibly fortunate when a disruptive technology aligns natural market forces with greenhouse-gas abatement, and that is exactly the nature of our natural gas revolution. No other state facing climate-related economic threats of a similar magnitude is as equipped to seize the economic benefits of climate-change mitigation. Globalizing the American natural gas revolution is a path to short-term greenhouse-gas reductions on a global scale. And right now, Louisiana stands as one of the few viable platforms to make that happen.

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