From:	Craig Segall - Sierra
To:	LNGStudy
Subject:	2012 LNG Export Study
Date:	Thursday, January 24, 2013 3:31:41 PM
Attachments:	NERA Study Comments - final_submitted.pdf Ex 5_Synapse LNG Exports Study.pdf

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January 24, 2013

Please find attached comments from the Sierra Club and a large coalition of non-profit organizations on the DOE's LNG Export Study. I am also attaching an expert report that these comments rely upon.

We are filing these comments both electronically and by hand-delivery because the comments have many more exhibits than just the attached expert report. In total, the comments have 79 exhibits -- CDs with copies of those exhibits are being hand-delivered to your office. The exhibits should, of course, be filed with the comments.

Thank you for confirming receipt of these comments and the exhibits.

Best,
Craig Segall

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I check email infrequently. Please call me if you need a quick reply.

Craig Segall
Staff Attorney
Sierra Club Environmental Law Program
50 F St NW, Eighth Floor
Washington, DC 20001
(202)-548-4597
(202)-547-6009 (fax)
Craig.Segall@sierraclub.org

January 24, 2013

U.S. Department of Energy (FE–34)
Office of Natural Gas Regulatory Activities
Office of Fossil Energy
Forrestal Building, Room 3E-042
Independence Ave SW,Washington, DC 20585
LNGStudy@hq.doe.gov.

Dear Secretary Chu:

Thank you and the Department of Energy's Office of Fossil Energy ("DOE/FE") for accepting these comments on NERA Economic Consulting's study (the "NERA Study," or "the Study") on the macroeconomic impacts of liquefied natural gas ("LNG") export on the U.S. economy. We submit these comments on behalf of the Sierra Club, including its Atlantic (New York), Colorado, Kansas, Michigan, Pennsylvania, Ohio, Oregon, Texas, Virginia, West Virginia, and Wyoming Chapters; and on behalf of Catskill Citizens for Safe Energy, the Center for Biological Diversity, Center for Coalfield Justice, Clean Air Council, Clean Ocean Action, Columbia Riverkeeper, Damascus Citizens for Sustainability, Delaware Riverkeeper Network, Earthworks' Oil and Gas Accountability Project, Food and Water Watch, Lower Susquehanna Riverkeeper, Shenandoah Riverkeeper, and Upper Green River Alliance, and on behalf of our millions of members and supporters.[1]

DOE/FE is required to determine whether gas exports are "consistent with the public interest." 15 U.S.C. § 717b(a). Although the NERA Study purports to demonstrate that LNG export is in the economic interest (if not the public interest) of the United States, it does not do so. In fact the study, prepared by a consultant with deep ties to fossil fuel interests, actually shows that LNG export would weaken the United States economy as a whole, while transferring wealth from the poor and middle class to a small group of wealthy corporations that own natural gas resources. This wealth transfer comes along with significant

[1] We have submitted these comments electronically. Hard copies of this document and CDs of all exhibits were also hand-delivered to TVA for filing, as requested by John Anderson at DOE/E today.

structural economic costs caused by increased gas production, which destabilizes regional economies and leaves behind a legacy of environmental damage.

Indeed, an independent analysis, attached to these comments and incorporated to them, demonstrates that NERA's own study shows that LNG export will harm essentially every other sector of the U.S. economy, driving down wages and potentially reducing employment by hundreds of thousands of jobs annually. While LNG exporters will certainly benefit, the nation will not.

An extensive economic literature demonstrates that nations that depend on exporting raw materials, rather than finished goods and intellectual capital, are worse off – a condition sometimes referred to as the "resource curse." The same curse often applies at the smaller scale of the towns and counties in which extraction occurs; those communities are often left with hollowed-out economies, damaged infrastructure, and environmental contamination once a resource boom passes. These dangers apply here with considerable force, but NERA did not even acknowledge, much less analyze them. Indeed, the basic economic model NERA used (which has not been shared with the public) is not suited for this analysis.

Moreover, NERA has entirely failed to account for, or even to acknowledge, the real economic costs which *environmental* harms impose. Intensifying gas production for export will also intensify the air and water pollution problems, public health threats, and ecological disruption associated with gas production – effects which DOE's own experts have cautioned are inadequately managed. The air pollution that gas production for export would generate would alone impose hundreds of millions or potentially billions of dollars of costs, and would greatly erode or even cancel the benefits of recent federal gas pollution standards. Yet, NERA omits this entire negative side of the ledger.

The NERA study, in short, is fundamentally flawed. DOE would be acting arbitrarily and capriciously if it relied upon that report to decide upon export licenses, because NERA misstates or entirely fails to consider critical aspects of this vital public interest question. *See* 5 U.S.C. § 706(2)(A); *see also Motor Vehicle Mftrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*¸ 463 U.S. 29, 43 (1983).

I. Introduction: The Magnitude of the LNG Export Issue and DOE/FE's Obligation to Protect the Public Interest

Recognizing the importance of the natural gas market to the national interest, Congress has vested DOE/FE with the power to license gas exports and imports. This direct regulatory control underlines the gravity of DOE/FE's responsibility. Gas exports, if they occur, will fundamentally affect the nation's environmental and economic future. DOE/FE has a strict Congressional charge to ensure that these exports only go forward if they are "consistent with the public interest." 15 U.S.C. § 717b(a).[2]

This inquiry has never before been so pointed because it has never before been possible for the United States even to consider exporting a large quantity of natural gas as LNG. Becoming a major supplier of LNG to the world market will increase gas production (and, hence, hydro-fracturing or "fracking"), and will also increase gas and energy prices.

These effects have the potential to be very large. DOE/FE is currently considering licenses to export 24.8 billion cubic feet per day ("bcf/d") of natural gas as LNG to nations with which the United States has not signed a free trade agreement ("nFTA" nations). It has already authorized 31.41 bcf/d of export to free-trade-agreement ("FTA") nations because it believes it lacks discretion to deny such FTA applications – though such FTA licenses are of somewhat less moment because most major gas importers are nFTA nations.[3] These are very large volumes of gas. In 2011, the United States produced just under 23,000 bcf of gas over the year.[4] The 24.8 bcf/d of nFTA exports are equivalent to 9,052 bcf/y, or about 39% of total U.S. production. Exporting such a large volume would have major effects on the U.S. economy and the environment, as production both increases and shifts away from domestic uses. While NERA assumes that lower volumes will ultimately be exported, the amounts involved are still large: The 4,380/y bcf case it uses as a high bar sees about 19% of current

[2] We note that the concerns raised below apply with equal force to exports from both onshore and offshore facilities.

[3] The Act separately provides that DOE/FE must approve exports to nations that have signed a free trade agreement requiring national treatment for trade in natural gas "without modification or delay." 15 U.S.C.§ 717b(c). This provision was intended to speed *imports* of natural gas from Canada. Congress never understood it to allow automatic licenses for export. *See generally*, C. Segall, *Look Before the LNG Leap*, Sierra Club White Paper (2012) at 40-41 (discussing the congressional history of this provision), attached as Ex. 1. That DOE/FE has nonetheless issued export licenses under it, without raising the issue for Congressional correction, is itself an arbitrary and dangerous decision, inconsistent with Congressional intent.

[4] EIA, Natural Gas Monthly December 2012, Table 1 (volume reported is dry gas), attached as Ex. 2.

U.S. production sent abroad; the 1,370 bcf/y "low" case is still 5% of current production.[5]

Although the effects of export would, of course, likely be smaller with smaller volumes of export, applications for 9,052 bcf/y are before DOE/FE, and it would be arbitrary not to consider the cumulative impacts of the full volume of export which DOE/FE is now weighing. But even exporting smaller volumes of gas would necessarily alter the domestic economy and environment in significant ways. The Energy Information Administration ("EIA") has concluded that about two-thirds of gas for export would be drawn from new production, while the remaining third would be diverted from domestic uses, such as power production and manufacturing.[6] On the order of 93% of the new production would come from unconventional gas sources, and so would require fracking to extract the gas.[7]

DOE/FE's earlier public interest investigations of LNG imports did not so directly implicate such shifts in daily domestic life. As a result, DOE/FE's past, largely laissez-faire approach to gas import questions does not translate to gas export. DOE/FE has recognized as much, writing, in response to Congressional inquiries, that the public interest inquiry is to be applied with a careful look across a wide range of factors, informed by reliable data. DOE/FE Deputy Assistant Secretary Christopher Smith has testified that "[a] wide range of criteria are considered as part of DOE's public interest review process, including . . . U.S. energy security . . . [i]mpact on the U.S. economy . . . [e]nvironmental considerations . . . [and] [o]ther issues raised by commenters and/or interveners deemed relevant to the proceeding."[8]

Such care is manifestly appropriate here, and is legally required. As well as charging DOE with "assur[ing] the public a reliable supply of gas at reasonable prices," *United Gas Pipe Line Co v. McCombs*, 442 U.S. 529 (1979), he Natural Gas Act also grants DOE/FE "authority to consider conservation, environmental, and antitrust questions." *NAACP v. Federal Power Comm'n*, 425 U.S. 662, 670 n.4 (1976) (citing 15 U.S.C. § 717b as an example of a public interest provision); *see*

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[5] *See* NERA Study at 10 (Figure 5).

[6] EIA, Effects of Increased Natural Gas Exports on Domestic Energy Markets (Jan. 2012) at 6, 10--11, attached as Ex. 3.

[7] *See id.*

[8] *The Department of Energy's Role in Liquefied Natural Gas Export Applications: Hearing Before the S. Comm. on Energy and Natural Resources*, 112th Cong. 4 (2011) (testimony of Christopher Smith, Deputy Assistant Secretary of Oil and Gas), attached as Ex 4.

also id. at 670 n.6 (explaining that the public interest includes environmental considerations). In interpreting an analogous public interest provision applicable to hydroelectric power, the Court has explained that the public interest determination "can be made only after an exploration of all issues relevant to the 'public interest,' including future power demand and supply, alternate sources of power, the public interest in preserving reaches of wild rivers and wilderness areas, the preservation of anadromous fish for commercial and recreational purposes, and the protection of wildlife." *Udall v. Fed. Power Comm'n*, 387 U.S. 428, 450 (1967) (interpreting § 7(b) of the Federal Water Power Act of 1920, as amended by the Federal Power Act, 49 Stat. 842, 16 U.S.C. § 800(b)). Other courts have applied *Udall*'s holding to the Natural Gas Act. See, e.g., *N. Natural Gas Co. v. Fed. Power Comm'n*, 399 F.2d 953, 973 (D.C. Cir. 1968) (interpreting section 7 of the Natural Gas Act).

Despite these clear legal requirements, DOE/FE has thus far failed actually to conduct a careful and reasoned analysis of LNG export. Such an analysis would offer a thorough description of LNG exports' implications for the economy on both a macro-scale and on the scale on which people actually live. It would consider the effects of increasing dependence on resource exports on communities in the gas fields, on domestic industry, on the environment, and on U.S. energy policy. It would also offer counterfactuals, considering whether or not the nation would be better off without LNG export, or with lower volumes of export than are now proposed.

The NERA Study does none of these things. Instead, it reduces its analysis ultimately to a consideration solely of U.S. GDP, concluding that because GDP rises with export in its model, even though real wages and incomes fall, export must benefit the country. This conclusion is unsupported, and fails even to weigh the real effects of exports on the nation's life. The NERA Study's many flaws, in particular, prevent that document from serving as a meaningful contribution to DOE/FE's decisionmaking. Rather than relying upon it, DOE/FE should prepare a new study, with full public participation, investigating the many fundamental economic issues which NERA entirely fails to consider.[9]

[9] Of course, economic issues are not the only matters germane to the public interest analysis. Environmental factors are also vital, and not only because environmental damage necessarily imposes economic costs (a point which we discuss in detail below). They are also relevant in their own right, as the Supreme Court has held and DOE/FE itself has repeatedly acknowledged.

Because DOE/FE must consider environmental impacts in addition to economic considerations, it must gather considerable additional information before deciding whether LNG exports are in the

II. The NERA Study Fails to Account for LNG Export's Significant Negative Impacts on the U.S. Economy

The NERA Study's fundamental flaw is that it mistakes an increase in U.S. GDP, which, even if real, would be captured largely by a narrow set of moneyed interests, for the public interest. It simplistically sums the gains from export that a few accrue with the losses of the many to conclude that Americans benefit overall. A fair look at NERA's own results, and the extensive literature on how resource extraction affects countries and communities, demonstrates that this facile equivalence is simply false.

NERA's flawed approach is perhaps best summed up by its own figures. The figure below, drawn directly from NERA's report[10] for one export scenario, shows a net change in GDP (the black line on the figure) occurring only because NERA expects the natural gas "resource income" which exporters and producers reap to rise somewhat more than labor and capital income fall in response to exports. Even if that is so, the groups that benefit are not the same as those that suffer. Many Americans would experience some portion of the approximately $45 billion in declining wages that NERA forecasts in a single year, and many would suffer the pollution and community disruption that comes with gas production for export. Only a few would reap the revenues. In essence, LNG export transfers billions from the middle class to gas companies.

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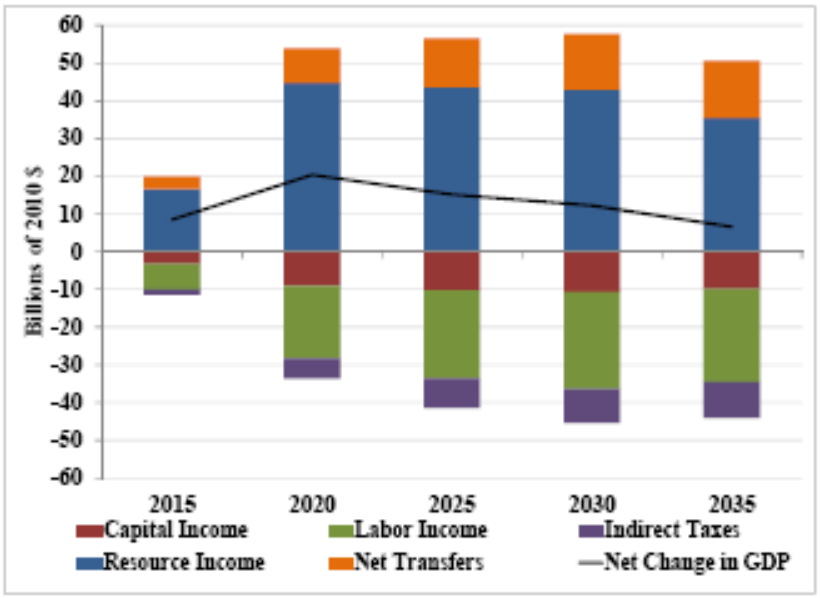
public interest. It can and must do so by complying with NEPA, which requires federal agencies to consider and disclose the "environmental impacts" of proposed agency actions. 42 U.S.C. § 4332(C)(i). NEPA requires preparation of an "environmental impact statement" (EIS) where, as is the case with LNG export proposals, the proposed major federal action would "significantly affect[] the quality of the human environment." 42 U.S.C. § 4332(C). DOE/FE regulations similarly provide that "[a]pprovals or disapprovals of authorizations to import or export natural gas . . . involving major operational changes (such as a major increase in the quantity of liquefied natural gas imported or exported)" will "normally require [an] EIS." 10 C.F.R. Part 1021, Appendix D, D9. DOE must assess these impacts cumulatively across all terminals and export proposals.

A full programmatic EIS is required here, and must consider, among many other points, both the immediate environmental consequences of constructing and operating LNG export facilities and the consequences of the increased gas production necessary to supply them.

[10] NERA Study at 8 (Figure 3).



The costs suffered by the rest of the country to procure a GDP increase that even NERA acknowledges is "very small"[11] are very large – and grow larger as the volume of export increases. They include falling wages and employment, a lasting legacy of community disruption, and likely long-term damage to the national economy's resilience and diversity. They also, as we discuss later in these comments, come with environmental damage, which imposes both economic and ecological costs.

A. The NERA Study Itself Demonstrates that LNG Exports Will Cause Economic Harm and That NERA Does Not Reliably Support Its Claims of Benefits

Sierra Club asked Synapse Energy Economics to conduct a thorough independent review of the NERA Study. Synapse's review is attached to these comments[12] and incorporated in full by reference. Synapse concluded, consistent with other comments in the record, that the NERA study is not reliable and does not demonstrate that LNG exports are in the national economic interest, much less in the public interest generally.[13]

Critical points in that analysis include:

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[11] *Id*. at 8.

[12] See attached, as Ex. 5.

[13] *See also, e.g.,* the Comments of Jannette Barth, Wallace Tyner, David Bellman, and Carlton Buford, in this docket.

LNG Exports Cause The Other Components of GDP To Fall

Just as NERA's own figures suggest, LNG export raises GDP almost entirely because LNG exporters can sell their product at a high price, and capture those revenues. Yet, because LNG export raises gas prices and diverts investment from other sectors, NERA's own results show that the other components of GDP either stay level or *decline* in response to export. In essence, the rest of the economy shrinks as exports expand, leaving a less diversified, and smaller, economy for those who do not profit directly from exports.

LNG Exports Cause Job Losses, According to NERA's Own Methodology

NERA avoided providing employment figures in this report, but the methodology that NERA has used in other studies for that purpose shows major job losses. The declining labor income NERA predicts translates into job losses of between 36,000 to 270,000 "job-equivalents"[14] *per year*; the greater the pace and magnitude of exports, the greater the job losses.

Most Americans Will *Only* Experience the Costs of Export

NERA acknowledges that "[h]ouseholds with income solely from wages" will not benefit from LNG export.[15] But that group contains *most* Americans. Only about half of all Americans own any stock, and only a few, generally wealthy, people own a significant amount. That means very few Americans will benefit at all from enriching LNG and gas companies. For most people, LNG exports simply mean declining wages and employment.

A Significant Amount of LNG and Natural Gas Revenues May Leave America

NERA assumes that LNG export revenues all rest in domestic companies. In fact, many of the companies which now propose to run export terminals are foreign-owned, in whole or in part (including one entity which is owned by the government of Qatar, which would be one of America's competitors in the LNG market), and some are not publicly-held. The complex ownership structure of these companies raises the real possibility that

[14] A "job-equivalent' is the salary of a worker earning the average salary.

[15] NERA Study at 8.

revenues will leave the United States and so may escape domestic taxation and securities markets.[16]

Increasing Exports of Raw Materials Is Associated with Economic Damage
Nations which emphasize raw material export often suffer from significant harm, as export impedes manufacturing and other economic mainstays. This "resource curse" has caused the decline of middle class industrial jobs in other nations, and is also associated with higher levels of corruption and other governance problems. Because the NERA Report relies on stale data that underestimates gas demand, it may underestimate the scope of these potential problems.

NERA Fails Even to Acknowledge the Economic Implications of Environmental Harm from Export
LNG export would significantly increase fracking and other environmental and public health threats. Increased environmental and health damage imposes substantial economic costs. Yet NERA does not acknowledge, much less analyze, these costs.

The Synapse analysis, in short, shows that NERA has entirely missed the point of its own report. Export will cause many wage-earners to lose their jobs or suffer decreased wage income as a result of increases in gas prices. Even employees whose jobs are not directly affected will suffer decreased "real wage growth" as gas prices and household gas expenditures increase relative to nominal wages.[17] All consumers of natural gas—residential, commercial, industrial, and electricity generating users—will suffer higher gas bills despite reducing their gas consumption.[18] While NERA trumpets GDP increases driven by increasing export revenues, its report really shows those increasing export dollars are coming out of the pockets of the American middle class.[19]

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[16] A detailed analysis of the ownership of LNG export companies is attached as Ex 6.
[17] NERA Report at 9.
[18] EIA Export study, at 11, 15. These increases are very large in absolute terms. At a minimum, in the EIA's low/slow scenario, gas and electricity bills increase by $9 billion per year, and this increase grows to $20 billion per year in other scenarios. *Id.* at 14.
[19] The very wealthy do not need more money. An extensive body of economic and philosophical literature demonstrates that the marginal utility of money declines with income—an extra $100 matters less the more money a person has. *See, e.g.*, Matthew D. Adler, *Risk Equity: A New Proposal*, 32 Harv. Envtl. L. Rev. 1 (2008), attached as Ex 7.

The more economic activity that is dedicated to gas production for LNG export, the less focus will there be on building a diversified and strong economic base in this country. Likewise, as LNG export wealth flows to a lucky few, income inequality will grow.

The public interest analysis must account for these effects. Indeed, the Obama Administration has repeatedly emphasized the need to avoid regressive policies that transfer wealth from the middle classes to the wealthy.[20] As the President has explained that "Our economic success has never come from the top down; it comes from the middle out. It comes from the bottom up."[21] Similarly, the President has warned against short-sighted management of wealth. As he explained in the 2009 State of the Union address, the nation erred when "too often short-term gains were prized over long-term prosperity, where we failed to look beyond the next payment, the next quarter, or the next election."[22] DOE/FE must not allow a "surplus [to] bec[o]me an excuse to transfer wealth to the wealthy instead of an opportunity to invest in our future."[23]

B. The NERA Study Underestimates Economic Harm to Manufacturing and Other Sectors That Will Offset the Purported Economic Benefits of Export

The Synapse report explains in detail that, as a result of several flawed assumptions and oversimplifications, the NERA study understates economic harms to manufacturing and other sectors that will result from LNG export. These errors may, in fact, be great enough, on their own, to actually depress total GDP, contrary to NERA's conclusions, as another macroeconomic study in the record, by Purdue economist Dr. Wallace Tyner, explains.[24] Certainly, little in the NERA study inspires any confidence:

First, NERA's use of outdated forecasts of domestic demand for natural gas caused it to significantly understate both price impacts and harm to gas-

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[20] *See, e.g.,* State of the Union Address (January 24, 2012), available at http://www.whitehouse.gov/the-press-office/2012/01/24/remarks-president-state-union-address

[21] Remarks by the President at the Daimler Detroit Diesel Plant, Redford, MI (Dec. 10, 2012), attached as Ex 8 and available at http://www.whitehouse.gov/the-press-office/2012/12/10/remarks-president-daimler-detroit-diesel-plant-redford-mi

[22] State of the Union Address (Feb. 24, 2009), attached as Ex 9 available at http://www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Address-to-Joint-Session-of-Congress

[23] *Id.*

[24] *See* Comments of Dr. Wallace Tyner in this docket.

dependent sectors of the U.S. economy. Second, NERA failed to model exports' impact on each economic sector potentially impacted by price increases, and thus impacts to individual industries are obscured. Third, NERA failed to assess impacts to several industries likely to be affected by export. Finally, NERA failed to account for LNG transaction costs that are likely to increase export volumes and exacerbate the price impacts of export. Unless these flaws are corrected, any LNG export decision based on the NERA study will "entirely fail[] to consider . . . important aspect[s]" of the export problem, and will thus be arbitrary and capricious. *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*¸ 463 U.S. 29, 43 (1983).

First, as Synapse explains in detail, the NERA Study inexplicably failed to use the EIA's most recent natural gas demand forecasts, even though NERA has used the more recent data in other reports. NERA used EIA's Annual Energy Outlook (AEO) 2011, even though AEO 2012 was finalized in June 2012, months before the NERA study was completed.[25] Indeed, an October 2012 report entitled *Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector* used the more recent data, showing that it would not have been infeasible for NERA to use it in its December 2012 export study. Moreover, an early release of AEO 2013 was published just days after NERA's report was finalized. NERA nonetheless failed to use the 2013 data – or even the 2012 data – in its analysis.

NERA's failure to use the most recent data significantly altered the outcome of its analysis. Between AEO 2011 and AEO 2012, projections of domestic consumption of natural gas rose above previously predicted levels. Accordingly, NERA's use of the older 2011 data resulted in an underestimate of domestic demand for gas. Using the more recently, higher predictions of demand would decrease the amount of natural gas available for export, thus increasing domestic prices and in turn increasing economic impacts that flow from price increases, including lost income to wage earners and increased costs to household and business consumers of natural gas for heating and electricity.[26]

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[25] See Synapse Report at 17.

[26] Synapse Report at 8. Contrasted against its willingness to use higher demand figures to generate inflated cost estimates for EPA rules controlling toxic mercury emissions, NERA's failure to use the same demand figures here underscores the appearance of bias discussed in detail in part IV, below. For DOE to rely on a study that contains such flaws would "raise questions as to whether the agency is fulfilling its statutory mandates impartially and competently." *Humane Soc'y v. Locke*, 626 F.3d 1040, 1049 (9th Cir. 2010).

Second, by its own admission NERA failed to model exports' impact on each economic sector potentially impacted by price increases, obscuring impacts to individual industries.[27] NERA fails to explain why sector-specific modeling could not be accomplished, stating simply that "it was not possible to model impacts of each of the potentially affected sectors."[28] As Congressman Markey points out in his letter to DOE, however, sector-specific modeling *was* recently conducted in an interagency report designed to assess the economic impacts of the Waxman-Markey cap-and-trade bill, demonstrating that such analysis is both feasible and useful.[29] Without sector-by-sector modeling that uses the most recent data available, impacts to individual economic sectors remain unknown, and those harmed by exports are consequently unable to fully understand and comment on these impacts. The failure to fully describe impacts sector-by-sector, using the most current data available, thus obscures exports' true costs and constrains public participation in export decisions.

Third, NERA failed to fully assess economic impacts to all industries likely to be affected by price increases. NERA states that energy-intensive, trade-exposed industries likely to be affected by price increases are "not high value-added industries," but it does not grapple with the contention – offered by Congressman Markey and by Dow Chemical – that impacts to the manufacturing sector propagate through the economy because they dampen production throughout the value chain.[30] DOE must address this shortcoming in NERA's analysis in order to make an informed decision whether to subject American industry to such far-reaching effects.

Finally, NERA fails to accurately account for transaction costs of LNG exports and thus fails to accurately predict the behavior of market participants. When properly accounted for, these costs tend to increase exports to levels exceeding those predicted by NERA, thus intensifying the impact of export on U.S. gas prices. NERA first potentially overstates the transportation costs associated with export of U.S. gas by assuming that all U.S. gas will be exported from the

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[27] NERA Study at 70.

[28] *Id.*

[29] Letter from Rep. Edward J. Markey to Hon. Steven Chu (Dec. 14, 2012), *available at* http://democrats.naturalresources.house.gov/sites/democrats.naturalresources.house.gov/files/documents/2012-12-14_Chu_NERA.pdf, at 5, attached as Ex 10. Senator Wyden has also written to express similar concerns. *See* Letter from Senator Ron Wyden to Hon. Steven Chu (Jan. 10, 2013), attached as Ex 11.

[30] *Id.* at 6.

Gulf Coast.[31] Exports from the Gulf Coast to Asia have high transportation costs, raising prices paid by the importer and thus making exports less economically attractive. Several export terminals are proposed for the West Coast, however, and these terminals will be able to transport gas to Asia with fewer transportation costs. Accordingly, completion of these terminals may lead to higher volumes of exports than NERA predicts.

In addition, NERA ignores the possibility that long-term contracts at export terminals will lock in exports regardless of subsequent domestic price increases. Under the "take or pay" liquefaction services arrangements that many LNG export terminals will likely adopt, would-be exporters will be required to pay a fee to reserve terminal capacity, regardless of whether that capacity is actually used to liquefy and export gas.[32] This arrangement may cause exporters to continue to export U.S. gas even if prices increase, because the required liquefaction services charges will discourage them from switching to alternative energy sources. As a result, exports may continue to occur – and prices may continue to rise – even where NERA predicts that exports will cease.[33] Such price increases would exacerbate harms to residential and commercial gas consumers, as well as wage earners in manufacturing and other energy-intensive sectors.

In short, NERA not only wrongly attempts to offset harm to the base of the American economy with benefits to a few gas corporations to reach its sunny conclusions, it also very likely understates the real magnitude of the harm.

C. LNG Exports Will Harm Communities Across the Country

Harms associated with LNG export are not limited to other industrial sectors. A closer look at the real consequences of increasing dependence on export and gas production underlines NERA's core error of mistaking gas company profits for the public interest. Indeed, the real costs extend beyond the national-level declines in middle class welfare and industry. The "resource curse" which LNG export portends for the nation as a whole is echoed by the stories of similarly "cursed" regions across the country that are dependent upon resource extraction as an economic driver. In those regions, the same patterns recur: Weak growth or decline in other industries, population losses, soaring infrastructure costs, and

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[31] NERA Study at 88-89, 210.

[32] *See Sabine Pass* DOE Order No. 2961, at 4 (May 20, 2011); Cheniere Energy April 2011 Marketing Materials, *available at* http://tinyurl.com/cqpp2h8 (last visited Jan. 13, 2013), at 14.

[33] *See* NERA Study at 37-46.

all the other consequences of being at the receiving end of an extractive apparatus that channels the wealth of a resource boom from an entire landscape into just a few pockets. [34]

Of course, many communities are already suffering these costs as the shale gas boom sweeps the nation. But the question now is whether to double-down on that economic strategy. Export will intensify the demand for gas, and accelerate the shift towards extraction-based economies around the country, with all the costs that attach to that choice. NERA entirely fails to consider these impacts, but they are central to the public interest question before DOE/FE, and it would be arbitrary and capricious to ignore them in the way that NERA has done. DOE/FE must weigh them in its analysis.

i. Resource Extraction Is Associated with Economic Damage

"Resource curse" effects are well documented in the economic literature. One of the most comprehensive surveys, by Professors Freudenburg and Wilson, of economic studies of "mining" communities (including oil and gas communities) concludes that the long-term economic outcomes are "consistently and significantly negative."[35] That research surveys a broad body of international and national work to conclude that strikingly few studies report long-term positive consequences for mining-dependent communities. One of the many papers recorded in that comprehensive survey concludes that census data from across the country showed that "mining-dependent counties had lower incomes and more persons in poverty than did the nonmining counties."[36]

These results occur because resource extraction dependent economies are fragile economies. Increasing dependence on raw material markets diverts investment from more durable industries, less influenced by resource availability and changing market costs. The inherent boom and bust cycle of such activities also stresses the infrastructure and social fabrics of regions focused on resource

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[34] Other workers have raised further important questions, which DOE/FE must consider, about the shale gas boom's implications for the domestic economy and environment, as well as for U.S. energy security. *See, e.g.*, Food and Water Watch, *U.S. Energy Insecurity: Why Fracking for Oil and Natural Gas is a False Solution* (2012), available at http://documents.foodandwaterwatch.org/doc/USEnergyInsecurity.pdf, and attached as Ex 12.

[35] W.R. Freudenburg & L.J. Wilson, *Mining the Data: Analyzing the Economic Implications of Mining for Nonmetropolitan Regions*, 72 Sociological Inquiry 549 (2002) at 549, attached as Ex 13.

[36] *Id.* at 552.

extraction to the exclusion of more sustainable growth. As Freudenburg & Wilson explain:

> [T]here is a potentially telling contrast in two types of studies that have gauged the reaction of local leaders. In regions that are expected increased mining or just beginning to experience a "boom," it is typical to find … "euphoria." Unfortunately, in regions that have actually experienced natural resource extraction, local leaders have been found to view their economic prospects less in terms of jubilation than of desperation.[37]

Indeed, the Rural Sociological Society's Task Force on Rural Poverty "ultimately identified resource extraction not as an antidote to poverty but as something more like a cause or correlate."[38]

A study of the long-term prospects of western U.S counties which focused on resource extraction rather than more durable economic growth strategies documents this trend. That 2009 study by Headwaters Economics looked at the performance of "energy-focusing" regions compared to comparable counties over the decades since 1970.[39] It concludes that "counties that have focused on energy development are underperforming economically compared to peer counties that have little or no energy development."[40]

These differences are stark. The economic data Headwaters gathered shows that energy-focused counties have careened through periods of intense booms and lasting busts which have impaired the resilience and long-term growth of their economies.[41] Although growth spiked during boom periods, it cratered when energy production faltered, creating economies "characterized by fast acceleration and fast deceleration."[42] This stutter-step depresses long-term growth. In energy-focusing counties from 1990 to 2005, for instance, the average rate of personal income growth was 0.6% lower than in more diversified counties, and the employment growth rate was 0.5% lower.[43]

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[37] *Id.* at 553.
[38] *Id.*
[39] Headwaters Economics, *Fossil Fuel Extraction as a County Economic Development Strategy: Are Energy-Focusing Counties Benefiting?* (revised. July 2009), attached as Ex 14.
[40] *Id.* at 2.
[41] *See id.* at 8-10.
[42] *Id.* at 10.
[43] *Id.*

These slow growth rates are symptomatic of deep structural differences. As Headwaters explains, the energy-focusing counties did not diversify their economies; indeed, they were nearly three times less diversified than their peer counties, meaning that they hosted far fewer different industries than their peers.[44] As a result, when growth occurred, it occurred only in a few sectors, leaving those counties vulnerable to contractions in energy use and to energy price spikes.[45]

Narrowly focusing on energy jobs also rendered these counties less broadly prosperous. A wage gap of over $30,000 annually opened between energy workers and workers in other fields in these counties between 1990 and 2006.[46] This "is not a healthy sign" because it means that "more people, including teachers, nurses, and farm workers, will be left behind if renewed energy development increases the general cost of living, especially the cost of housing."[47] The energy-focusing counties show this divergence between haves and have-nots: their income distributions show a larger proportion of relatively poorer families and a few very wealthy ones, indicating that energy wealth does not flow readily into the larger economy.[48]

The energy-focusing counties also had systematically lower levels of education, and lower levels of retirement and investment dollars than their peers.[49] By focusing on energy, rather than providing a broad range of services, they were less able than their peers to attract a broad economic base that could attract new investors and educated workers.

The upshot is that, on almost every measure, energy production did not prove to be a successful development strategy. Only one of the 30 energy-focused counties Headwaters studied ranked among the top 30 economic performers in the western United States in 2009, and more than half were losing population.[50] As Headwaters summarized its conclusions:

> EF ["Energy-focusing"] counties are today less well positioned to compete economically. EF counties are less diverse economically, which makes them

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[44] *Id.* at 17.
[45] *See id.* at 17-18.
[46] *Id.* at 19.
[47] *Id.*
[48] *Id.* at 20.
[49] *Id.* at 20-21.
[50] *Id.* at 2.

> less resilient but also means they are less successful at competing for new jobs and income in growing service sectors where most of the West's economic growth has taken place in recent decades. EF counties are also characterized by a greater gap between high and low income households, and between the earnings of mine and energy workers and all other workers. And EF counties are less well educated and attract less investment and retirement income, both important areas for future competitiveness.[51]

The experience of one of these counties, Sublette County, Wyoming, is particularly telling in this regard. A 2009 report prepared for the Sublette County Commissioners[52] describes experiences consistent with those analyzed by Freudenburg & Wilson and by Headwaters.

The Sublette study shows that a gas boom accompanied by thousands of wells, has caused real economic stress in the country, even as it enriched some residents. It determined that the 34% population increase in the county, which far outstripped historical trends, and accompanying demands on infrastructure and social services, were seriously disrupting the regional economy.[53]

The study records a region struggling under the impacts of a boom. The population of the country increased by over 3,000 people in under a decade, and is expected to grow by another 3,000.[54] This huge influx of energy-related employees is badly stressing regional social and physical infrastructure. The regional governments have already spent over $60 million on capital upgrades to improve roads and sewers which are crumbling under the strain, but remain at least $160 million in the hole relative to projects which they need to undertake to accommodate their new residents.[55] One town will need to spend the equivalent of ten years of annual revenue for just one necessary sewer project and "[s]imilar scenarios exist for all jurisdictions within Sublette County."[56] Municipalities across the country are unable to afford upgrades necessary to maintain their systems.[57]

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[51] *Id.* at 22.

[52] Ecosystem Research Group, *Sublette County Socioeconomic Impact Study Phase II- Final Report* (Sept. 28, 2009), attached as Ex 15

[53] *See id* at ES-3 – ES-5.

[54] *Id.*at 10-15.

[55] *Id.* at 55.

[56] *Id.*

[57] *Id.* at 115-116.

Meanwhile, just as Headwaters reported for the West generally, energy extraction is driving up economic inequality and making it more difficult to sustain other county residents. Housing prices in Sublette County increased by over $21,000 *annually*,[58] far ahead of income growth. Indeed, the gap between the qualifying income to buy an average Sublette County home and the median wage was over $17,000 in 2007.[59] The report concludes that "[i]f this trend continues fewer and fewer families will be able to afford an average home."[60] Only employees in the gas sector could afford such purchases; "all other employment sectors had average annual incomes significantly below that required to buy a house."[61]

Consistent with the increase in housing costs, the cost of living increased throughout the county, with energy job wages far outpacing those in all other sectors meaning that "[w]orkers in sectors with lower average wages may find it difficult to keep up."[62]

The boom has also come with social disruption. Traffic has vastly increased and accidents have more than doubled, with over a quarter of them resulting in injury.[63] Over $87 million in road projects are necessary to manage this increased traffic.[64] Crime has also jumped: there were only 2 violent offenses (such as rape and murder) in 2000, before the boom but there were 17 in 2007.[65] Juvenile arrests rose by 92% and DUI cases have spiked sharply upwards, increasing by 57% from 2000 to 2007.[66]

All these disruptions and tens of millions in spending come to support a boom that will not last. The report records that the oil and gas companies operating in the counties expect to see employment drop from thousands of workers to only several hundred within the next decades.[67] Once the wave passes, Sublette County will be left with lingering infrastructure costs, a less diversified economy, and the pollution from thousands of wells and associated equipment. That path

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[58] *Id.*at 90.
[59] *Id.* at 92.
[60] *Id.*
[61] *Id.*
[62] *Id.*at 87.
[63] *Id.*at 102.
[64] *Id.* at 107.
[65] *Id.*
[66] *Id.* at 110-11.
[67] *Id.* at 81.

leads, as the Headwaters report shows, towards a less resilient, less prosperous, future.

ii. The Shale Gas Boom is Causing Similar Problems, and LNG Export Will Worsen Them

The shale gas production boom which LNG export would exacerbate is very likely to follow this familiar pattern of short-term gain for a few, accompanied by long-term economic suffering for many more residents of resource production regions. Although the boom is still in a relatively early phase, available analysis already suggests that the same problems will recur. Export-linked production will intensify the pace and severity of the boom, causing further economic dislocation.

One recent study by Amanda Weinstein and Professor Mark Partridge of Ohio State University, for instance, documents patterns that mimic those seen in the Headwaters and Sublette studies, and in the Freudenburg and Wilson review paper.[68] Using Bureau of Economics Analysis statistics, the study directly compared employment and income in counties in Pennsylvania with significant Marcellus drilling and without significant drilling, and before after the boom started. As Table 1, below, shows, counties in both areas *lost* jobs even as drilling accelerated during the economic recession of 2008, and that the drilling counties lost jobs more quickly. Income increased more quickly in those counties at the same time in a pattern that tracks the results from the western United States studies discussed above: Drilling activities brings more wealth into an area, but that wealth is concentrated in the extraction sector, even as job losses occur in other sectors

Table 1: Comparing Pennsylvania Counties, With and Without Drilling, Over Time[69]

	Employment Growth Rate 2001-2005	**Employment Growth Rate 2005-2009**	**Income Growth Rate 2001-2005**	**Income Growth Rate 2005-2009**
Drilling	1.4%	-0.6%	12.8%	18.2%

[68] Amanda Weinstein and Mark D. Partridge, *The Economic Value of Shale Natural Gas in Ohio*, OHIO STATE UNIVERSITY, Swank Program in Rural-Urban Policy Summary and Report (December 2010) ("Ohio Study"), attached as Ex 16.

[69] Adapted from Table 1 of the *Ohio Study* at 15.

Counties				
Non-Drilling Counties	5.3%	-0.4%	12.6%	13.6%

These shifts in the job market are accompanied by the same set of infrastructure costs and harms to other industries that are familiar from the western case studies.[70] Tourism, a particularly lucrative industry in the northeastern regions where the Marcellus Shale boom is expanding, is likely to be particularly hard hit. Gas production harms tourism by clogging roads, impacting infrastructure, diminishing the scenic value of rural areas, and through other means. These threats to the tourism industry are particularly concerning for many parts of the Marcellus region, including New York's Southern Tier, where tourism is a major source of income and employment. In the Southern Tier, according to one recent study, the tourism industry directly accounts for $66 million in direct labor income, and 4.7% of all jobs, and supports 6.7% of the region's employment.[71]

And, once again, job losses seem likely to follow the boom, as the initial production phase ends. As the Ohio Study explains, "impact studies do not produce continuous employment numbers. If an impact study says there are 200,000 jobs, this does not mean 200,000 workers are continuously employed on a permanent basis. . . . [W]hile the public is likely more interested in continuous ongoing employment effects, impact studies are producing total numbers of supported jobs that occur in a more piecemeal fashion."[72] This failing is particularly relevant here, because the manufacturing and other jobs LNG exports and export-related production will eliminate are typically permanent positions,[73] whereas the gas production jobs induced production will create typically do not provide sustainable, well-paying local employment. This is in part because the industry's employment patterns are uneven: one study found that, in Pennsylvania, "*the drilling phase accounted for over 98% of the natural gas*

[70] Infrastructure costs include, for example, costs to roads, water, and hospitals. *See, e.g.*, CJ Randall, *Hammer Down: A Guide to Protecting Local Roads Impacted by Shale Gas Drilling* (Dec. 2010), attached as Ex 17; Susan Riha & Brian G. Rahm, *Framework for Assessing Water Resource Impacts from Shale Gas Drilling* (Dec. 2010), attached as Ex 18; Associated Press, *Gas Field Workers Cited in Pa. Hospital's Losses*, Pressconnects.com (Dec. 24, 2012), attached as Ex 19.

[71] Andrew Rumbach, *Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier* (2011), attached as Ex 20.

[72] Ohio Study at 11.

[73] NERA report at 62.

industry workforce engaged at the drilling site," and that complementary Wyoming data showed a similar drop-off.[74]

Drilling jobs, in short, correspond to the boom and bust cycle inherent to resource extraction industries.[75] The remaining, small, percentage of production-phase and office jobs are far more predictable, but must be filled with reasonably experienced workers.[76] Although job training at the local level can help residents compete, the initial employment burst is usually made up for people from out of the region moving in and out of job sites; indeed, "[t]he gas industry consistently battles one of the highest employee turnover problems of any industrial sector."[77]

A set of studies from Cornell University's Department of City and Regional Planning confirm this pattern of a short burst of economic activity followed by general economic decline. Those researchers spent more than a year studying the economic impacts of the gas boom on Pennsylvania and New York. Their core conclusion is that boom-bust cycle inherent in gas extraction makes employment benefits tenuous, and may leave some regions hurting if they are unable to convert the temporary boom into permanent growth. As the researchers put it:

> The extraction of non-renewable natural resources such as natural gas is characterized by a "boom-bust" cycle in which a rapid increase in economic activity is followed by a rapid decrease. The rapid increase occurs when drilling crews and other gas-related businesses move into a region to extract the resource. During this period, the local population grows and jobs in construction, retail and services increase, though because the natural gas extraction industry is capital rather than labor intensive, drilling activity itself will produce relatively few jobs for locals. Costs to communities also rise significantly, for everything from road maintenance and public safety to schools. When drilling ceases because the commercially recoverable resource is depleted, there is an economic "bust" – population and jobs depart the region, and fewer people are left to support the boomtown infrastructure.[78]

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[74] *See* Jeffrey Jacquet, *Workforce Development Challenges in the Natural Gas Industry*, at 4 (Feb. 2011) (emphasis in original), attached as Ex 21.

[75] *Id.*

[76] *Id.* at 4-5, 12-14.

[77] *Id.* at 13.

[78] Susan Cristopherson, CaRDI Reports, *The Economic Consequences of Marcellus Shale Gas Extraction: Key Issues* (Sept. 2011) at 4, attached as Ex 22.

This boom and bust cycle is exacerbated by the purportedly vast resources of the Marcellus play, because regional impacts will persist long after local benefits have dissipated, as the authors explain, and may be destructive if communities are not able to plan for, and capture, the benefits of industrialization:

> [B]ecause the Marcellus Play is large and geologically complex, the play as a whole is likely to have natural gas drilling and production over an extended period of time. While individual counties and municipalities within the region experience short-term booms and busts, the region as a whole will be industrialized to support drilling activity, and the storage and transportation of natural gas, for years to come. Counties where drilling-related revenues were never realized or could have ended may still be impacted by this regional industrialization: truck traffic, gas storage facilities, compressor plants, and pipelines. The cumulative effect of these seemingly contradictory impacts – a series of localized short-term boom-bust cycles coupled with regional long-term industrialization of life and landscape – needs to be taken into account when anticipating what shale gas extraction will do communities, their revenues, and the regional labor market, as well as to the environment.[79]

Some people will prosper and some will not during the resultant disruption and, warn the Cornell researchers, the long-term effects may well not be positive, based upon years of research on the development of regions dependent on resource extraction:

> [T]he experience of many economies based on extractive industries warns us that short-term gains frequently fail to translate into lasting, community-wide economic development. *Most alarmingly, a growing body of credible research evidence in recent decades shows that resource dependent communities can and often do end up worse than they would have been without exploiting their extractive reserve.* When the economic waters recede, the flotsam left behind can look more like the aftermath of a flood than of a rising tide.

Id. at 6 (emphasis supplied).

[79] *Id.* (emphasis in original).

A later, peer-reviewed and formally published version of this work, builds upon these lessons.[80] Collecting research from around the country, including the Sublette County experience discussed above, it canvasses the infrastructure stresses,[81] social dislocations and population shifts,[82] and environmental costs of resource extraction,[83] to conclude that expanding the shale gas boom may well harm many communities, explaining that "rural regions whose economies are dependent on natural resource extraction frequently have poor long-term development outcomes."[84]

In fact, the researchers conclude that in some cases communities "may wind up worse off" than they were before the boom started.[85] They explain that the boom-related cost of living and materials expense increases may well crowd out other industries, such as the fragile dairy industry now operating in many northeastern shale plays.[86] Gas boom regions may even wind up shrinking. Counties in New York and Pennsylvania with significant natural gas drilling between 1994 and 2009 have lost more population than peers without drilling activity.[87]

After the boom recedes, the weakened local economy struggles to provide for the infrastructure that was required to support the boom:

> During the boom period, the county's physical infrastructure was planned and installed to accommodate an expanding population. The nature of infrastructure such as roads, sewer and water facilities, and schools is that once it is built, it generates ongoing maintenance costs (as well as debt service costs) even if consumption of the facilities declines…. The departure of [boom time] workers and higher income, mobile professionals [will leave] the burden of paying for such costs to remaining smaller, lower-income, population.[88]

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[80] S. Christopherson & N. Rightor, *How shale gas extraction affects drilling localities: Lessons for regional and city policy makers*, 2 Journal of Town & City Management 1 (2012), attached as Ex 23.
[81] *Id.* at 11-12.
[82] *Id.* at 10-11.
[83] *Id.* at 12-13.
[84] *Id.* at 15.
[85] *Id.*
[86] *Id.*
[87] *Id.*
[88] *Id.* at 16.

In short, resource booms may bring wealth to a few companies, and, transiently, to some regions, but the long-term consequences are negative.[89] After the boom passes, those who remain behind must live with a lasting negative legacy. If LNG exports drive regional economies towards an even more intense boom, the bust, when it comes, will be all the worse.

D. Conclusions on Industrial Costs and Community Impacts

At bottom, LNG export means intensifying an economic strategy that has failed nations and communities over and over again. It would mark a path towards increasing economic inequality, a weaker social fabric in communities across the country, and a weaker middle class. Even during the boom, infrastructure costs and social disruption impose major burdens on extraction regions. DOE/FE must consider all these costs. But NERA sets all those costs at naught because the raw revenues from LNG export are so large for those that capture them. DOE/FE's task, though, is to look to the *public* interest, not the interest of a narrow segment of industry. It would be arbitrary and capricious to approve of exports on the basis of the NERA Report, which so entirely under-values the very considerations which must be at the heart of DOE/FE's analysis.

III. NERA Fails to Account for the Economic Implications of Environmental Harm Caused by LNG Export; DOE/FE Must Do So.

Just as NERA ignores or improperly downplays the serious negative consequences of developing a resource-extraction based economy for export, it also entirely fails to acknowledge that LNG exports impose substantial environmental costs. These costs range from the immediate costs of treating waste from fracking to the public health costs of air and water pollution from the gas production sector to the increased risk of global climate change inherent in deepening our dependence on fossil fuels. Indeed, air pollution emissions alone likely impose costs in the hundreds of millions of dollars, at a minimum, and would erode recent pollution control efforts.

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[89] Indeed, there is significant evidence that many studies touting high benefits from gas extraction suffer from systematic procedural flaws which render them unreliable. *See* T. Kinnaman, *The economic impact of shale gas extraction: A review of existing studies*, 70 Ecological Economics 1243 (2011). Dr. Kinnaman concludes that a careful review of actual data on shale gas reserves in Pennsylvania, Arkansas, and Texas shows that "shale drilling and extraction activities decreased per capita incomes" rather than benefitting residents of gas fields in those areas, attached as Ex 24.

The existence of these impacts, and their importance, should be familiar to DOE/FE, based upon the work of DOE's own Secretary of Energy Advisory Board Subcommittee on Shale Gas Production.[90] In response to Presidential and Secretarial directives, the Subcommittee met for months to assess measures to be taken to reduce the environmental impact of shale gas production. It concluded that "if action is not taken to reduce the environmental impact accompanying the very considerable expansion of shale gas production expected across the country… there is real risk of serious environmental consequences."[91] Action is especially necessary because the gas production industry currently enjoys exemptions to many federal environmental statutes, and as such, gas producers have greater ability act in ways that impose external costs on the public.[92] The Subcommittee recommended building a "strong foundation of regulation and enforcement" to improve shale gas production practices, and set forth twenty regulatory recommendations addressing air and water pollution and other threats from current production practices.[93] The Subcommittee was alarmed that progress on these recommendations was less than it had hoped, and urged "concerted and sustained action is needed to avoid excessive environmental impacts of shale gas production."[94]

The vast majority of the Subcommittee's recommendations, which were made in 2011, remain unfulfilled, meaning that the risk of "excessive environmental impacts" remains pressing, as the Subcommittee put it. The LNG exports DOE/FE is now considering would intensify these risks by intensifying shale gas production around the country. The environmental costs of that decision are very real. They are measured in the costs of treatment plants and landfills, of emergency room visits and asthma attacks, of lost property values and rising seas. They will be felt as acutely as the wage and income losses export will cause, and must be accounted for in any proper economic analysis. Indeed, the very existence of these impacts, and the continued absence of the "strong foundation" of regulation recommended by the expert Subcommittee

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[90] Secretary of Energy Advisory Board Shale Gas Production Subcommittee, *Second 90-Day Report* (Nov. 18, 2011), attached as Ex 25.

[91] *Id.* at 10.

[92] For example, gas production is exempt from various provisions of the Safe drinking Water Act, 42 U.S.C. § 300h(d)(1)(B), certain hazardous air pollution regulations under the Clean Air Act, 42 U.S.C. § 7412(n)(4)(B) , stormwater provisions of the Clean Water Act, 33 U.S.C. § 1362(24), and the Comprehensive Environmental Response, Compensation, and Liability Act 42 U.S.C. § 9601(10)(I), (14), (33).

[93] *See SEAB Second 90-Day Report* at 10, 16-18.

[94] *Id.* at 10.

demonstrates that LNG exports counsels strongly against moving forward with export.

Yet, NERA ignores these impacts completely. Because its report fails to even acknowledge this critically important negative side of the ledger, the study is ultimately incomplete and unreliable.

A. Induced Production Can and Must be Analyzed as Part of This Accounting

Before turning to some of the many environmental costs imposed by LNG export, it is important to emphasize that DOE/FE can, in fact, account for them. These costs fall into two classes: The environmental impacts associated with LNG export infrastructure itself (such as the emissions from liquefaction facilities, increased traffic of LNG tankers, and the network of pipelines and compressors needed to support them); and the environmental impacts of the major increase in natural gas production to supply gas for export. There is no real dispute, even within DOE/FE, that the first set of impacts can be estimated. But DOE/FE has previously questioned whether it can analyze the second set of impacts. In fact, DOE's own models allow it to do so.

As the NERA Study acknowledges, LNG exports will increase U.S. gas production.[95] Indeed, these production increases provide at least a portion of the purported benefits of export that the Study touts.[96] If DOE/FE intends to advance induced production as part of the justification for exports, then induced production is plainly a reasonably foreseeable effect of exports that must be analyzed under NEPA. DOE/FE must consider the considerable impacts on air, land, water, and human health from induced production.[97]

These impacts can be calculated. EIA and DOE have precise tools enabling them to estimate how U.S. production will change in response to LNG exports. These tools enable DOE/FE to predict how and when production will increase in individual gas plays. EIA's core analytical tool is the National Energy Modeling System ("NEMS"). NEMS was used to produce the EIA exports study that

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[95] NERA Study at 51-52 & fig. 30.

[96] *See, e.g., id.* at 9 fig.4; 62 fig.39.

[97] Sierra Club has described these impacts in numerous comments on individual export proposals. *E.g.*, Sierra Club Mot. Intervene, Protest, and Comments, *In the Matter of Southern LNG Company*, DOE/FE Dkt. No. 12-100-LNG (Dec. 17, 2012), attached as Ex 26.

preceded the NERA study. NEMS models the economy's energy use through a series of interlocking modules that represent different energy sectors on geographic levels.[98] Notably, the "Natural Gas Transmission and Distribution" module already models the relationship between U.S. and Canadian gas production, consumption, and trade, specifically projecting U.S. production, Canadian production, imports from Canada, etc.[99] For each region, the module links supply and demand annually, taking transmission costs into account, in order to project how demand will be met by the transmission system.[100] Importantly, the Transmission Module is *already* designed to model LNG imports and exports, and contains an extensive modeling apparatus allowing it to do so on the basis of production in the U.S., Canada, and Mexico.[101] At present, the Module focuses largely on LNG imports, reflecting U.S. trends up to this point, but it also already links the Supply Module to the existing Alaskan *export* terminal and projects exports from that site and their impacts on production.[102]

Similarly, the "Oil and Gas Supply" module models individual regions and describes how production responds to demand across the country. Specifically, the Supply Module is built on detailed state-by-state reports of gas production curves across the country.[103] As EIA explains, "production type curves have been used to estimate the technical production from known fields" as the basis for a sophisticated "play-level model that projects the crude oil and natural gas supply from the lower 48."[104] The module distinguishes coalbed methane, shale gas, and tight gas from other resources, allowing for specific predictions distinguishing unconventional gas supplies from conventional supplies.[105] The module further projects the number of wells drilled each year, and their likely production – which are important figures for estimating environmental impacts.[106] In short, the supply module "includes a comprehensive assessment method for

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[98] Energy Information Administration ("EIA"), *The National Energy Modeling System: An Overview*, 1-2 (2009), attached as Ex 27, available at http://www.eia.gov/oiaf/aeo/overview/pdf/0581(2009).pdf.

[99] *Id.* at 59.

[100] EIA, *Model Documentation: Natural Gas Transmission and Distribution Module of the National Energy Modeling System*, 15-16 (2012), attached Ex 28, *available at* http://www.eia.gov/FTPROOT/modeldoc/m062(2011).pdf.

[101] *See id.* at 22-32.

[102] *See id.* at 30-31.

[103] EIA, *Documentation of the Oil and Gas Supply Module*, 2-2 (2011), attached as Ex 29, *available at* http://www.eia.gov/FTPROOT/modeldoc/m063(2011).pdf.

[104] *Id.* at 2-3.

[105] *Id.* at 2-7.

[106] *See id.* at 2-25 to 2-26.

determining the relative economics of various prospects based on future financial considerations, the nature of the undiscovered and discovered resources, prevailing risk factors, and the available technologies. The model evaluates the economics of future exploration and development from the perspective of an operator making an investment decision."[107] Thus, for each play in the lower 48 states, the EIA is able to predict future production based on existing data. The model is also equipped to evaluate policy changes that might impact production; according to EIA, "the model design provides the flexibility to evaluate alternative or new taxes, environmental, or other policy changes in a consistent and comprehensive manner."[108]

EIA is not alone in its ability to predict localized effects of LNG exports. A study and model developed by Deloitte Marketpoint claims the ability to make localized predictions about production impacts, and numerous other LNG export terminal proponents have relied on this study in applications to FERC and DOE.[109] According to Deloitte, its "North American Gas Model" and "World Gas Model" allow it to predict how gas production, infrastructure construction, and storage will respond to changing demand conditions, including those resulting from LNG export. According to Deloitte, the model connects to a database that contains "field size and depth distributions for every play," allowing the company to model dynamics between these plays and demand centers. "The end result," Deloitte maintains, "is that valuing storage investments, identifying maximally effectual storage field operation, positioning, optimizing cycle times, demand following modeling, pipeline sizing and location, and analyzing the impacts of LNG has become easier and generally more accurate."[110]
But even if not all impacts can be precisely estimated and monetized, DOE/FE cannot avoid acknowledging them. Where uncertainty exists, DOE/FE could still meaningfully analyze the environmental impacts of induced drilling by estimating impacts from all permitted exports in the aggregate, based on industry-wide data regarding the impacts of gas drilling.

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[107] *Id.* at 2-3.

[108] *Id.*

[109] Deloitte Marketpoint, *Made in America: The Economic Impact of LNG Exports from the United States* (2011), available at http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Energy_us_er/us_er_MadeinAmerica_LNGPaper_122011.pdf and attached as

[110] Deloitte, *Natural Gas Models*, http://www.deloitte.com/view/en_US/us/Industries/power-utilities/deloitte-center-for-energy-solutions-power-utilities/marketpoint-home/marketpoint-data-models/b2964d1814549210VgnVCM200000bb42f00aRCRD.htm (last visited Dec. 20, 2012).

Thus, there is no technical barrier to modeling where exports will induce production going forward, or to beginning to monetize and disclose the costs they will impose. Indeed, EIA used such models for its export study, which forecast production and price impacts, and which DOE/FE already relies upon. DOE/FE cannot assert that it is unable to count the significant environmental and economic costs associated with increased gas production for export. It must do disclose and consider these costs.

B. Gas Production for Export Will Come With Significant Environmental Costs

The environmental toll of increased unconventional gas production is very great, especially without full implementation of the Shale Gas Subcommittee report. We do not intend here to fully count these costs: That is DOE/FE's charge, under both NEPA and the Natural Gas Act. The discussion in these comments merely indicates some of the many costs which DOE/FE must consider, and which NERA failed to disclose.

In this regard, we draw DOE/FE's attention to a recent report by researchers at Environment America, which attempts to monetize many costs from fracking activities, ranging from direct pollution costs to infrastructure costs to lost property values.[111] We incorporate that report by reference. DOE/FE should fully account for all the costs enumerated therein.

It is true that some uncertainty necessarily attaches to environmental costs like the ones we discuss below. But, as the Ninth Circuit Court of Appeals explained in *Center for Biological Diversity v. NHTSA*, some uncertainty in estimation methodologies does not support declining to quantitatively value benefits associated with reducing climate change pollution at all.[112] Where, as here, "the record shows that there is a range of values [for these benefits], the value of carbon emissions reduction is certainly not zero."[113] Therefore, the agency is obligated to consider such a value, or range of values.[114] Since LNG export plainly imposes these significant environmental costs, DOE/FE should calculate and disclose them (accompanied by an explanation of any limitations or

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[111] *See* T. Dutzik *et al., The Costs of Fracking* (2012), attached as Ex 30.

[112] *See Center for Biological Diversity,* 538 F.3d 1172, 1200 (9th Cir. 2008) (citing Office of Management and Budget Circular A-4 as providing that "agencies are to monetize costs and benefits whenever possible.").

[113] *See id.*

[114] *See id.* at 1203.

uncertainties in each methodology, as necessary). It may not, however, simply ignore them.

i. Air Pollution and Climate Costs

Oil and gas production, transmission, and distribution sources are among the very largest sources of methane and volatile organic compounds in the country, and also emit large amounts of hazardous air pollutants ("HAPs") and nitrogen oxide, among other pollutants.[115] Although EPA has recently issued pollution standards that control some pollutants from new sources, the majority of the industry remains unregulated. Increasing gas production will necessarily increase air pollution from the industry. Indeed, gas export would produce enough air pollution to diminish – if not to entirely offset – the benefits of EPA's recent standards.

LNG exports would also increase air pollution costs in other ways. They would, for instance, likely increase the use of coal-fired electricity, which imposes significant public health costs. They would also deepen our economic dependence on fossil fuels, which are exacerbating global climate change. DOE/FE must account for all of these costs.

Direct Emissions Costs

The potential air pollution increase from LNG exports is very large. 9,052 bcf per year of gas are proposed for export, and NERA considered scenarios of between 4,380 bcf and 1,370 bcf of exports per year by 2035. The EIA's induced production models indicate that 63% of this gas (or more) will come from new production.[116] Although the range of estimates for gas leaked from productions systems varies, if even a small amount of this newly produced gas escapes to the atmosphere the pollution consequences are major.

EPA's current greenhouse gas inventory implies that about 2.4% of gross gas production leaks to the atmosphere in one way or another, a leak rate that makes

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[115] *See generally* U.S. EPA, *Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution* : *Background Supplemental Technical Support Document for the Final New Source Performance Standards* (2012) (discussing these and other pollutants), attached as Ex 31; U.S. EPA, *Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution: Background Technical Support Document for Proposed Standards* (2011) (hereinafter "2011 TSD"), attached as Ex 32.

[116] EIA Study at 10.

oil and gas production the single largest source of industrial methane emissions in the country, and among the very largest sources of greenhouse gases of any kind.[117] More recent work by National Oceanic and Atmospheric Administration ("NOAA") scientists suggest, based on direct measurement at gas fields, that this leak rate may be between 4.8% and 9%, at least in some fields.[118] These leak rates, and EPA conversion factors between the typical volumes of methane, VOC, and HAP in natural gas,[119] make it possible to calculate the potential impact of increasing gas production in the way that LNG export would require. We note that fugitive emissions include additional pollutants not discussed here, such as radioactive radon.[120]

The table below shows our calculations of expected pollution from fugitive emissions of methane, VOCs, and HAP based on these conversion factors, at varying leak rates (starting at 1% of production and going to 9%).[121] We acknowledge, of course, that these calculations are necessarily only a first cut at the problem. The point, here, is not to generate the final analysis (which DOE/FE must conduct) but to demonstrate that the problem is a serious one.

Export Volume in	Methane (tons)	VOC (tons)	HAP (tons)

[117] Alvarez *et al.*, *Greater focus needed on methane leakage from natural gas infrastructure*, Proceedings of the National Academy of Science (Apr. 2012) at 1, attached as Ex 33; *see also* EPA, *U.S. Greenhouse Gas Emissions and Sinks 1990-2010* (Apr. 15, 2012) at Table ES-2, attached as Ex 34.

[118] *See* G. Petron *et al.*, *Hydrocarbon emissions characterization in the Colorado Front Range – A pilot study*, Journal of Geophysical Research (2012), attached as Ex 35; J. Tollefson, *Methane leaks erode green credentials of natural gas*, Nature (2013), attached as Ex 36.

[119] *See* EPA, 2011 TSD at Table 4.2. EPA calculated average composition factors for gas from well completions. These estimates, which are based on a range of national data are robust, but necessarily imprecise for particular fields and points along the line from wellhead to LNG terminal. Nonetheless, they provide a beginning point for quantitative work. EPA's conversions are: 0.0208 tons of methane per mcf of gas; 0.1459 lb VOC per lb methane; and 0.0106 lb HAP per lb methane.

[120] *See* Marvin Resnikoff, *Radon in Natural Gas from Marcellus Shale* (Jan. 10, 2012), attached as Ex 37**.** Insofar as LNG exports induce greater gas production nationwide, and exports predominantly draw on wells in the Gulf (as NERA assumes), then exports will presumably increase the share of gas used in households in the Northeast that is provided by Marcellus shale wells, and thereby aggravate the radon exposure issues highlighted by Resnikoff.

[121] These figures were calculated by multiplying the volume of gas to be exported (in bcf) by 1,000,000 to convert to mcf, and then by 63% to generate new production volumes. The new production volumes of gas were, in turn, multiplied by the relevant EPA conversion factors to generate tonnages of the relevant pollutants. These results are approximations: Although we reported the arithmetic results of this calculation, of course only the first few significant figures of each value should be the focus.

2035 (bcf)			
1% Leak Rate			
9,052 bcf	1,186,174	173,062.8	12,573.45
4,380 bcf	573,955.2	83,740.06	6,083.925
1,370 bcf	179,524.8	26,192.67	1,902.963
2.4% Leak Rate			
9,052 bcf	2,846,818	415,350.7	30,176.27
4,380 bcf	1,377,492	200,976.2	14,601.42
1,370 bcf	430,859.5	62,862.4	45,67.111
4.8% Leak Rate			
9,052 bcf	5,693,636	830,701.4	60,352.54
4,380 bcf	2,754,985	401,952.3	29,202.84
1,370 bcf	861,719	125,724.8	9,134.222
9% Leak Rate			
9,052 bcf	10,675,567	1,557,565	113,161
4,380 bcf	5,165,597	753,660.6	54,755.33
1,370 bcf	1,615,723	235,734	17,126.67

The *total* emissions reductions associated with EPA's new source performance standards for oil and gas production are, according to EPA, about 1.0 million tons of methane, 190,000 tons of VOC, and 12,000 tons of HAP. As the table demonstrates, the additional air pollution which would leak from the oil and gas system substantially erodes those figures, even at the lowest volume of LNG export and the lowest leak rate of 1% -- which is well below the 2.4% leak rate which EPA now estimates. It would generate over 179,000 tons of methane, over 26,000 tons of VOC, and over 1,902 tons of HAP. More realistic leak rates make the picture even worse: At the EPA's estimated 2.4% leak rate, the figures for the lowest export volume are over 430,000 tons of methane, over 62,000 tons of VOC, and over 45,000 tons of HAP.

Put differently, even if LNG export is almost 9 times less than the current volume proposed for license before DOE/FE, and even if the natural gas system leak rate is less than half that which EPA now estimates, LNG export will still produce enough air pollution to erode the benefits of EPA's air standards by on the order of 20%. If export volumes increase, or if the leak rate is higher, the surplus emissions swamp the air standards completely. At a 4.8% leak rate and the mid-range 4,380 bcf export figure, LNG export would produce almost three times as many methane emissions – 2.7 million tons -- as the EPA air standards control.

In short, ramping up production for export comes with major air pollution increases. This additional pollution would impose real public health and environmental burdens.

Methane emissions, for instance, are linked to ozone pollution and to global climate change. The climate change risks associated with methane are monetizable using the Social Cost of Carbon framework developed by a federal working group led by EPA.[122] These costs vary based on assumptions of the discount rate at which to value future avoided harm from emissions reductions, and also likely vary by gas (methane, for instance, is a more potent climate forcer than carbon dioxide). Nonetheless, in its recent air pollution control rules, EPA estimated monetized climate emissions benefits from methane reductions simply by multiplying the reductions by the social cost of carbon dioxide (at a 3% discount rate) and the global warming potential of methane (which converts the radiative forcing of other greenhouse gases to their carbon dioxide equivalents).[123]

The global warming potential of methane, on a 100-year basis,[124] is at least 25,[125] and the social cost of carbon at a 3% discount rate is $25/ton (in 2008 dollars).[126] Thus, the social cost of the roughly 179,000 tons of methane emissions produced even by the lowest volume of export at the lowest leak rate is (25)(25)(179,000) or $111,875,000 *per year*. The same volume of export at 2.4% leak rate imposes methane costs of approximately $274 million per year. Again, higher volumes of export, and higher leak rates are associated with even higher costs.

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[122] EPA, *The Social Cost of Carbon*, available at http://www.epa.gov/climatechange/EPAactivities/economics/scc.html, attached as Ex 38.

[123] EPA, *Regulatory Impact Analysis: Final New Source Performance Standards and Amendments to the National Emissions Standards for Hazardous Air Pollutants for the Oil and Natural Gas Industry* (2012) at 4-32 – 4-33, attached as Ex 39. EPA acknowledges that its method is still provisional, but it does provide at least a sense of the real economic costs of methane emissions.

[124] Methane acts more quickly than carbon dioxide to warm the climate, and also oxidizes rapidly. As such, many argue that a shorter time period (20 years or less) is appropriate to calculate its global warming potential. We have conservatively used a 100 years here. The true cost of methane emissions is thus likely higher.

[125] Intergovermental Panel on Climate Change, *Direct Global Warming Potentials* (2007), available at http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html, attached as Ex 39.

[126] 2012 RIA at 4-33.

Our calculation is notably conservative: It uses a global-warming potential that is lower than that reported in more recent literature,[127] and a higher discount rate for climate damages than may be appropriate. Yet even this conservative calculation identifies hundreds of millions of dollars in damages from methane associated with export. More recent global warming potentials (which exceed 70) or more appropriate discount rates (which arguably should be zero or negative), would readily push these costs into the billions of dollars annually.

Other large costs arise from the VOC emissions from production. VOCs are often themselves health hazards, and interact with other gases in the atmosphere to produce ozone.[128] Ozone is a potent public health threat associated with thousands of asthma attacks annually, among other harm to public health. Ground-level ozone has significant and well-documented negative impacts on public health and welfare, and gas production is already strongly linked to ozone formation. One recent study, for instance, showed that over half of the ozone precursors in the atmosphere near Denver arise from gas operations.[129] Other studies show that ozone can increase by several parts per billion immediately downwind of individual oil and gas production facilities.[130] The cumulative impact of dozens or hundreds of such individual facilities can greatly degrade air quality – so much so that the study's author concludes that gas facilities may make it difficult for production regions to come into compliance with public health air quality standards if not controlled.[131]

Some studies have documented how reductions in ground-level ozone would benefit public health and welfare, and so also demonstrate how increases in ozone levels will harm the public. Using a global value of a statistical life (VSL) of $1 million (substantially lower than the value used by EPA, currently $7.4 million (in 2006 dollars)[132]), West *et al.* calculate a monetized benefit from avoided mortality due to methane reductions of $240 per metric ton (range of

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[127] We use the IPCC's methane 100-year global warming potential of 25, *see supra* n.125. A more recent study puts this figure at approximately 34, while acknowledging that it could be significantly higher. Drew T. Shindell, *et al.*, *Improved Attribution of Climate Forcing Emissions*, 326 Science No. 5953, page 717 fig. 2 (Oct. 30 2009), attached as Ex 40.

[128] Methane is also an ozone precursor, albeit a somewhat less potent one

[129] J.B. Gilman *et al.*, *Source signature of volatile organic compounds from oil and natural gas operations in northeastern Colorado*, Env. Sci. & Technology (2013), attached as Ex 41.

[130] E.P. Olaguer, *The potential near-source ozone impacts of upstream oil and gas industry emissions*, Journal of the Air & Waste Management Assoc. (2012), attached as Ex 42.

[131] *Id.* at 976.

[132] http://yosemite.epa.gov/ee/epa/eed.nsf/pages/MortalityRiskValuation.html, attached as Ex 43.

$140 - $450 per metric ton).[133] Because VOCs are more potent ozone precursors than methane,[134] the monetary benefits of VOC reduction for avoided mortality are certainly greater on a tonnage basis. Further, as well as direct mortality and morbidity impacts, ozone can significantly reduce the productivity of individual workers, even at low levels. One recent study shows that even a 10 ppb increase in ozone concentrations can decrease the productivity of field workers by several percentage points – a difference that translates into something on the order of $700 million in annual productivity costs.[135]

Ground-level ozone also significantly reduces yields of a wide variety of crops. A recent study finds that in 2000, ozone damage reduced global yields 3.9-15% for wheat, 8.5-14% for soybeans, and 2.2-5.5% for corn, with total costs for these three crops of $11 billion to $18 billion and costs within the US alone over $3 billion (all in year 2000 dollars).[136] Due to the growth in the emissions of ozone precursors in coming years, these crop losses are likely to increase. In 2030, ozone is predicted to reduce global yields 4-26% for wheat, 9.5-19% for soybeans, and 2.5-8.7% for corn, with total costs for these three crops (2000 dollars) of $12 billion to $35 billion.[137] Another recent study included damage to rice (3-4% reduction in yield for year 2000) and finds even higher total costs for year 2000 ($14 billion to $26 billion).[138] Many other crops are damaged by ozone, so these estimates only capture a portion of the economic damage to crops from ground-level ozone. Ozone precursors from export-linked production would add to these costs.

The HAPs from gas production for export also impose significant public health costs. HAPs, by definition, are toxic and also may be carcinogenic. High levels of carcinogens, including benzene compounds, are associated with gas production sites. Unsurprisingly, recent risk assessments from Colorado

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[133] West *et al.* at 3991.
[134] Methane, technically, *is* a VOC; it is often referred to separately, however, and we do so here.
[135] J. Graff Zivin & M. Neidell, *Pollution and Worker Productivity*, 102 American Economic Review 3652 at 3671 (2012), attached as Ex 44.
[136] Avnery, S, D.L. Mauzerall, J. Liu, and L.W. Horowitz (2011) "Global crop yield reductions due to surface ozone exposure: 1. Year 2000 crop production losses and economic damage," *Atmos. Env.*, 45, 2284-2296, attached as Ex 45.
[137] Avnery, S, D.L. Mauzerall, J. Liu, and L.W. Horowitz (2011) "Global crop yield reductions due to surface ozone exposure: 2. Year 2030 potential crop production losses and economic damage under two scenarios of O_3 pollution," *Atmos. Env.*, 45, 2297-2309, attached as Ex 46.
[138] Van Dingenen, R, F.J. Dentener, F. Raes, M.C. Krol, L. Emberson, and J. Cofala, (2009) "The global impact of ozone on agricultural crop yields under current and future air quality legislation," *Atmos. Env.*, 43, 604-618, attached as Ex 47.

document elevated health risks for residents living near gas wells.[139] Indeed, levels of benzene and other toxics near wells in rural Colorado were "higher than levels measured at 27 out of 37 EPA air toxics monitoring sites … including urban sites" in major industrial areas."[140] These pollution levels are even more concerning than these high concentrations would suggest because several of the toxics emitted by gas operations are endocrine disruptors, which are compounds known to harm human health by acting on the endocrine system even at very low doses; some such compounds may, in fact, be especially dangerous specifically at the low, chronic, doses one would expect near gas operations.[141]

Other air pollutants add to all of these public health burdens. Particulate matter from flares and dusty roads, diesel fumes from thousands of truck trips, NO_x emissions from compressors and other onsite engines, and so on all add to the stew of pollution over gas fields. LNG export will increase all of these emissions in proportion to the scale of export.

Further, these emissions would not be spread uniformly around the country. Instead, they would be concentrated in and around gas fields. Those fields, like the Barnett field in Dallas Fort-Worth, or the Marcellus Shale near eastern cities, often are not far from (or are even directly within) major population centers. Residents of those cities will receive concentrated doses of air pollution, as will residents of the fields themselves. They thus will suffer public health harms from particularly concentrated pollution.

Costs from Increased Use of Coal

The EIA estimates that gas price increases associated with LNG export will favor continued and increased use of coal power, on the margin.[142] Another recent study, prepared by the Joint Institute for Strategic Energy Analysis (JISEA), also modeled power sector futures resulting from increasing U.S. reliance on natural gas.[143] That study found that, under baseline assumptions for future electricity

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[139] L. McKenzie *et al.*, *Human health risk assessment of air emissions from development of unconventional natural gas resources*, Science of the Total Environment (2012), attached as Ex 48.
[140] *Id.* at 5.
[141] *See* L. Vandenberg *et al.*, *Hormones and Endocrine-Disrupting Chemicals: Low-Dose Effects and Nonmonotonic Dose Responses*, Endocrine Disruption Review (2012), attached as Ex 49.
[142] EIA Study at 17-18.
[143] Jeffrey Logan et al., Joint Inst. for Strategic Analysis, Natural Gas and the Transformation of the U.S. Energy Sector (2012) ("JISEA report"), available at http://www.nrel.gov/docs/fy13osti/55538.pdf, attached as Ex 50.

demand and policy measures, "natural gas and coal swap positions compared to their historical levels," with wind energy growing at a rate that represents "a significant reduction from deployment in recent years;" as a result, CO_2 emissions "do not begin to transition to a trajectory that many scientists believe is necessary to avoid dangerous impacts from climate change."[144]

The costs of the increased CO_2 emissions triggered by LNG export are along significant, and DOE/FE must disclose and weigh them. DOE/FE suggests that they are on the order of 200-1500 million metric tons of CO_2.[145] Again, depending on the social cost of carbon figure used, these increased emissions may impose hundreds of millions or billions in additional costs.

And costs extend beyond climate disruption. Coal combustion is a particularly acute public health threat. It is among the largest sources of all forms of air pollution in the country, including toxic mercury emissions and emissions particulate matter, which is linked to asthma and to heart attacks. To the extent that LNG export prolongs or intensifies the use of coal power, the public health costs of that additional coal use are attributable to export, and must be accounted for.

Likewise, EPA, in calculating compliance costs for several of its clean air rules, has assumed that some portion of these costs will be addressed by switching from coal to natural gas. If these switches still occur, but LNG exports have raised natural gas prices, the compliance costs of necessary public health measures will be higher than they otherwise would be.

Costs from Further Investment in Fossil Fuels

LNG exports will also deepen our national investment in fossil fuels, even though those fuels are causing destructive climate change. The costs of increased climate risks must be factored into the export calculation.

Specifically, a recent study by the International Energy Agency predicts that international trade in LNG and other measures to increase global availability of natural gas will lead many countries to use natural gas in place of wind, solar, or other renewables, displacing these more environmentally beneficial energy sources instead of displacing other fossil fuels, and that these countries may also

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[144] *Id.* at 98.

[145] EIA Study at 19.

increase their overall energy consumption beyond the level that would occur with exports.[146] In the United States alone, the IEA expects the gas boom to result in a 10% reduction in renewables relative to a baseline world without increased gas use and trade.[147] The IEA goes on to conclude that high levels of gas production and trade will produce "only a small net shift" in global greenhouse gas emissions, with atmospheric CO_2 levels stabilizing at over 650 ppm and global warming in excess of 3.5 degrees Celsius, "well above the widely accepted 2°C target."[148]

Such temperature increases would be catastrophic. Yet, an LNG export strategy commits the United States, and the world, to further fossil fuel combustion, increasing the risk of hundreds of billions of economic costs imposed by severe climate change.

Summing up air pollution impacts

Across all of these harms, the public health damage associated just with air pollution from increased production to support export very likely runs into the hundreds of millions, if not billions, of dollars. DOE/FE must account for these costs as it weighs the economic merits of expanding gas production, and gas pollution, for export.

ii. Water Pollution Costs

The hundreds or thousands of wells required to support export will require millions of gallons of water to frack and will produce millions of gallons of wastewater. The extraction process will likewise increase the risk of contamination from surface spills and casing failures, as well as from the fracking process itself. All of these contamination and treatment risks impose economic costs which DOE must take into account.

Water Withdrawal Costs

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[146] International Energy Agency, *Golden Rules for a Golden Age of Gas*, Ch. 2 p. 91 (2012), available at http://www.iea.org/publications/freepublications/publication/WEO2012_GoldenRulesReport.pdf, attached as Ex 51.

[147] *Id.* at 80.

[148] *Id.*

Fracking requires large quantities of water. The precise amount of water varies by the shale formation being fracked. The amount of water varies by well and by formation. For example, estimates of water needed to frack a Marcellus Shale wells range from 4.2 to over 7.2 million gallons.[149] In the Gulf States' shale formations (Barnett, Haynesville, Bossier, and Eagle Ford), fracking a single well requires from 1 to over 13 million gallons of water, with averages between 4 and 8 million gallons.[150] Fresh water constitutes 80% to 90% of the total water used to frack a well even where operators recycle "flowback" water from the fracking of previous wells for use in drilling the current one.[151] Many wells are fractured multiple times over their productive life.

DOE/FE can and must predict the number of wells that will be needed to provide the volume of gas exported. We provide an unrealistically conservative (i.e., industry-friendly) estimate here to illustrate the magnitude of the problem, although DOE/FE can and must engage in a more sophisticated analysis of the issue. As noted above, EIA predicts that at least 63% percent of the gas exported will come from additional production, and that roughly 72% of this production will come from shale gas sources, with an additional 23% coming from other unconventional gas reserves. The USGS has estimated that even in the most productive formations, average expected ultimate recoveries for unconventional shale gas wells are less than 3 bcf, and that most formations provided drastically

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[149] TNC, Pennsylvania Energy Impacts Assessment, Report 1: Marcellus Shale Natural Gas and Wind 10, 18 (2010), attached as Ex 52. *Accord* N.Y. Dep't of Envtl. Conservation, Revised Draft Supplemental General Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, 5-5 (2011) ("NY RDSGEIS") at 6-10, available at http://www.dec.ny.gov/energy/75370.html ("Between July 2008 and February 2011, average water usage for high-volume hydraulic fracturing within the Susquehanna River Basin in Pennsylvania was 4.2 million gallons per well, based on data for 553 wells."). Other estimates suggest that as much as 7.2 million gallons of frack fluid may be used in a 4000 foot well bore. NRDC, *et al.*, *Comment on NY RDSGEIS on the Oil, Gas and Solution Mining Regulatory Program* (Jan. 11, 2012) (Attachment 2, Report of Tom Myers, at 10), attached as Ex 53 ("Comment on NY RDSGEIS").

[150] Jean-Philippe Nicot, *et al.*, *Draft Report – Current and Projected Water Use in the Texas Mining and Oil and Gas Industry*, 52-54 (Feb. 2011) (water use from 1 to over 13 million gallons), attached as Ex 54; Jean-Philippe Nicot, *et al.*, *Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report* 11-14 (Sept. 2012) (updated data presented as averages), attached as Ex. 55**.** DOE's Shale Gas Subcommittee generally states that nationwide, fracking an individual well requires between 1 and 5 million gallons of water. DOE, Shale Gas Production Subcommittee First 90-Day Report (2012), at 19, attached as Ex 56.

[151] NY RDSGEIS at 6-13, *accord* Nicot 2012, *supra* n.150, at 54.

lower average expected ultimate recoveries.[152] As noted above, the average horizontal fracked well requires roughly 4 million gallons of water, at least 80% of which (3.2 million gallons) is new fresh water.[153]

Combining these figures and assuming high average recovery, low/average water per frack jobs, only a single frack per well, and maximal use of recycled water, we see the following volumes of water. These figures are only for *shale* gas production, because we have water use figures for such wells; additional unconventional production, of the sort that the EIA predicts, would increase water use.

Volume of exports (bcf/y)	Induced Shale Gas Production (bcf/y)[a]	Equivalent Number of Shale Wells Needed Per Year[b]	New Fresh Water Required (millions of gallons per year)[c]
9,052	4,105	1,368	4,378
4,308	1,954	651	2,038
1,370	621	207	662

[a.] Volume of export * 0.63 * 0.72

[b.] Volume of production / 3.

[c.] Number of wells * 3.2

Of course, we reiterate that this forecast methodology is crude and that the inputs we use are unrealistically conservative, but at the very least, this illustrates the minimum scale of the problem. This calculation ignores the production curves for gas wells and the fact that although wells produce over a number of years, all of the water (under the assumption of one frack job per well) is consumed up front; the table naively averages water requirements out over the duration of exports. Additionally, this only considers water withdrawals associated with the shale gas production EIA predicts: EIA predicts that other forms of production (primarily other unconventional production) will also

[152] USGS, *Variability of Distributions of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United* States, USGS Open-File Report 212-1118 (2012), attached as Ex 57**.** Although some oil and gas producers have publicly stated higher expected ultimate recoveries, DOE/FE must begin with the data-backed assessment of its expert and impartial sister agency.

[153] Taking the most industry friendly of each of these values is particularly unrealistic because the values are not independent. For example, higher-producing wells are likely to be wells with a longer fracked lateral, which are in turn wells that use higher volumes of water. Using the high range of the average expected ultimate recovery but the low range of the average water requirement therefore represents a combination unlikely to occur in reality.

increase alongside the above increases in shale gas production, and this other production will also require significant water withdrawals. In its public interest analysis, DOE/FE must engage in a more considered evaluation of the water consumption exports will require, and the costs (environmental and economic) thereof.

These water withdrawals would drastically impact aquatic ecosystems and human communities. Their effects are larger than their raw volumes because withdrawals would be concentrated in particular watersheds and regions. Reductions in instream flow negatively affect aquatic species by changing flow depth and velocity, raising water temperature, changing oxygen content, and altering streambed morphology.[154] Even when flow reductions are not themselves problematic, the intake structures can harm aquatic organisms.[155] Where water is withdrawn from aquifers, rather than surface sources, withdrawal may cause permanent depletion of the source. This risk is even more prevalent with withdrawals for fracking than it is for other withdrawal, because fracking is a consumptive use. Fluid injected during the fracking process is (barring accident) deposited below freshwater aquifers and into sealed formations.[156] Thus, the water withdrawn from the aquifer will be used in a way that provides no opportunity to percolate back down to the aquifer and recharge it.

The impacts of withdrawing this water – especially in arid regions of the west – are large, and can greatly change the demand upon local water systems. The Environment America report notes that fracking is expected to comprise 40% of water consumption in one county in the Eagle Ford shale region of Texas, for example.[157] As fracking expands, and operators seek to secure water rights to divert water from other uses, these withdrawal costs will also rise.

Groundwater Contamination

Gas extraction activities pose a substantial risk of groundwater contamination. Contaminants include chemicals added to the fracturing fluid and naturally

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[154] *Id.* at 6-3 to 6-4; *see also* Maya Weltman-Fahs, Jason M. Taylor, *Hydraulic Fracturing and Brook Trout Habitat in the Marcellus Shale Region: Potential Impacts and Research Needs*, 38 Fisheries 4, 6-7 (Jan. 2013), attached as Ex 58.

[155] *Id.* at 6-4.

[156] *Id.* at 6-5; First 90-Day Report at 19 ("[I]n some regions and localities there are significant concerns about consumptive water use for shale gas development.").

[157] *The Cost of Fracking* at 26.

occurring chemicals that are mobilized from deeper formations to groundwater via the fracking process. Contamination may occur through several methods, including where the well casing fails or where the fractures created through drilling intersect an existing, poorly sealed well. Although information on groundwater contamination is incomplete, the available research indicates that contamination has already occurred on multiple occasions.

Once groundwater is contaminated, the clean-up costs are enormous. The Environment America report, for instance, documents costs of over $109,000 for methane removal for just 14 households with contaminated groundwater.[158] EPA has estimated treatment costs for some forms of groundwater remediation at between $150,000 to $350,000 per acre.[159] Such costs can continue for years, with water replacement costs adding additional hundreds of thousands in costs.[160] Indeed, a recent National Research Council report observed that for many forms of subsurface and groundwater hazardous chemical contamination, "significant limitations with currently available remedial technologies" make it unlikely that contaminated aquifers can be fully remediated "in a time frame of 50-100 years."[161]

There are several vectors by which gas production can contaminate groundwater supplies. Perhaps the most common or significant are inadequacies in the casing of the vertical well bore.[162] The well bore inevitably passes through geological strata containing groundwater, and therefore provides a conduit by which chemicals injected into the well or traveling from the target formation to the surface may reach groundwater. The well casing isolates the groundwater from intermediate strata and the target formation. This casing must be strong enough to withstand the pressures of the fracturing process—the very purpose of which is to shatter rock. Multiple layers of steel casing must be used, each pressure tested before use, then centered within the well bore. Each layer of casing must be cemented, with careful testing to ensure the integrity of the cementing.[163]

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[158] *Id.* at 13.

[159] *Id.* at 14.

[160] *Id.*

[161] National Research Council, *Prepublication Copy- Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites*, ES-5 (2012), executive summary attached as Ex 59, full report available at http://www.nap.edu/catalog.php?record_id=14668#toc.

[162] DOE, Shale Gas Production Subcommittee First 90-Day Report at 20.

[163] Natural Resources Defense Council, Earthjustice, and Sierra Club, Comments [to EPA] on Permitting Guidance for Oil and Gas Hydraulic Fracturing Activities Using Diesel Fuels 3, (June 29, 2011), at 5-9, attached as Ex 60.

Separate from casing failure, contamination may occur when the zone of fractured rock intersects an abandoned and poorly-sealed well or natural conduit in the rock.[164] One recent study concluded, on the basis of geologic modeling, that frack fluid may migrate from the hydraulic fracture zone to freshwater aquifers in less than ten years.[165]

Available empirical data indicates that fracking has resulting in groundwater contamination in at least five documented instances. One study "documented the higher concentration of methane originating in shale gas deposits . . . into wells surrounding a producing shale production site in northern Pennsylvania."[166] By tracking certain isotopes of methane, this study – which the DOE Subcommittee referred to as "a recent, credible, peer-reviewed study" determined that the methane originated in the shale deposit, rather than from a shallower source.[167] Two other reports "have documented or suggested the movement of fracking fluid from the target formation to water wells linked to fracking in wells."[168] "Thyne (2008)[[169]] had found bromide in wells 100s of feet above the fracked zone. The EPA (1987)[[170]] documented fracking fluid moving into a 416-foot deep water well in West Virginia; the gas well was less than 1000 feet horizontally from the water well, but the report does not indicate the gas-bearing formation."[171]

More recently, EPA has investigated groundwater contamination in Pavillion, Wyoming and Dimock, Pennsylvania. In the Pavillion investigation, EPA's draft

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[164] Comment on NY RDSGEIS, attachment 3, Report of Tom Myers, at 12-15.

[165] Tom Myers, *Potential Contaminant Pathways from Hydraulically Fractured Shale to Aquifers* (Apr. 17, 2012), attached Ex 61.

[166] DOE, Shale Gas Production Subcommittee First 90-Day Report at 20 (citing Stephen G. Osborn, Avner Vengosh, Nathaniel R. Warner, and Robert B. Jackson, *Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing*, Proceedings of the National Academy of Science, 108, 8172-8176, (2011), attached as Ex 62).

[167] *Id.*

[168] Comment on NY RDSGEIS, attachment 3, Report of Tom Myers, at 13.

[169] Dr. Myers relied on Geoffrey Thyne, *Review of Phase II Hydrogeologic Study* (2008), prepared for Garfield County, Colorado, *available at* http://cogcc.state.co.us/Library/Presentations/Glenwood_Spgs_HearingJuly_2009/(1_A)_ReviewofPhase-II-HydrogeologicStudy.pdf.

[170] Environmental Protection Agency, *Report to Congress, Management of Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas, and Geothermal Energy*, vol. 1 (1987), *available at* nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20012D4P.txt, attached as Ex 63.

[171] Comment on NY RDSGEIS, attachment 3, Report of Tom Myers, at 13.

report concludes that "when considered together with other lines of evidence, the data indicates likely impact to ground water that can be explained by hydraulic fracturing."[172] EPA tested water from wells extending to various depths within the range of local groundwater. At the deeper tested wells, EPA discovered inorganics (potassium, chloride), synthetic organic (isopropanol, glycols, and tert-butyl alcohol), and organics (BTEX, gasoline and diesel range organics) at levels higher than expected.[173] At shallower levels, EPA detected "high concentrations of benzene, xylenes, gasoline range organics, diesel range organics, and total purgeable hydrocarbons."[174] EPA determined that surface pits previously used for storage of drilling wastes and produced/flowback waters were a likely source of contamination for the shallower waters, and that fracturing likely explained the deeper contamination.[175] The U.S. Geological Survey, in cooperation with the Wyoming Department of Environmental Quality, also provided data regarding chemicals found in wells surrounding Pavillion.[176] Although the USGS did not provide analysis regarding the likely source of the contaminants found, an independent expert who reviewed the USGS and EPA data at the request of Sierra Club and other environmental groups concluded that the USGS data supports EPA's findings.[177]

EPA also identified elevated levels of hazardous substances in home water supplies near Dimock, Pennsylvania.[178] EPA's initial assessment concluded that

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[172] EPA, Draft Investigation of Ground Water Contamination near Pavillion, Wyoming, at xiii (2011), available at http://www.epa.gov/region8/superfund/wy/pavillion/EPA_ReportOnPavillion_Dec-8-2011.pdf, attached as Ex 64. EPA has not yet released a final version of this report, instead recently extending the public comment period to September 30, 2013. 78 Fed. Reg. 2396 (Jan. 11, 2013).

[173] *Id.* at xii.

[174] *Id.* at xi.

[175] *Id.* at xi, xiii.

[176] USGS, *Groundwater-Quality and Quality-Control Data for two Monitoring Wells near Pavillion, Wyoming, April and May 2012*, USGS Data Series 718 p.25 (2012), attached as Ex 65.

[177] Tom Myers, *Assessment of Groundwater Sampling Results Completed by the U.S. Geological Survey* (Sept. 30, 2012), attached as Ex 66. Another independent expert, Rob Jackson of Duke University, has stated that the USGS and EPA data is "suggestive" of fracking as the source of contamination. Jeff Tollefson, *Is Fracking Behind Contamination in Wyoming Groundwater?*, Nature (Oct. 4, 2012), attached as Ex 67. *See also* Tom Meyers, *Review of DRAFT: Investigation of Ground Water Contamination near Pavillion Wyoming* (April 30, 2012) (concluding that EPA's initial study was well-supported), attached as Ex 68.

[178] EPA Region III, Action Memorandum - Request for Funding for a Removal Action at the Dimock Residential Groundwater Site (Jan. 19, 2012), available at http://www.epaosc.org/sites/7555/files/Dimock%20Action%20Memo%2001-19-12.PDF, attached

"a number of home wells in the Dimock area contain hazardous substances, some of which are not naturally found in the environment," including arsenic, barium, bis(2(ethylhexyl)phthalate, glycol compounds, manganese, phenol, and sodium.[179] Arsenic, barium, and manganese were present in five home wells "at levels that could present a health concern."[180] Many of these chemicals, including arsenic, barium, and manganese, are hazardous substances as defined under CERCLA section 101(14). *See* 42 U.S.C. § 9604(a); 40 C.F.R. § 302.4. EPA's assessment was based in part on "Pennsylvania Department of Environmental Protection (PADEP) and Cabot Oil and Gas Corporation (Cabot) sampling information, consultation with an EPA toxicologist, the Agency for Toxic Substances and Disease Registry (ATSDR) Record of Activity (AROA), issued, 12/28/11, and [a] recent EPA well survey effort."[181] The PADEP information provided reason to believe that drilling activities in the area led to contamination of these water supplies. Drilling in the area began in 2008, and was conducted using the hazardous substances that have since been discovered in well water. Shortly thereafter methane contamination was detected in private well water. The drilling also caused several surface spills. Although EPA ultimately concluded that the five homes with potentially unsafe levels of hazardous substances had water treatment systems sufficient to mitigate the threat, [182] the Dimock example indicates the potential for gas development to contaminate groundwater.

The serious groundwater contamination problems experienced at the Pavillion and Dimock sites demonstrate a possibility of contamination, and attendant human health risks. Such risks are not uncommon in gas field sites, and will be intensified by production for export. DOE/FE must account for these risks, as well, in its economic evaluation.

Surface Water Contamination

Of course the same chemicals that can contaminate groundwater can also contaminate surface water, either through spills or communication with groundwater, or simply through dumping or improper treatment. Even the extensive road and pipeline networks created by gas extraction come with a risk

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as Ex 69; EPA, *EPA Completes Drinking Water Sampling in Dimock, Pa.* (Jul. 25, 2012), attached as Ex 70.

[179] *Id.* at 1, 3-4.

[180] *EPA Completes Drinking Water Sampling in Dimock, Pa.*, *supra* n.178

[181] *Id.* at 1.

[182] *EPA Completes Drinking Water Sampling in Dimock, Pa.*, *supra* n.178

of significant stormwater and sediment run-off which can contaminate surface waters. Gas field operations themselves, with their significant waste production and spill potential exacerbate these risks.

The Environment America report, for instance, documents fish kills caused by pipeline ruptures in the Marcellus Shale region, which impose costs on Pennsylvania's multi-billion dollar recreational fishing industry.[183] Such risks will be intensified by extraction for export.

Summing up water pollution costs

Water pollution is expensive to treat and can impose enormous burdens on public health and ecosystem function. Even a single instance of contamination can lead to hundreds of thousands of dollars in treatment costs, and many such incidents are not only possible, but likely, with an expansion of gas production for export. DOE/FE must account for these risks.

iii. Waste Management Costs

Fracturing produces a variety of liquid and solid wastes that must be managed and disposed of. These include the drilling mud used to lubricate the drilling process, the drill cuttings removed from the well bore, the "flowback" of fracturing fluid that returns to the surface in the days after fracking, and produced water that is produced over the life of the well (a mixture of water naturally occurring in the shale formation and lingering fracturing fluid). Because these wastes contain the same contaminants described in the preceding section, environmental hazards can arise from their management and ultimate disposal. Managing these wastes is costly, and all waste management options come with significant infrastructure costs and environmental risk.

On site, drilling mud, drill cuttings, flowback and produced water are often stored in pits. Open pits can have harmful air emissions, can leach into shallow groundwater, and can fail and result in surface discharges. Many of these harms can be minimized by the use of seal tanks in a "closed loop" system.[184] Presently, only New Mexico mandates the use of closed loop waste management systems, and pits remain in use elsewhere.

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[183] *The Cost of Fracking* at 20.

[184] *See, e.g.,* NY RDSGEIS, at 1-12.

Flowback and produced water must ultimately be disposed of offsite. Some of these fluids may be recycled and used in further fracturing operations, but even where a fluid recycling program is used, recycling leaves concentrated contaminants that must be disposed of. The most common methods of disposal are disposal in underground injection wells or through water treatment facilities leading to eventual surface discharge.

Underground injection wells present risks of groundwater contamination similar to those identified above for fracking itself. Gas production wastes are not categorized as hazardous under the Safe Drinking Water Act, 42 U.S.C. § 300f *et seq.*, and may be disposed of in Class II injection wells. Class II wells are brine wells, and the standards and safeguards in place for these wells were not designed with the contaminants found in fracking wastes in mind.[185]

Additionally, underground injection of fracking wastes appears to have induced earthquakes in several regions. For example, underground injection of fracking waste in Ohio has been correlated with earthquakes as high as 4.0 on the Richter scale.[186] Underground injection may cause earthquakes by causing movement on existing fault lines: "Once fluid enters a preexisting fault, it can pressurize the rocks enough to move; the more stress placed on the rock formation, the more powerful the earthquake."[187] Underground injection is more likely than fracking to trigger large earthquakes via this mechanism "because more fluid is usually being pumped underground at a site for longer periods."[188] In light of the apparent induced seismicity, Ohio has put a moratorium on injection in the affected region. Similar associations between earthquakes and injection have occurred in Arkansas, Texas, Oklahoma and the United Kingdom.[189] In light of these effects, Ohio and Arkansas have placed moratoriums on injection in the

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[185] *See* NRDC et al., *Petition for Rulemaking Pursuant to Section 6974(a) of the Resource Conservation and Recovery Act Concerning the Regulation of Wastes Associated with the Exploration, Development, or Production of Crude Oil or Natural Gas or Geothermal Energy* (Sept. 8, 2010), attached as Ex 71.

[186] Columbia University, Lamont-Doherty Earth Observatory, Ohio Quakes Probably Triggered by Waste Disposal Well, Say Seismologists (Jan. 6, 2012), available at http://www.ldeo.columbia.edu/news-events/seismologists-link-ohio-earthquakes-waste-disposal-wells, attached as Ex 72.

[187] *Id.*

[188] *Id.*

[189] *Id.*; *see also* Alexis Flynn, Study Ties Fracking to Quakes in England, Wall Street Journal (Nov. 3, 2011), *available at* http://online.wsj.com/article/SB10001424052970203804204577013771109580352.html.

affected areas.[190] The recently released abstract of a forthcoming United States Geological Survey study affirms the connection between disposal wells and earthquakes.[191]

As an alternative to underground injection, flowback and produced water is also sent to water treatment facilities, leading to eventual surface discharge. This presents a separate set of environmental hazards, because these facilities (particularly publicly owned treatment works) are not designed to handle the nontraditional pollutants found in fracking wastes. For example:

> One serious problem with the proposed discharge (dilution) of fracture treatment wastewater via a municipal or privately owned treatment plant is the observed increases in trihalomethane (THM) concentrations in drinking water reported in the public media (Frazier and Murray, 2011), due to the presence of increased bromide concentrations. Bromide is more reactive than chloride in formation of trihalomethanes, and even though bromide concentrations are generally lower than chloride concentrations, the increased reactivity of bromide generates increased amounts of bromodichloromethane and dibromochloromethane (Chowdhury, et al., 2010). Continued violations of an 80microgram/L THM standard may ultimately require a drinking water treatment plant to convert from a standard and cost effective chlorination disinfection treatment to a more expensive chloramines process for water treatment. Although there are many factors affecting THM production in a specific water, simple (and cheap) dilution of fracture treatment water in a stream can result in a more

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[190] Lamont-Doherty Earth Observatory; Arkansas Oil and Gas Commission, Class II Commercial Disposal Well or Class II Disposal Well Moratorium (Aug. 2, 2011), *available at* http://www.aogc.state.ar.us/Hearing%20Orders/2011/July/180A-2-2011-07.pdf.

[191] Ellsworth, W. L., et al., Are Seismicity Rate Changes in the Midcontinent Natural or Manmade?, Seismological Society of America, (April 2012), available at http://www2.seismosoc.org/FMPro?-db=Abstract_Submission_12&-recid=224&-format=%2Fmeetings%2F2012%2Fabstracts%2Fsessionabstractdetail.html&-lay=MtgList&-find, attached as Ex 73.

> expensive treatment for disinfection of drinking water. This transfer of costs to the public should not be permitted.[192]

Similarly, municipal treatment works typically to not treat for radioactivity, whereas produced water can have high levels of naturally occurring radioactive materials. In one examination of three samples of produced water, radioactivity (measured as gross alpha radiation) were found ranging from 18,000 pCi / L to 123,000 pCi/L, whereas the safe drinking water standard is 15 pCi/L.[193]

A recent NRDC expert report describes these options in detail, and we direct DOE/FE's attention to it.[194] The report demonstrates that all waste treatment options have significant risks, and require substantial investments to manage properly. Fracking for export, again, has the potential to significantly increase these waste management costs. Such costs will largely fall on communities in the gas fields, which may be ill-equipped to bear them.

Summing Up Waste Management Costs

More drilling means significantly greater waste management problems, and more waste management costs.[195] It is not surprising DOE's own Shale Gas Subcommittee urged significant new regulatory work on waste management rules and research. Thus far, though, these problems have not been addressed systematically. LNG export will exacerbate them, imposing further costs on communities across the country.

iv. Costs Arising from Damage to Property and Landscapes

Expanding gas production alters entire landscapes, fundamentally compromising ecosystem services and reducing property values. Land use disturbance associated with gas development impacts plants and animals

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[192] Comment on NY RDSGEIS, attachment 3, Report of Glen Miller, at 13.

[193] *Id.* at 4.

[194] R. Hammer *et al.*, *In Fracking's Wake: New Rules are Needed to Protect Our Health and Environment from Contaminated Wastewater* (2012), attached as Ex 74.

[195] Indeed, the waste from existing fracking operations are already on the verge of overwhelming disposal infrastructure. *See, e.g.*, Bob Downing, Akron Beacon-Journal, *Pennsylvania Drilling Wastes Might Overwhelm Ohio Injection Wells* (Jan. 23, 2012), available at http://www.ohio.com/news/local/pennsylvania-drilling-wastes-might-overwhelm-ohio-injection-wells-1.367102, attached as Ex 75.

through direct habitat loss, where land is cleared for gas uses, and indirect habitat loss, where land adjacent to direct losses loses some of its important characteristics. These costs, too, must figure in the export economic analysis.

The presence of gas production equipment can markedly reduce property values, both through direct resource damage and through perceived increases in risk. A recent Resources for the Future study, for instance, canvasses empirical data from Pennsylvania to show that concerns (rather than any demonstrated damage) over groundwater contamination reduced property values for ground-water dependent homes by as much as 24%.[196] A study from Texas saw decreases in value of between 3-14% for homes near wells, and a Colorado study saw decreases of up to 22% for homes near wells.[197] Notably, the Resources for the Future study concluded that the property value declines it measured completely offset any increased value from expected lease payments.[198] And these decreases are only those associated with ordinary operation of gas activities. Actual contamination will, of course, reduce property values still more. Thus, as gas extraction spreads across the landscape, many properties may actually lose value, even as some owners secure royalty payments.

Other threats to property values come through risks to home financing. Gas extraction is a major industrial activity inconsistent with essentially all home mortgage policies.[199] Accordingly, signing a gas lease without the consent of the lender may cause an immediate mortgage default, leading to foreclosure.[200] And most lenders will refuse such consent, and will refuse to grant new mortgages allowing gas development.[201] The result is that that expansion of gas drilling, including extraction for export, may significantly limit the ability of many people to extract value from their homes.

In addition to these immediate threats to property values, gas production also threatens ecosystems and the services they provide. Land is lost through development of well pads, roads, pipeline corridors, corridors for seismic testing, and other infrastructure. The Nature Conservancy (TNC) estimated that in

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[196] L. Muehlenbachs *et al.*, *Shale Gas Development and Property Values Differences across Drinking Water Sources*, Resources for the Future Discussion Paper (2012), attached as Ex 76.
[197] *The Costs of Fracking* at 30.
[198] Muehlenbachs *et al.* at 29-30.
[199] E. Radow, *Homeowners and Gas Drilling Leases: Boom or Bust?*, New York State Bar Association Journal (Dec. 2011), attached as Ex 77.
[200] *Id.* at 20.
[201] *Id.* at 21.

Pennsylvania, "[w]ell pads occupy 3.1 acres on average while the associated infrastructure (roads, water impoundments, pipelines) takes up an additional 5.7 acres, or a total of nearly 9 acres per well pad."[202] New York's Department of Environmental Conservation reached similar estimates.[203] After initial drilling is completed the well pad is partially restored, but 1 to 3 acres of the well pad will remain disturbed through the life of the wells, estimated to be 20 to 40 years.[204] Associated infrastructure such as roads and corridors will likewise remain disturbed. Because these disturbances involve clearing and grading of the land, directly disturbed land is no longer suitable as habitat.[205]

Indirect losses occur on land that is not directly disturbed, but where habitat characteristics are affected by direct disturbances. "Adjacent lands can also be impacted, even if they are not directly cleared. This is most notable in forest settings where clearings fragment contiguous forest patches, create new edges, and change habitat conditions for sensitive wildlife and plant species that depend on "interior" forest conditions."[206] "Research has shown measureable impacts often extend at least 330 feet (100 meters) into forest adjacent to an edge."[207]

These effects are profound. Although impacts could be reduced with proper planning,[208] more development makes mitigation more difficult. Indeed, the Pennsylvania Department of Conservation and Natural Resources, for instance, recently concluded that "zero" remaining acres of the state forests are suitable for leasing with surface disturbing activities, or the forests will be significantly degraded.[209]

The lost ecosystem services from wild land and clean rivers and wetlands are valuable. Such services can be monetized in various ways, including through surveys of citizens' "willingness to pay" for them, which generally show that people view ecosystem services as major economic assets. Work in

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[202] TNC, Pennsylvania Energy Impacts Assessment, Report 1: Marcellus Shale Natural Gas and Wind 10, 1.
[203] NY RDSGEIS at 5-5.
[204] Id. at 6-13.
[205] *Id.* at 6-68.
[206] Pennsylvania Energy Impacts Assessment at 10.
[207] NY RDSGEIS at 6-75.
[208] *See id.*
[209] Penn. Dep't of Conservation and Natural Resources, *Impacts of Leasing Additional State Forest for Natural Gas Development* (2011), attached as Ex 78.

Pennsylvania, for instance, showed that undisturbed forests were worth at least $294 per acre to residents.[210] Thus, increased production for export effectively costs Pennsylvanians at least this much per acre of forest disrupted. Similarly, in the gas fields of western Pennsylvania, households are willing to pay up to $51 per household to improve water quality in a single stream.[211] Water degradation can properly be said to impose these costs in return. Direct recreational spending also provides an index of the costs to society of landscape disruption; for instance, if export-linked production risks disrupting Pennsylvania's over $1.4 billion in spending by anglers and $1.8 billion in spending by hunters,[212] these costs, too, must be taxed against export projects.

Summing Up Land-Related Costs

Just as with direct pollution costs, the costs of landscape disruption may well be in the hundreds of millions of dollars in harm to property values and ecosystem services. NERA ignores these costs, as well, but DOE/FE must account for them.

C. Conclusions on Environmental Costs

Our discussion of environmental costs only scratches the surface. It is clear that these costs are in the billions of dollars annually, and range from burdens on regional infrastructure to long-lasting ecosystem service disruptions. These costs are just as real as reduced income to labor, and just as pressing for policymakers. DOE/FE is required to consider them under its public interest mandate. NERA's conclusions that export would produce economic benefits are completely unfounded because they neglect these costs entirely.

IV. DOE/FE's Use of the NERA Study is Procedurally Flawed and Raises a Serious and Inappropriate Appearance of Bias

DOE/FE reliance on the NERA study would be inappropriate not just for the many substantive reasons discussed above but because the study process has been procedurally flawed from the outset in ways that limit public participation and raise serious questions of bias. NERA has significant ties to the fossil fuel industry, including to parties which would benefit financially from LNG export,

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[210] ECONorthwest, *An Economic Review of the Environmental Assessment of the MARC I Hub Line Project* at 25 (July 2011), attached as Ex 79.
[211] *Id.* at 24.
[212] *Id.* at 29.

and the consultant who authored the report is known for his hostility to government regulation of the energy sector. NERA was selected through a secret contracting process and developed its results with a proprietary model which has not been released to the public. NERA's ideological commitments, financial conflicts, and closed process all raise, at a minimum, the appearance of serious bias and conflicts of interest. DOE/FE cannot properly rely upon a study that is tainted in this way.

NERA has spent years attacking environmental regulations on behalf of the American Petroleum Institute and the coal industry, among others. The LNG export report's author, NERA senior vice president W. David Montgomery, has strongly opposed regulatory and legislative efforts to control climate change, raise fuel efficiency, and improve air quality. These ideological commitments, and business relationships, all raise serious questions about NERA's role in this process.

NERA was founded in 1961 by conservative economists and has maintained this ideological anti-regulation bent.[213] Indeed, co-founder Irwin Stelzer is now a senior fellow at the right-wing Hudson Institute, which advocates against environmental regulations and supports climate skeptics.[214] Following that lead, NERA itself has been a consistent voice against environmental safeguards. In recent years, NERA staff have repeatedly opposed environmental efforts on behalf of industry groups. NERA staff have:

- Written, on behalf of the American Petroleum Institute, against the tightened ozone smog standards recommended by EPA's science advisors.[215]
- On behalf of the American Coalition for Clean Coal Energy, generated inflated cost estimates for EPA rules controlling toxic mercury emissions, asthma-inducing SO_2, and other pollutants.[216]
- Testified against EPA's efforts to control mercury emissions.[217]

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[213] http://www.nera.com/7250.htm.

[214] *See* http://www.hudson.org/learn/index.cfm?fuseaction=staff_bio&eid=StelIrwi.

[215] NERA, *Summary and Critique of the Benefits Estimates in the RIA for the Ozone NAAQS Reconsideration* (2011), available at: http://www.nera.com/nera-files/PUB_Smith_OzoneNAAQS_0711.pdf.

[216] NERA, *Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector* (2012), available at: http://www.nera.com/nera-files/PUB_ACCCE_1012.pdf.

[217] Testimony of Anne E. Smith before the House Subcommittee on Energy and Power (Feb. 8, 2012), available at: http://www.nera.com/nera-files/PUB_Smith_Testimony_ECC_0212.pdf.

- Testified against new soot standards designed to protect the public from the respiratory problems and heart disease.[218]
- Prepared a report, on behalf of the Utility Water Group, opposing standards designed to reduce fish kills and protect aquatic ecosystems from cooling water withdrawals.[219]

Dr. Montgomery, a NERA Senior Vice President, shares the basic ideological commitments of his firm. He has repeatedly spoken against President Obama's green jobs agenda and the Department of Energy's efforts to promote renewable energy. He has also consistently opposed legislative efforts to reduce domestic carbon pollution, including the Kyoto Protocols. Dr. Montgomery has also been a fellow at the far-right Marshall Institute, an industry-funded group which devotes much of its resources to attacking climate science.[220] In recent years Dr. Montgomery has:

- Testified against capping U.S. carbon pollution emissions.[221]
- Testified repeatedly against EPA's public health air rules, arguing that they have high costs and should be reconsidered.[222]
- Testified against DOE's programs supporting green energy investment, arguing that "the entire concept of using stimulus money to create a Green Economy is unsound."[223]
- Testified opposing the Federal Green Jobs Agenda.[224]

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[218] Testimony of Anne E. Smith before the House Subcommittee on Energy and Power (June 28, 2012), available at: http://www.nera.com/nera-files/PUB_Smith_EPA_0612.pdf.

[219] NERA, *Comments on EPA's Notice of Data Availability for § 316(b) Stated Preference Survey* (July 2012), available at: http://www.nera.com/nera-files/PUB_UWAG_0712_final.pdf.

[220] *See http://www.marshall.org/experts.php?id=103.*

[221] Testimony of W. David Montgomery before the House Committee on Science, Space and Technology (March 31, 2011), available at: http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/Montgomery%203_31_11%20v2.pdf.

[222] *See* Testimony of W. David Montgomery before the Senate Committee on Environment and Public Works (Feb. 15, 2011), available at: http://epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=5abed004-c3d2-4f28-a721-734ad78cdd99; and Testimony of W. David Montgomery Senate Committee on Environment and Public Works (Mar. 17, 2011), available at: http://epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=227a0fdb-905d-47b1-ac1d-b5dad9c6a605.

[223] Testimony of W. David Montgomery before the House Committee on Oversight and Government Spending (Nov. 2, 2011), available at: http://democrats.oversight.house.gov/images/stories/Montgomery_testimony.pdf

- Opposed raising fuel efficiency standards as "the worst strategy you could think of."[225]

Dr. Montgomery and NERA, in short, share intellectual commitments that have made them preferred advocates of business interests seeking to oppose President Obama's public health and environmental efforts, as well as DOE's own efforts to increase the use of cleaner energy in this country. Many of those same interests have much to gain from LNG exports. The members and funders of the American Petroleum Institute, a NERA client, will naturally benefit from increased gas production. Likewise, coal interests, which are also frequent NERA clients, stand to benefit if LNG export leads to an increase in U.S. coal use, as the EIA has predicted. NERA does not acknowledge, much less address, these and similar conflicts in the LNG study. Nor does DOE/FE.

This failure of disclosure has infected the process as a whole. To our knowledge, DOE/FE issued no public solicitation of bids for the LNG export analysis, nor offered the public any chance, until now, to comment upon the contractors it selected. Nor have either DOE/FE or NERA provided the underlying NewERA model which NERA used to produce its results. Obviously, it is difficult to fully evaluate the study without access to the modeling files and underlying assumptions which NERA used. Other commenters[226] have made clear that it is good contracting practice to provide such materials as a matter of course. It is certainly appropriate to do so here, where DOE/FE must transparently justify its decisions after a full public process, as required by the Natural Gas Act and the Administrative Procedure Act. DOE/FE's failure to provide these critical disclosures undermines the public's ability to critically assess and analyze the study.

DOE/FE also has not disclosed how it has funded the NERA study, nor how DOE/FE influenced the study's conclusions. The magnitude of DOE/FE's involvement and investment here is of critical importance because DOE/FE claims that it has taken no position on the study or its conclusions and will dispassionately weigh public comments. Yet, if DOE/FE staff have funded the

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[224] Testimony of W. David Montgomery before the House Committee on Energy and Commerce (June 19, 2012), available at: http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/Hearings/OI/20120619/HHRG-112-IF02-WState-DMontgomery-20120619.pdf.

[225] Heritage Foundation, *Fuel Economy Standards: Do they Work? Do they Kill?* (2002), available at: http://www.heritage.org/research/reports/2002/03/fuel-economy-standards.

[226] *See* the Comments of Dr. Jannette Barth in this docket, for instance.

study, and, more importantly, shared in its development, there is a serious question whether DOE/FE will be able to fairly weight the finished product on its own merits. Staff clearly had some such involvement: Dr. Montgomery writes on the first page of the document that he is providing a "clean" copy, implying that past DOE/FE comments have been incorporated and addressed. The scope and nature of this involvement, however, remains unclear. DOE/FE must make its involvement transparent if it is set itself up as a neutral arbiter of the merits of NERA's work.

If DOE does not share this information in time for it inform public comment, it will have prevented the public from participating in a pressing policy debate. The courts have repeatedly held that such a denial is an irreparable injury, so preventing such an injury is plainly a compelling need. *See, e.g.*, *Electronic Privacy Info. Ctr. v. Dep't of Justice*, 416 F. Supp. 2d 30, 41-42 (D.D.C. 2006); *Washington Post v. Dep't of Homeland Security*, 459 F. Supp. 2d 61, 74-75 (D.D.C. 2006); *Electronic Frontier Found. v. Office of the Director*, 2007 WL 4208311, *6 (N.D. Cal. 2007); *EFF v. Office of the Director*, 542 F. Supp. 2d 1181,1186 (N.D. Cal. 2008).

DOE/FE must not take the arbitrary and capricious step of relying upon the questionable results of a study infected with the appearance (and perhaps the reality) of bias. Nor may it finally adopt or seriously weigh the conclusions of the study if it shuts out of the process in the way that it has done.

V. Conclusion

NERA is able to conclude that LNG export is in the nation's economic interest only because it wrongly believes that transferring billions of dollars from the nation's middle class to a small group of gas export companies benefits the country as a whole. It does not: As we have demonstrated in these comments, the likely consequences of a major shift towards LNG export will be a weakened domestic economy, "resource-cursed" communities, and lasting environmental damage.

Even if one were to accept NERA's indefensible attempt to balance national suffering against the private economic prosperity of a few, its conclusions are not maintainable. NERA projects at most a net GDP increase of at most $ 20 billion in a single year when it does this sum, subtracting labor income from LNG export revenues; the net benefit is often much less – on the order of a few billion

dollars.[227] We have identified billions of dollars in pollution costs, infrastructure damage, and property value losses that NERA has not accounted for. Indeed, the cost just of increased methane emissions from LNG export is at least in the hundreds of millions annually. These costs almost certainly offset the nominal benefits which NERA claims to have identified. Certainly, NERA cannot claim otherwise, since it has not even considered them.

The Natural Gas Act charges DOE/FE with the weighty responsibility of protecting the public interest. Licensing LNG export would not serve that interest, and the NERA study certainly does not provide a basis to think otherwise. DOE/FE must not approve export licenses in reliance upon that flawed study, prepared by a contractor with at least the appearance of serious conflicts of interest. Instead, DOE/FE should begin an open, public process intended to fully identify and accurately account for the many economic and environmental impacts of LNG export.

Sincerely,

Craig Holt Segall
Nathan Matthews
Ellen Medlin
Attorneys, Sierra Club Environmental Law Program

Please Send All Correspondence to:
Sierra Club
50 F St NW, Eighth Floor
Washington, DC, 20001
(202)-548-4597
Craig.Segall@sierraclub.org

[227] NERA Study at 8.

Synapse
Energy Economics, Inc.

Will LNG Exports Benefit the United States Economy?

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AUTHORS

Elizabeth A. Stanton, PhD

Frank Ackerman, PhD

Tyler Comings,

Patrick Knight,

Tommy Vitolo, PhD, and

Ezra Hausman, PhD

485 Massachusetts Ave.
Suite 2
Cambridge, MA 02139

617.661.3248
www.synapse-energy.com

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1. Overview

DOE is considering whether large scale exports of liquefied natural gas (LNG) are in the public interest. As part of that inquiry, DOE has commissioned a team of researchers from NERA Economic Consulting, led by W. David Montgomery, to prepare a report entitled "Macroeconomic Impacts of LNG Exports from the United States" (hereafter, the NERA Report) in December 2012.[1] Unfortunately, that report suffers from serious methodological flaws which lead it to significantly underestimate, and, in some cases, to entirely overlook, many negative impacts of LNG exports on the U.S. economy.

NERA finds that LNG exports would be very good for the United States in every scenario they examined:

> …the U.S. was projected to gain net economic benefits from allowing LNG exports. Moreover, for every one of the market scenarios examined, net economic benefits increased as the level of LNG exports increased. (NERA Report, p.1)

The measure of benefits used by NERA, however, reflects only the totals for the U.S. economy as a whole. In fact, the NERA study finds that natural gas exports are beneficial to the natural gas industry alone, at the expense of the rest of the U.S. economy—reducing the size of the U.S. economy excluding LNG exports.

This white paper examines the NERA Report, and identifies multiple problems and omissions in its analyses of the natural gas industry and the U.S. economy:

- NERA's own modeling shows that LNG exports in fact cause GDP to decline in all other economic sectors.
- Although NERA does not calculate employment figures, the methods used in previous NERA reports would indicate job losses linked to export of tens to hundreds of thousands.
- NERA undervalues harm to the manufacturing sector of the U.S. economy.
- NERA ignores significant economic burdens from environmental harm caused by export.
- NERA ignores the distribution of LNG-export benefits among different segments of society, and makes a number of questionable and unrealistic economic assumptions:
    - In NERA's model, everyone who wants a job has one; by definition, LNG exports cannot cause unemployment.
    - All economic benefits of LNG export return to U.S. consumers without any leakage to foreign investors.
    - Changes to the balance of U.S. trade are constrained to be very small.

[1] W. David Montgomery, et al., *Macroeconomic Impacts of LNG Exports from the United States,* December 2012. http://www.fossil.energy.gov/programs/gasregulation/reports/nera_lng_report.pdf

- NERA's modeling of economic impacts is based entirely on the proprietary N_{ew}ERA model, which is not available for examination by other economists.
- NERA's treatment of natural gas resources and markets makes selective use of data to portray exports in a favorable light. In some cases, the NERA Report uses older data when newer revisions from the same sources were available; at times, it disagrees with other analysts who have carefully studied the same questions about the gas industry.

Even if NERA's flawed and incomplete analysis were to be accepted at face value, its conclusion that opening LNG exports would be good for the United States as a whole is not supported by its own modeling. Instead, NERA's results demonstrate that manufacturing, agriculture, and other sectors of the U.S. economy would suffer substantial losses. The methodology used to estimate job losses in other NERA reports, if applied in this case, would show average losses of wages equivalent to up to 270,000 jobs lost in each year.

2. LNG exports: Good for the gas industry, bad for the United States

According to the NERA Report, LNG exports would benefit the natural gas industry at the expense of the rest of the U.S. economy. Two sets of evidence illustrate this point: a comparison of natural gas export revenues with changes in gross domestic product (GDP), and a calculation, employed by NERA in other reports, of the "job-equivalents" from decreases in labor income. Applying this calculation to the NERA Report analysis suggests that opening LNG exports would result in hundreds of thousands of job losses. These losses would not be confined to narrow sections of U.S. industry, as NERA implies.

The NERA Report presents 13 "feasible" economic scenarios for LNG export, with projections calculated by NERA's proprietary N_{ew}ERA model for 2015, 2020, 2025, 2030, and 2035. The scenarios differ in estimates of the amount of natural gas that will ultimately be recovered per new well: seven scenarios (with labels beginning with USREF) use the estimate from the federal Energy Information Administration's AEO 2011; five (beginning with HEUR) assume 150 percent of the AEO level; and one (beginning with LEUR) assumes 50 percent of the AEO level. In the LEUR scenario, LNG exports are barely worthwhile; in the HEUR scenarios, exports are more profitable than in the USREF scenarios.

LNG exports cause U.S. GDP (excluding LNG exports) to fall

Careful analysis of these LNG export scenarios reveals that the gain in GDP predicted by the NERA Report is driven—almost entirely—by revenues to gas exporters and gas companies; the remainder of the economy declines.

On average (across the five reporting years), export revenues were 74 percent or more of GDP growth in every scenario; in the eight scenarios with average or low estimated gas recovery per well, export revenues averaged more than 100 percent of GDP growth. In the median scenario, export revenues averaged 169 percent of GDP growth; in the worst case, export revenues averaged 240 percent of GDP growth.

Table 1 compares natural gas export revenues to the increase in GDP for each scenario.[2] When export revenues are greater than 100 percent of GDP growth, the size of the U.S. economy, excluding gas exports, is shrinking. For instance, for the year 2035 in the first two scenarios in Table 1, LNG export revenues are almost $9 billion higher than in the reference case, while GDP—which includes those export revenues along with everyone else's incomes—is only $3 billion higher. Thus, as a matter of arithmetic, everyone else's incomes (i.e., GDP excluding LNG export revenues) must have gone down by almost $6 billion. (If your favorite baseball team scored 3 more home runs this year than last year, and one of its players scored 9 more than he did last year, then it must be the case that the rest of the team scored 6 fewer.)

Similarly, in every case where natural gas export revenues exceed 100 percent of the increase in GDP—cases that appear throughout Table 1—the export revenues are part of GDP, so the remainder of GDP must have gone down.

Table 1: LNG Exports as a Share of GDP Gains[3]

Scenario	Exports as Percent of GDP Gains					
	2015	2020	2025	2030	2035	average
USREF_D_LSS	72%	75%	193%	225%	286%	170%
USREF_D_LS	50%	89%	193%	225%	286%	169%
USREF_D_LR	62%	112%	257%	338%	429%	240%
USREF_SD_LS	50%	77%	204%	258%	468%	211%
USREF_SD_LR	59%	90%	244%	258%	702%	271%
USREF_SD_HS	50%	67%	140%	216%	429%	180%
USREF_SD_HR	59%	75%	158%	216%	501%	202%
HEUR_SD_LSS	19%	38%	69%	109%	152%	77%
HEUR_SD_LS	24%	40%	82%	109%	152%	81%
HEUR_SD_LR	31%	42%	82%	123%	152%	86%
HEUR_SD_HS	24%	37%	64%	106%	142%	74%
HEUR_SD_HR	28%	39%	74%	111%	142%	79%
LEUR_SD_LSS	0%	164%	*NA*	*NA*	158%	107%

NA - not applicable (GDP did not increase over the no-export reference case)
Source: Author's calculations based on NERA Report, Figures 144-162.

As Table 1 demonstrates, export revenues exceed GDP growth: GDP (not including gas exports) is shrinking by 2030 or earlier in all scenarios, and by 2025 or earlier in all scenarios using the AEO assumption about gas recovery per well (i.e., USREF). In other words, after the initial years of construction of export facilities, when construction activities may create some local economic

[2] The increase in GDP is the difference between the scenario GDP projections and the GDP in the corresponding no-export reference case (for USREF, HEUR, or LEUR assumptions). Data from NERA Report, pp.179-197.

[3] In the second term in the scenario names, international cases are defined by increases in global demand and/or decreases in global supply: D=International Demand Shock, SD=International Supply/Demand Shock. In the third term in the scenario names, export cases for quantity/growth are defined as follows: LSS=Low/Slowest, LS=Low/Slow, LR=Low/Rapid, HS=High/Slow, HR=High/Rapid.

benefits, gas exports create increased income for the gas industry, at the expense of everyone else.[4]

Loss of labor income from LNG exports is equivalent to huge job losses

NERA avoids predicting the employment implications of LNG export, and downplays the aggregate billions of dollars in decreased labor income predicted by its report. In fact, using NERA's own methods, the following analysis shows the potential for hundreds of thousands of job losses per year.

In other reports using the N_{ew}ERA model, NERA has reported losses of labor income in terms of "job-equivalents." This may seem paradoxical, since the N_{ew}ERA model assumes full employment, as discussed later in this white paper. As NERA has argued elsewhere, however, a loss of labor income can be expressed in terms of job-equivalent losses, by assuming that it consists of a loss of workers earning the average salary.[5] In other words, a given decrease in labor income can be interpreted as a loss of workers who would make that income.

This method can be applied to the losses of labor income projected for each of the 13 scenarios in the NERA Report. These losses are expressed as percentages of gross labor income; we have assumed that NERA's "job-equivalent losses" represent the same percentage of the labor force. For example, we assume the loss of 0.1 percent of gross labor income in scenario HEUR_SD_HS in 2020 is equivalent to job losses of 0.1 percent of the projected 2020 labor force of 159,351,000 workers, or roughly 159,000 job-equivalent losses.[6]

The results of this analysis are shown in Table 2. Job-equivalent losses, averaged across the five reporting years, range from 36,000 to 270,000 per year; the median scenario has an average job-equivalent loss of 131,000 per year. We do not necessarily endorse this method of calculation of labor impacts, but merely note that NERA has adopted it in other reports using the same model. If NERA had used this method in the NERA Report analysis, it would have shown that LNG exports have the potential to significantly harm employment in many sectors.

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[4] Other modeled results in the record cast further doubt on NERA's study. See Wallace E. Tyner, "Comparison of Analysis of Natural Gas Export Impacts," January 14, 2013. http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/30_Wallace_Tyner01_14_13.pdf

[5] See, e.g., NERA's Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector, October 2012, p. ES-6: "Job-equivalents are calculated as the total loss in labor income divided by the average salary." http://www.nera.com/nera-files/PUB_ACCCE_1012.pdf

[6] The Bureau of Labor Statistics projects annual growth of the civilian labor force at 0.7% per year from 2010 to 2020 (Mitra Toosi. "Labor force projections to 2020: a more slowly growing workforce." Monthly Labor Review, January 2012. http://www.bls.gov/opub/mlr/2012/01/art3full.pdf.) We have used the same annual growth rate to project the labor force through 2035.

Table 2: Employment equivalents of reduced labor income

	Job-equivalent loss, NERA method					
	2015	2020	2025	2030	2035	average
USREF_D_LSS	15,000	77,000	108,000	77,000	62,000	68,000
USREF_D_LS	31,000	77,000	108,000	77,000	62,000	71,000
USREF_D_LR	108,000	92,000	108,000	77,000	62,000	89,000
USREF_SD_LS	31,000	200,000	169,000	139,000	123,000	132,000
USREF_SD_LR	123,000	215,000	169,000	139,000	123,000	154,000
USREF_SD_HS	31,000	185,000	292,000	292,000	246,000	209,000
USREF_SD_HR	108,000	292,000	308,000	292,000	246,000	249,000
HEUR_SD_LSS	15,000	62,000	108,000	108,000	92,000	77,000
HEUR_SD_LS	15,000	169,000	139,000	108,000	92,000	105,000
HEUR_SD_LR	108,000	169,000	139,000	108,000	92,000	123,000
HEUR_SD_HS	15,000	154,000	246,000	215,000	200,000	166,000
HEUR_SD_HR	92,000	385,000	292,000	231,000	200,000	240,000
LEUR_SD_LSS	0	92,000	77,000	0	0	34,000
Labor force	*153,889,000*	*153,889,000*	*153,889,000*	*153,889,000*	*153,889,000*	

Source: Author's calculations based on NERA Report, Figures 144-162.

NERA downplays their estimated shifts in employment from one sector to another saying that is smaller than normal rates of turnover in those industries, but, of course, normal labor turnover is enormous. It is true that job losses caused by LNG exports will be less than the annual total of all retirements, voluntary resignations, firings, layoffs, parental and medical leaves, new hires, moves to new cities and new jobs, and switching from one employer to another for all sorts of reasons: Throughout the entire U.S. labor force normal turnover amounts to almost 40 million people each year.[7] The comparison of job losses to job turnover is irrelevant.

Harm to U.S. economy is not confined to narrow sections of industry, as NERA implies

The NERA Report emphasizes the fact that only a few branches of industry are heavily dependent on natural gas (NERA Report, pp.67-70). This discussion is described as an attempt "to identify where higher natural gas prices might cause severe impacts such as plant closings" (p.67). The NERA Report makes two principal points in this discussion. First, it quotes a 2009 study of the expected impacts of the Waxman-Markey proposal for climate legislation, which found that only a limited number of branches of industry would be harmed by higher carbon costs; NERA argues that price increases caused by LNG exports will have an even smaller but similarly narrow effect on industry. Second, NERA observes that industries where value added (roughly the sum of wages and profits) makes up a large fraction of sales revenue are unlikely to have high energy costs, while industries with high energy costs probably have a low ratio of value added to sales.

[7] "Job Openings and Labor Turnover," Bureau of Labor Statistics, November 2012, Table 3. http://www.bls.gov/news.release/pdf/jolts.pdf

Both points may be true, but they are largely irrelevant to the evaluation of LNG exports. NERA's use of the Waxman-Markey study is inappropriate, as Representative Markey himself has pointed out, because that proposed bill directed significant resources to industries harmed by higher costs to mitigate any negative impact.[8] No such mitigation payments are associated with LNG export, so relying upon Waxman-Markey examples to downplay potential economic damage is inappropriate. If those exports increase domestic gas prices, industry will be harmed both by higher electricity prices and by higher costs for direct use of natural gas. Further, it is true that direct use of natural gas is relatively concentrated, but it is concentrated in important sectors; as the natural gas industry itself explains, "Natural gas is consumed primarily in the pulp and paper, metals, chemicals, petroleum refining, stone, clay and glass, plastic, and food processing industries."[9] These are not small or unimportant sectors of the U.S. economy.[10] In any case, discussion of sectors where higher natural gas prices might cause "severe impacts such as plant closings" is attacking a straw man; NERA's own calculations imply moderate harm would be imposed throughout industry, both by rising electricity prices and by the costs of direct gas consumption—offset by benefits exclusively concentrated in the hands of the natural gas industry.

Similarly, it does not seem particularly important to know whether industries that use a lot of natural gas have high or low ratios of value added to sales. Are aluminum, cement, fertilizer, paper, and chemicals less important to the economy because they have many purchased inputs, and therefore low ratios of value added to sales?

3. Costs and benefits from LNG exports are unequally distributed

As the results above show, LNG exports essentially transfer revenue away from the rest of the economy and into the hands of companies participating in these exports. This shift has significant economic implications that are not addressed in the NERA Report's analysis.

The NERA Report asserts that "all export scenarios are welfare-improving for U.S. consumers" (NERA Report, p.55). While LNG exports will result in higher natural gas prices for U.S. residents, NERA projects that these costs will be outweighed by additional income received from the exports—and thus, "consumers, in aggregate are better off as a result of opening LNG exports." (NERA Report, p.55) Or, to put this another way, the gains of every resident of the United States, added together, will be greater than the losses of every resident of the United States, added together. The distribution of these benefits and costs—who will suffer costs and who will reap gains—is discussed only tangentially in the NERA Report, but is critical to a complete understanding of the effects of LNG exports on the U.S. economy. A closer look reveals that LNG exports benefit only a very narrow section of the economy, while causing harm to a much broader group.

[8] Letter from Rep. Markey to Secretary Steve Chu (Dec. 14, 2012).
[9] http://www.naturalgas.org/overview/uses_industry.asp.
[10] Other commenters also point out that NERA does not even appear to have included some gas-dependent industries, including fertilizer and fabric manufacture, in its analysis. *See* Comments of Dr. Jannette Barth (Dec. 14, 2012).

Focus on "net impacts" ignores key policy issues

The results presented in the NERA Report focus on the net impacts on the entire economy—combining together everyone's costs and benefits—and on the "welfare" of the typical or average family, measured in terms of equivalent variation.[11] NERA dismisses the need to discuss the distribution of the costs and benefits among groups that are likely to experience very different impacts from LNG exports, stating that: "[t]his study addresses only the net economic effects of natural gas price changes and improved export revenues, not their distribution." (NERA Report, p.211) NERA alludes to an unequal distribution of costs and benefits in its results, but does not present a complete analysis:

> Although there are costs to consumers of higher energy prices and lower consumption and producers incur higher costs to supply the additional natural gas for export, these costs are more than offset by increases in export revenues along with a wealth transfer from overseas received in the form of payments for liquefactions services. The net result is an increase in U.S. households' real income and welfare. (NERA Report, p.6)

Instead, the NERA Report combines the economic impacts of winners and losers from LNG exports. In the field of economics, this method of asserting that a policy will improve welfare for society as a whole as long as gains to the winners are greater than costs to the losers is known as the "Kaldor-Hicks compensation principle" or a "potential Pareto improvement." The critiques leveled at cost-benefit analyses that ignore important distributional issues have as long a history as these flawed methods. Policy decisions cannot be made solely on the basis of aggregated net impacts: costs to one group are never erased by the existence of larger gains to another group. The net benefit to society as a whole shows only that, if the winners choose to share their gains, they have the resources to make everyone better off than before—but not that they *will* share their gains. In the typical situation, when the winners choose to keep their winnings to themselves, there is no reason to think that everyone, including the losers, is better off.

As previous congressional testimony by W. David Montgomery—the lead author of the NERA Report—on the impacts of cap-and-trade policy support explained it: "There are enough hidden differences among recipients of allowances within any identified group that it takes far more to compensate just the losers in a group than to compensate the average. Looking at averages assumes that gainers compensate losers within a group, but that will not occur in practice."[12]

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[11] One of the complications in estimating the costs and benefits of a policy with the potential to impact prices economy-wide, is that simply measuring changes in income misses out on the way in which policy-driven price changes affect how much can be bought for the same income. (For example, if a policy raises incomes but simultaneously raises prices, it takes some careful calculation to determine whether people are better or worse off.) The NERA Report uses a measure of welfare called "equivalent variation," which is the additional income that the typical family would have to receive today (when making purchases at current prices) in order to be just as well off as they would be with the new incomes and new price levels under the proposed policy. It can be thought of as the change in income caused by the policy, adjusted for any change in prices caused by the policy.

[12] Prepared Testimony of W. David Montgomery, before the Committee on Energy and Commerce Subcommittee on Energy and Environment, U.S. House of Representatives, Hearing on Allowance Allocation Policies in Climate Legislation, June 9, 2009. http://democrats.energycommerce.house.gov/Press_111/20090609/testimony_montgomery.pdf.

Wage earners in every sector except natural gas will lose income

In every scenario reviewed in the NERA Report, labor income rises in the natural gas industry, and falls in every other industry.[13] Economy-wide, NERA finds that "capital income, wage income, and indirect tax revenues drop in all scenarios, while resource income and net transfers associated with LNG export revenues increase in all scenarios." (NERA Report, p.63)[14] Even without a detailed distributional analysis, the NERA Report demonstrates that some groups will lose out from LNG exports:

> Overall, both total labor compensation and income from investment are projected to decline, and income to owners of natural gas resources will increase… Nevertheless, impacts will not be positive for all groups in the economy. Households with income solely from wages or government transfers, in particular, might not participate in these benefits. (NERA Report, p.2)

NERA's "might not participate in these benefits" could and should be restated more accurately as "will bear costs." Although NERA doesn't acknowledge it, most Americans will not receive revenues from LNG exports; many more Americans will experience decreased wages and higher energy prices than will profit from LNG exports.

Wage earners in every major sector except for natural gas will lose income, and, as domestic natural gas prices increase, households and businesses will have to pay more for natural gas (for heat, cooking, etc.), electricity, and other goods and services with prices that are strongly impacted by natural gas prices. The NERA Report briefly mentions these price effects:

> Natural gas is also an important fuel for electricity generation, providing about 20% of the fuel inputs to electricity generation. Moreover, in many regions and times of the year natural gas-fired generation sets the price of electricity so that increases in natural gas prices can impact electricity prices. These price increases will also propagate through the economy and affect both household energy bills and costs for businesses. (NERA Report, p.13-14)

Additional analysis required to understand electricity price impacts

There are no results presented in the NERA Report to display the effect of changes in electricity prices on consumers. Negative effects on the electricity sector itself are shown in NERA's Figure 38, but changes in electric rates and electricity bills, and the distributional consequences of these changes, are absent from the results selected for display in this report. NERA certainly could have conducted such an analysis. NERA's October 2012 report on recent and anticipated EPA regulations affecting the U.S. electricity sector using the N_{ew}ERA model displayed electricity price impacts for eleven regions and three scenarios.[15]

[13] See NERA Report, Figure 39.
[14] See NERA Report, Figure 40.
[15] Harrison, et al., Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector, October 2012. NERA Economic Consulting. See Table 17. http://www.nera.com/67_7903.htm.

Dr. Montgomery previous testimony also presents increases in household electric utility bills.[16] He describes a "decline in purchasing power" for the average household, claiming that "the cost for the average family will be significant" and "generally the largest declines in household purchasing power are occurring in the regions with the lowest baseline income levels."[17] A careful distributional analysis would greatly improve the policy relevance of the NERA Report's economic impact projections.

Benefits of stock ownership are not as widespread as NERA assumes

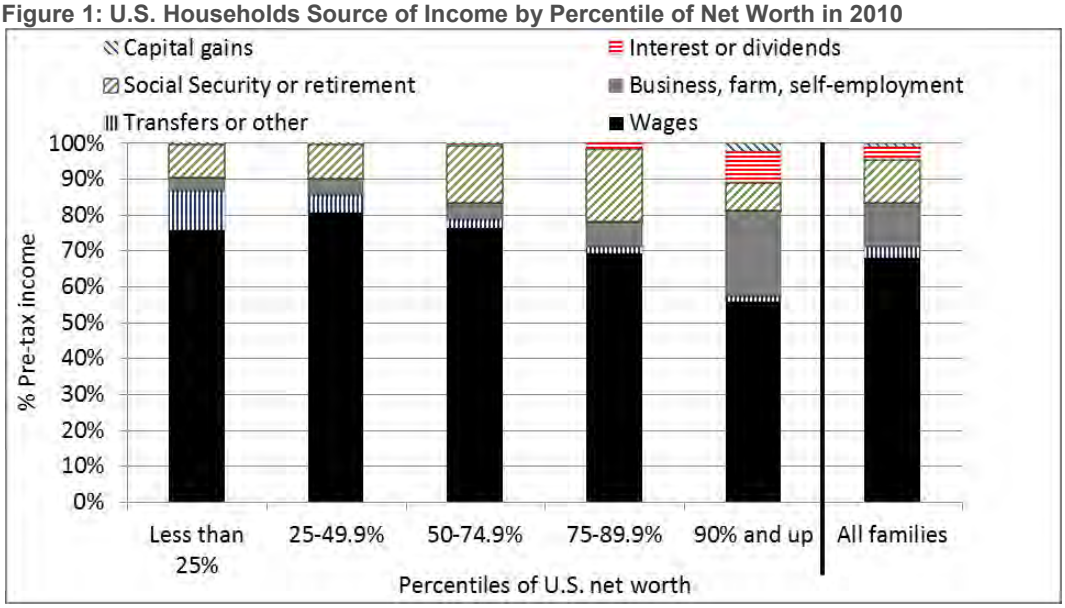
There is no evidence to support NERA's implication that the benefits of stock ownership are broadly shared among U.S. families across the economic spectrum—and therefore no evidence that they will "participate" in benefits secured by LNG exports.

NERA's claim of widespread benefits is not supported by data from the U.S. Census Bureau. In 2007, just before the financial crash, only about half of all families owned any stock, including indirect holdings in retirement accounts. Indeed, only 14 percent of families with the lowest incomes (in the bottom 20 percent) held any stock at all, compared to 91 percent of families with the highest incomes (the top 10 percent).[18]

For most households the primary source of income is wages. According to the Federal Reserve, 68 percent of all family income in 2010 (the latest data available) came from wages, while interest, dividends and capital gains only amounted to 4.5 percent (see Figure 1). Families with the least wealth (the bottom 25 percent) received 0.2 percent of their income from interest, dividends, and capital gains, compared to 11 percent for the wealthiest families (the top 10 percent).

[16] Prepared Testimony of W. David Montgomery, before the Committee on Energy and Commerce Subcommittee on Energy and Environment, U.S. House of Representatives, Hearing on Allowance Allocation Policies in Climate Legislation, June 9, 2009. http://democrats.energycommerce.house.gov/Press_111/20090609/testimony_montgomery.pdf.
[17] Ibid.
[18] U.S. Census Bureau, Statistical Abstract of the United States: 2012, 2012. See Table 1211. http://www.census.gov/compendia/statab/2012/tables/12s1211.pdf.

Figure 1: U.S. Households Source of Income by Percentile of Net Worth in 2010



Source: Federal Reserve, Changes in U.S. Family Finances from 2007 to 2010: Evidence from the Survey of Consumer Finances, Table 2.

And yet the NERA Report appears to assume that the benefits of owning stock in natural gas export companies are widespread, explaining that:

> U.S. consumers receive additional income from…the LNG exports provid[ing] additional export revenues, and…consumers who are owners of the liquefaction plants, receiv[ing] take-or-pay tolling charges for the amount of LNG exports. These additional sources of income for U.S. consumers outweigh the loss associated with higher energy prices. Consequently, consumers, in aggregate, are better off as a result of opening up LNG exports. (NERA Report, p.55)

In the absence of detailed analysis from NERA, it seems safe to assume that increases to U.S. incomes from LNG exports will accrue to those in the highest income brackets. Lower income brackets, where more income is derived from wages, are far more likely to experience losses in income—unless they happen to work in the natural gas industry—and natural gas extraction currently represents less than 0.1 percent of all jobs in the United States.[19] At the same time, everyone will pay more on their utility bills.

[19] Share of jobs in oil and gas extraction. Data for the share of jobs in the natural gas industry alone is not available but would, necessarily, be smaller. Support activities for mining represents an additional 0.25 percent of jobs, petroleum and coal products 0.08 percent, and pipeline transportation 0.03 percent. Taken together, these industries, which include oil, coal and other mining operations, represent 0.5 percent of all U.S. employment. Bureau of Economic Analysis, Full-Time and Part-Time Employees by Industry, 2011 data. http://bea.gov/iTable/iTable.cfm?ReqID=5&step=1

NERA's assumption that all income from LNG exports will return to U.S. residents is incorrect

In the N_{ew}ERA analysis, two critical assumptions assure that all LNG profits accrue to U.S. residents. First, "Consumers own all production processes and industries by virtue of owning stock in them." (NERA Report, p.55) The unequal distribution of stock ownership (shown as interest, dividend, and capital gains income in the Federal Reserve data in Figure 1) is not made explicit in the NERA Report, nor is the very small share that natural-gas-related assets represent in all U.S.-based publically traded stock.[20] In discussing impacts on households' wealth, NERA only mention that "if they, or their pensions, hold stock in natural gas producers, they will benefit from the increase in the value of their investment." (NERA Report, p.13) A more detailed distributional analysis would be necessary to determine the exact degree to which LNG profits benefit different income groups; however, it is fair to conclude that lower-income groups and the middle class are much less likely to profit from LNG exports than higher-income groups that receive a larger portion of income from stock ownership.

Second, the NERA Report assumes that "all of the investment in liquefaction facilities and natural gas drilling and extraction comes from domestic sources." (NERA Report, p.211) This means that the N_{ew}ERA model implausibly assumes that all U.S.-based LNG businesses are solely owned by U.S. residents. There is no evidence to support this assumption. On the contrary, many players in this market have significant foreign ownership shares or are privately held, and may be able to move revenues in ways that avoid both the domestic stock market and U.S. taxes. Cheniere Energy, the only LNG exporter licensed in the United States, is currently building an export terminal on the Gulf of Mexico for $5.6 billion—$1 billion of which is coming from investors in China and Singapore.[21] Cheniere's largest shareholders include holding companies in Singapore and Bermuda, as well as a hedge fund and a private equity firm, which in turn have a mix of domestic and foreign shareholders.[22] This situation is not atypical. As illustrated in Figure 2, 29 percent (by Bcf/day capacity) of the applications for U.S. LNG export licenses are foreign-owned, including 6 percent of total applications from foreign governments. Additionally, 70 percent of domestic applicants are publicly owned and traded, most of which have both domestic and foreign stock holders. Gas extraction companies, similarly, operate with a diverse mix of foreign and domestic investment, and of public and private ownership structures. NERA's claim that profits from LNG exports will be retained in the United States is unfounded.

NERA certainly could have addressed this issue in its analysis. Dr. Montgomery's previous testimony on cap-and-trade assumed that "all auction revenues would be returned to households,

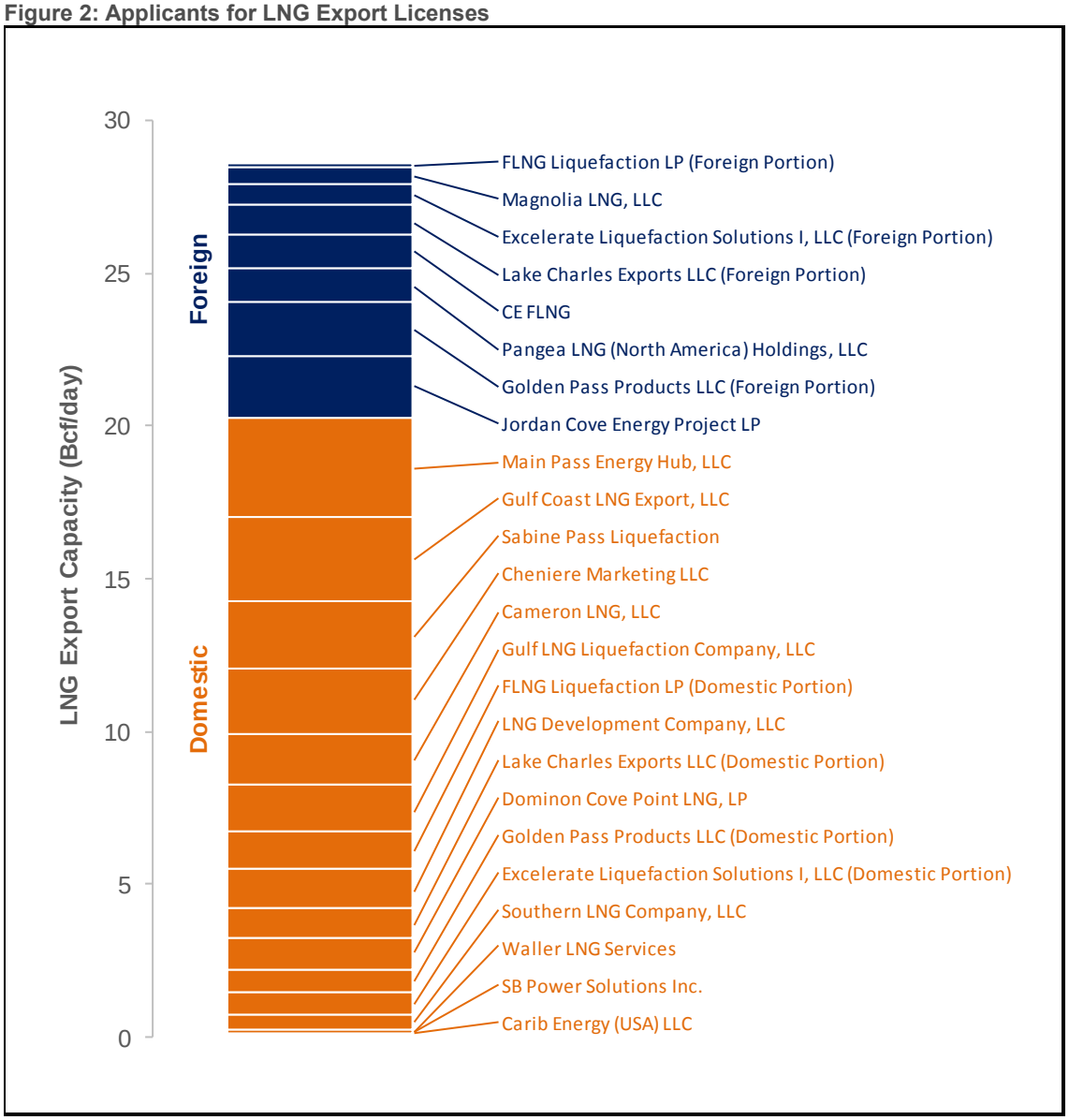
[20] NYSE companies involved in LNG export applications account for 5.8 percent of the total market capitalization, but this includes the value of shares from Exxon Mobil—by itself 2.9 percent of the NYSE market cap—as well as several other corporations with diverse business interests, such as General Electric, Dow, and Seaboard (owner of Butterball Turkeys among many other products). Reuters Stocks website, downloaded January 22, 2013 (following marketclose), http://www.reuters.com/finance/stocks. World Federation of Exchanges, "2012 WFE Market Highlights" (January 2013), page 6. http://www.world-exchanges.org/files/statistics/2012%20WFE%20Market%20Highlights.pdf.

[21] "UPDATE 2-China, Singapore wealth funds invest $1 bln in US LNG export plant-source." Reuters, August 21, 2012. http://www.reuters.com/article/2012/08/21/cic-cheniere-idUSL4E8JL0SC20120821

[22] Ownership data from NASDAQ for Cheniere Energy, Inc. (LNG). http://www.nasdaq.com/symbol/lng/ownership-summary#.UPmZgCfLRpU.

except for the allowance allocations that are given to foreign sources."[23] This assumption led him to conclude that, for the cap-and-trade program, a "large part of the impact on household costs is due to wealth transfers to other countries."[24] This level of analytical rigor should have been applied when estimating the U.S. domestic benefits from opening natural gas exports.

Figure 2: Applicants for LNG Export Licenses



[23] Prepared Testimony of W. David Montgomery, before the Committee on Energy and Commerce Subcommittee on Energy and Environment, U.S. House of Representatives, Hearing on Allowance Allocation Policies in Climate Legislation, June 9, 2009, http://democrats.energycommerce.house.gov/Press_111/20090609/testimony_montgomery.pdf.
[24] Ibid.

Source: See Appendix A for a full list of sources.

Opening LNG export will also incur environmental costs

The discussion of LNG exports in the NERA Report, and most of our analysis of the report, is concerned with monetary costs and benefits: Exports cause an increase in natural gas prices, boosting incomes in the natural gas industry itself while increasing economic burdens on the rest of the economy. There are, in addition, environmental impacts of natural gas production and distribution that do not have market prices, but may nonetheless become important if LNG exports are expanded. Increases in exports are likely to increase production of natural gas, entailing increased risks of groundwater pollution and other environmental problems potentially associated with hydraulic fracturing ("fracking"). Increases in production, transportation of natural gas from wells to export terminals, and the liquefaction process itself, all increase the risks of leaks of natural gas, a potent greenhouse gas that contributes to global warming. These environmental impacts should be weighed, alongside the monetary costs and benefits of export strategies, in evaluation of proposals for LNG exports.

Clearly, as NERA itself acknowledges, the NERA Report would benefit from more detailed analysis of the distribution of costs and benefits from opening LNG exports: "Although convenient to indicate that there are winners and losers from any market or policy change, this terminology gives limited insight into how the gains and losses are distributed in the economy." (NERA Report, p.211)

4. Dependence on resource exports has long-run drawbacks

The harm that LNG exports cause to the rest of the U.S. economy, even in NERA's model, are consistent with an extensive body of economic literature warning of the dangers of resource-export-based economies.

If NERA's economic modeling is accepted at face value, it implies that the United States should embrace resource exports, even at the expense of weakening the rest of the economy. GDP, net incomes, and "welfare" as measured by NERA would all rise in tandem with LNG exports. There would be losses in manufacturing and other sectors, especially the energy-intensive sectors of paper and pulp, chemicals, glass, cement, and primary metal (iron, steel, aluminum, etc.) manufacturing (NERA Report, p. 64). But NERA asserts that these would be offset by gains in the natural gas industry. There would be losses of labor income, equivalent to a decline of up to 270,000 average-wage jobs per year. But, according to NERA, these losses would be offset by increased incomes for resource (natural gas) owners.

For those who are indifferent to the distribution of gains and losses—or who imagine that almost everyone owns a share of the natural gas industry—the shift away from manufacturing and labor income toward raw material exports could be described as good for the country as a whole. (So, too, could any shift among types of income, as long as its net result is an increase in GDP.) The rising value of the dollar relative to other currencies would allow affluent Americans to buy more imports, further increasing their welfare, even as the ability of industry to manufacture and export from the United States would decline.

There is, however, a longer-term threat of LNG exports to the U.S. economy: NERA's export scenarios would accelerate the decline of manufacturing and productivity throughout the country, pushing the nation into increased dependence on raw material exports. Developing countries have often struggled to escape from this role in the world economy, believing that true economic development requires the creation of manufacturing and other high-productivity industries. International institutions such as the IMF and the World Bank have often insisted that developing countries can maximize their short-run incomes by sticking to resource exports.

NERA is in essence offering the same advice to the United States: Why strive to make things at home, if there is more immediate profit from exporting raw materials to countries that can make better use of them? Europe, China, Japan, and Korea have much more limited natural resources per capita, but they are very good at making things out of resources that they buy from the United States and other resource-rich countries. In the long run, which role do we want the United States to play in the world economy? Do we want to be a resource exporter, with jobs focused in agriculture, mining, petroleum and other resource-intensive industries? Or do we want to export industrial goods, with jobs focused in manufacturing and high-tech sectors?

Economists have recognized that resource exports can impede manufacturing, even in a developed country; the problem has been called the "resource curse" or the "Dutch disease." The latter name stems from the experience of the Netherlands after the discovery of natural gas resources in 1959; gas exports raised the value of the guilder (the Dutch currency in pre-Euro days), making other Dutch exports less competitive in world markets and resulting in the eventual decline of its manufacturing sector.[25] In other countries, the "resource curse" has been associated with increased corruption and inequality; countries that depend on a few, very profitable resource exports may be less likely to have well-functioning government institutions that serve the interests of the majority.[26] Protecting an economy against the resource curse requires careful economic management of prospective resource exports.

In particular, it may be more advantageous in the long run to nurture the ability to manufacture and export value-added products based on our natural resources—even if it is not quite as profitable in the short run. The NERA Report is notably lacking in analysis of this strategy; there are no scenarios exploring promotion of, for example, increased use of natural gas in the chemical industry and increased exports of chemicals from the United States. The 25-year span of NERA's analysis provides for scope to develop a longer-term economic strategy with a different pattern of winners and losers. The benefits in this case might extend well beyond the narrow confines of the natural gas industry itself.

5. Unrealistic assumptions used in NERA's N_{ew}ERA model

Despite its sunny conclusions, the NERA Report indicates that LNG exports pose serious challenges to the U.S. economy. It is troubling, then, that the underlying modeling in the report is notably difficult to assess, and is reliant on a number of unrealistic assumptions.

[25] "The Dutch Disease." *The Economist*, November 26, 1977, pp. 82-83.
[26] Papyrakis and Gerlagh. "The resource curse hypothesis and its transmission channels." *Journal of Comparative Economics*, 2004, 32:1 p.181-193; Mehlum, Moene and Torvik. "Institutions and the Resource Curse." *The Economic Journal*, 2006, 116:508 p.1-20.

The NERA Report relies on NERA Consulting's proprietary model, called N_{ew}ERA. Detailed model assumptions and relationships have never been published; we are not aware of any use of the model, or even evaluation of it in detail, by anyone outside NERA.

According to the NERA Report, N_{ew}ERA is a computable general equilibrium (CGE) model. Such models typically start with a series of assumptions, adopted for mathematical convenience, that are difficult to reconcile with real-world conditions. The base assumptions of the N_{ew}ERA model are described as follows: "The model assumes a perfect foresight, zero profit condition in production of goods and services, no changes in monetary policy, and full employment within the U.S. economy." (NERA Report, p. 103)

Here we discuss the implications of each of these assumptions, together with two additional critical modeling assumptions described elsewhere in the NERA Report: limited changes to the balance of trade, and sole U.S. financing of natural gas investments.

Full employment

The full employment assumption, common to most (though not all) CGE models, means that in every year in every scenario, anyone who wants a job can get one. This assumption is arguably appropriate—or at least, introduces only minor distortions—at times of very high employment such as the late 1990s. It is, however, transparently wrong under current conditions, when unemployment rates are high and millions of people who want jobs cannot find them.

The NERA Report expands on its Pollyannaish vision of the labor market, saying:

> The model assumes full employment in the labor market. This assumption means total labor demand in a policy scenario would be the same as the baseline policy projection… The model assumes that labor is fungible across sectors. That is, labor can move freely out of a production sector into another sector without any adjustment costs or loss of productivity. (NERA Report, p.110)

It also includes, in its "Key Findings," the statement that: "LNG exports are not likely to affect the overall level of employment in the U.S." (NERA Report, p.2)

In fact, this is an assumption—baked into the model—and not a finding. N_{ew}ERA, by design, never allows policy changes to affect the overall assumed level of employment. The unemployment rate must, by definition, always be low and unchanging in NERA's model.

For this reason, the potential economic impact that is of the greatest interest to many policymakers, namely the effects of increased LNG exports on jobs, cannot be meaningfully studied with NERA's model. Addressing that question requires a different modeling framework, one that recognizes the existence of involuntary unemployment (when people who want jobs cannot find them) and allows for changes in employment levels. (Despite N_{ew}ERA's full employment assumption, NERA has used the model results to calculate the "job-equivalents" lost to other environmental policies, as discussed above. Had NERA seriously addressed the question, as we discussed earlier, it might have discovered serious job loss potential.)

Perfect foresight

N_{ew}ERA, like other CGE models, assumes that decision-makers do not make systematic errors (that is, errors that bias results) when predicting the future. This is a common assumption in economic modeling and, while more complex theories regarding the accuracy of expectations of the future do exist, they only rarely enter into actual modeling of future conditions.

Zero profit condition

A more puzzling assumption is the "zero profit condition," mentioned in the quote above. Analyzing fossil fuel markets under the assumption of zero profits sounds like a departure from the familiar facts of modern life. The picture is less than clear, since the N_{ew}ERA model includes calculations of both capital income and "resource" income (the latter is received by owners of resources such as natural gas); these may overlap with what would ordinarily be called profits. Without a more complete description of the N_{ew}ERA model, it is impossible to determine exactly how it treats profits in the fossil fuel industries. In any case, the business media are well aware of the potential for profits in natural gas; a recent article, based in part on the NERA Report, includes the subheading "How LNG Leads to Profits."[27]

Invariable monetary policy

N_{ew}ERA also assumes that economy-wide interest rates and other monetary drivers will stay constant over time. Changes to monetary policy could, of course, have important impacts on modeling results, but forecasting these kinds of changes may well be considered outside of the scope of NERA's analysis. That being said, several of NERA's classes of scenarios involve supply and demand shocks to the economy as a whole: exactly the kind of broad-based change in economic conditions that tends to provoke changes in monetary policy.

Limited changes to the balance of trade

NERA's treatment of foreign trade involves yet another unrealistic assumption:

> We balance the international trade account in the N_{ew}ERA model by constraining changes in the current account deficit over the model horizon. The condition is that the net present value of the foreign indebtedness over the model horizon remains at the benchmark year level. (NERA Report, p.109)

Although U.S. exports increase in many scenarios, NERA assumes that there can be very little change in the balance of trade. Instead, increases in exports largely have the effect of driving up the value of the dollar relative to other currencies (NERA Report, p. 110). This assumption results in a benefit to consumers of imports, who can buy them more cheaply; conversely, it harms exporters, by making their products more expensive and less competitive in world markets.

[27] Ben Gersten, "Five U.S. Natural Gas Companies Set to Soar from an Export Boom," December 14, 2012. http://moneymorning.com/tag/natural-gas-stocks/

Sole U.S. financing of natural gas investments

Finally, NERA assumes that all income from natural gas investments will be received by U.S. residents: "[F]inancing of investment was assumed to originate from U.S. sources." (NERA Report, p.5) This improbable assumption, discussed in more detail above, means that benefits of investment in U.S. LNG export facilities and extraction services return, in full, to the United States. As discussed earlier, under the more realistic assumption that LNG exports are in part financed by foreign investors, some of the benefits of U.S. exports would flow out of the country to those investors.

6. Use of stale data leads to underestimation of domestic demand for natural gas

An additional important concern regarding the NERA Report is its use of unnecessarily outdated data from the rapidly changing U.S. Energy Information Administration (EIA) *Annual Energy Outlook* natural gas forecasts. Inexplicably, the NERA Report failed to use the EIA's most recent data, even though it had done so in prior reports.

The following timeline of EIA data releases and NERA reports illustrates this point:

- April 2011: EIA's Final **AEO 2011**[28] published
- December 2011: EIA's **AEO 2012**[29] Early Release published
- June 2012: EIA's Final **AEO 2012**[30] published
- October 2012: NERA's "Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector"[31] N_{ew}ERA model report published using **AEO 2012** data
- December 3, 2012: NERA's "Macroeconomic Impacts of LNG Exports from the United States"[32] N_{ew}ERA model report published using **AEO 2011** data
- December 5, 2012: EIA's **AEO 2013** Early Release published[33]

NERA's October 2012 N_{ew}ERA report on regulations affecting the electricity sector used AEO 2012 data, but its December 2012 report on LNG exports used older, AEO 2011 data. Days after NERA's December 2012 release of its LNG analysis, EIA released its AEO 2013 data.

By choosing to use stale data in its report, NERA changed the outcome of its analysis in significant ways. There have been important changes to EIA's natural gas forecasts in each recent AEO release. Even between AEO 2011 (used in NERA's LNG analysis) and AEO 2012 (which was available but not used by NERA), projected domestic consumption, production, and export of

[28] EIA, Annual Energy Outlook 2011, 2011. http://www.eia.gov/forecasts/archive/aeo11/er/
[29] EIA, *Annual Energy Outlook 2012 Early Release*, 2012. http://www.eia.gov/forecasts/archive/aeo12/er/
[30] EIA, *Annual Energy Outlook 2012,* 2012. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf
[31] David Harrison, et al., *Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector*, October 2012. http://www.nera.com/nera-files/PUB_ACCCE_1012.pdf
[32] W. David Montgomery, et al., *Macroeconomic Impacts of LNG Exports from the United States*, December 2012. http://www.fossil.energy.gov/programs/gasregulation/reports/nera_lng_report.pdf
[33] EIA, *Annual Energy Outlook 2013 Early Release*, 2013. http://www.eia.gov/forecasts/aeo/er/

natural gas rise, imports fall, and projected (Henry Hub) gas prices take a deeper drop in the next decades than previously predicted.

NERA's use of the older AEO 2011 data results in an underestimate of domestic demand for natural gas. The assumed level of domestic demand for natural gas is critical to NERA's modeling results; higher domestic demand—as predicted by more recent AEO data—would decrease the amount of natural gas available for export and would increase domestic prices. Domestic natural gas prices—both in the model's reference case baseline and its scenarios assuming LNG exports—are a key determinant of U.S. LNG's profitability in the global market.

7. Conclusions and policy recommendations

NERA's study of the macroeconomic impacts of LNG exports from the United States is incomplete, and several of its modeling choices appear to bias results towards a recommendation in favor of opening LNG exports. NERA's imagined future clashes with the obvious facts of economic life.

NERA's own modeling shows that LNG exports depress growth in the rest of the U.S. economy.

- NERA's results demonstrate that when LNG exports are opened, the size of the U.S. economy (excluding these export revenues) will shrink. An example helps to illustrate this point: In some cases, when LNG export revenues are $9 billion, GDP is $3 billion larger than in the no-export reference case. This means that GDP excluding gas exports has shrunk by almost $6 billion.
- Using a methodology adopted by NERA in other N_{ew}ERA analyses, job-equivalent losses from opening LNG exports can be estimated as ranging from 36,000 to 270,000 per year; the median scenario has an average job-equivalent loss of 131,000 per year.
- NERA's assumption that all income from LNG exports will return to U.S. residents is simply incorrect, and results in an overestimate of the benefits that will accrue to U.S.-based resource owners.
- Most American households do not own significant amounts of stock in general, and natural gas stocks represent just a tiny fraction of total stock ownership. The benefits to the typical American household from a booming gas industry are too small to measure.
- Higher prices for natural gas and electricity, and declining job prospects outside of the natural gas industry, would cause obvious harm to people throughout the country.
- NERA's export strategy would have the effect of maximizing short-run incomes at the expense of long-term economic stability. If NERA's export scenarios were to be carried out as federal policy, the result would be an acceleration of the decline of U.S. manufacturing and productivity, and an increased national dependence on raw material exports. Too strong of a dependence on resource exports—a problem often called the "resource curse" or the "Dutch disease"—can weaken the domestic manufacturing sector, even in a developed country.
- In the long run, it may prove more advantageous to nurture U.S. manufacture and export of value-added products made from our natural resources—even if it is not quite as

profitable in the short run. For example, surplus natural gas could be used to increase the U.S. manufacture and export of products, such as chemicals, that use natural gas as a raw material.

- The NERA Report has significant methodological issues. The proprietary N_{ew}ERA model is not available for examination by reviewers outside of NERA. The application of this type of closed-source model to U.S. federal policy decisions seems inappropriate.
- The limited documentation provided by NERA points to several unrealistic modeling assumptions, including: decision-makers' perfect foresight regarding future conditions; zero profits in the production of goods and services; no change to monetary policy, even in the face of economy-wide demand and supply shocks; and constraints on how much the U.S. balance of trade can shift in response to opening LNG exports.
- Full employment—also assumed in NERA's modeling—is not guaranteed, and nothing resembling full employment has occurred for quite a few years. At the writing of this white paper, the U.S. unemployment rate stood at 7.8 percent of the labor force (that is, of those actively employed or seeking work).[34] Furthermore, unemployed factory workers do not automatically get jobs in natural gas production, or in other industries.
- The NERA Report used outdated AEO 2011 data when AEO 2012 data were available. These older data underestimate U.S. domestic consumption of natural gas. Accurate modeling of domestic demand for natural gas is essential to making a creditable case for the benefits of opening LNG exports.

The Department of Energy is charged with determining whether or not approving applications—and thus opening U.S. borders—for LNG exports is in the public interest. At this important juncture in the development of U.S. export and resource extraction policy, a higher standard for data sources, methodology, and transparency of analysis is clearly required. Before designating LNG exports as beneficial to the U.S. public, the Department of Energy must fully exercise its due diligence by considering a far more complete macroeconomic analysis, including a detailed examination of distributional effects.

[34] December 2012 unemployment rate; U.S. Bureau of Labor Statistics, *Labor Force Statistics from the Current Population Survey*, Series ID: LNS14000000, Seasonal Unemployment Rate. http://data.bls.gov/timeseries/LNS14000000.

Appendix A

This appendix contains source information for Figure 2: Applicants for LNG Export Licenses.

Table A-1: Source information for Figure 3

Company	Status	Publicly traded?	Source	Quantity	FTA Applications (Docket Number)	Non-FTA Applications (Docket Number)
Golden Pass Products LLC	Foreign / Domestic	yes: XOM ExxonMobil	Golden Pass Products LLC is a joint venture between ExxonMobil Corp and Qatar Petroleum http://online.wsj.com/article/SB10000872396390444375104577595760678718068.html#articleTabs%3Darticle	2.6 Bcf/d(d)	Approved (12-88 -LNG)	Under DOE Review (12-156-LNG)
Lake Charles Exports, LLC	Foreign / Domestic	yes: SUG Southern Union Company, Foreign: BG Bg Group on London Stock Exchange	Lake Charles Exports LLC is a jointly owned subsidiary of Southern Union Company and BG Group http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/11_59_lng.pdf	2.0 Bcf/d (e)	Approved (11-59-LNG)	Under DOE Review (11-59-LNG)
Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC (h)	Foreign / Domestic	Foreign: stock 9532:JP (Osaka Gas Co., Japan)	Osaka Gas's subsidiary Turbo LNG, LLC has a 10% stake in FLNG Development, which is a parent company for Freeport LNG Expansion, L.P, which in turn is a parent company of FLNG Liquafaction LP http://www.freeportlng.com/ownership.asp	1.4 Bcf/d (d)	Approved (12-06-LNG)	Under DOE Review (11-161-LNG)
Main Pass Energy Hub, LLC	Domestic	yes: MMR Freeport-MacMoRan Exploration Co.	Freeport-MacMoRan Exploration Co. owns a 50% stake in Main Pass Energy Hub, LLC http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_114_lng.pdf	3.22 Bcf/d	Approved (12-114-LNG)	n/a
Gulf Coast LNG Export, LLC (i)	Domestic	privately held	97% owned by Michael Smit, 1.5 % each by trusts http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_05_lng.pdf	2.8 Bcf/d(d)	Approved (12-05-LNG)	Under DOE Review (12-05-LNG)
Sabine Pass Liquefaction, LLC	Domestic	yes: CQP Cheniere Energy Partners L.P	Sabine Pass Liquefaction is a subsidiary of Cheniere Energy Partners L.P http://www.chenieereenergypartners.com/liquefaction_project/liquefaction_project.shtml	2.2 billion cubic feet per day (Bcf/d) (d)	Approved (10-85-LNG)	#N/A
Cheniere Marketing, LLC	Domestic	yes: LNG Cheniere Energy Inc.	Cheniere Marketing is a subsidiary of Cheniere Energy Inc. http://www.cheniere.com/corporate/about_us.shtml	2.1 Bcf/d(d)	Approved (12-99-LNG)	Under DOE Review (12-97-LNG)

Table A-1: Source information for Figure 3 (Continued)

Company	Status	Publicly traded?	Source	Quantity	FTA Applications (Docket Number)	Non-FTA Applications (Docket Number)
Cameron LNG, LLC	Domestic	yes: SRE Sempra Energy	Cameron LNG is a Sempra affiliate http://cameron.sempralng.com/about-us.html	1.7 Bcf/d (d)	Approved (11-145-LNG)	#N/A
Gulf LNG Liquefaction Company, LLC	Domestic	yes: KMI Kinder Morgan and GE General Electric (GE Energy Financial Services, a unit of GE)	KMI owns 50 pct stake in Gulf LNG Holdings http://www.kindermorgan.com/business/gas_pipelines/east/LNG/gulf.cfm. GE Energy Financial Services, directly and indirectly, controls its 50 percent stake in Gulf LNG http://www.geenergyfinancialservices.com/transactions/transactions.asp?transaction=transactions_archoldings.asp	1.5 Bcf/d(d)	Approved (12-47-LNG)	Under DOE Review (12-101-LNG)
Excelerate Liquefaction Solutions I, LLC	Foreign / Domestic	Foreign: stock RWE.DE domestic: privately held	Owned by Excelerate Liquefaction Solutions, source: http://www.gpo.gov/fdsys/pkg/FR-2012-12-06/html/2012-29475.htm . Those are owned by Excelerate Energy, LLC (same source). THAT is owned 50% by RWE Supply & Tradding and 50% by Mr. George B. Kaiser (an individual). George Kaiser is the American $10B George Kaiser: http://en.wikipedia.org/wiki/George_Kaiser and http://excelerateenergy.com/about-us	1.38 Bcf/d(d)	Approved (12-61-LNG)	Under DOE Review (12-146-LNG)
LNG Development Company, LLC (d/b/a Oregon LNG)	Domestic	privately held	Owned by Oregon LNG source: http://www.gpo.gov/fdsys/pkg/FR-2012-12-06/html/2012-29475.htm	1.25 Bcf/d(d)	Approved (12-48-LNG)	Under DOE Review (12-77-LNG)
Dominion Cove Point LNG, LP	Domestic	yes: D Dominion	source: https://www.dom.com/business/gas-transmission/cove-point/index.jsp	1.0 Bcf/d (d)	Approved (11-115-LNG)	#N/A
Southern LNG Company, L.L.C.	Domestic	yes: KMI Kinder Morgan	KMI owns El Paso Pipeline Partners source: http://investor.eppipelinepartners.com/phoenix.zhtml?c=215819&p=irol-newsArticle&id=1624861 . El Paso Pipeline Partners owns El Paso Pipeline Partners Operating Company source: http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=46603039 . El Paso Pipeline Partners Operating Company owns Southern LNG page 2 of http://www.ferc.gov/whats-new/comm-meet/2012/051712/C-2.pdf	0.5 Bcf/d(d)	Approved (12-54-LNG)	Under DOE Review (12-100-LNG)

Table A-1: Source information for Figure 3 (Continued)

Company	Status	Publicly traded?	Source	Quantity	FTA Applications (Docket Number)	Non-FTA Applications (Docket Number)
Waller LNG Services, LLC	Domestic	privately held	Wholly owned by Waller Marine: http://www.marinelog.com/index.php?option=com_content&view=article&id=3196:waller-marine-to-develop-small-scale-lng-terminals&catid=1:latest-news . Waller Marine private: http://www.linkedin.com/company/waller-marine-inc.	0.16 Bcf/d	Approved (12-152-LNG)	n/a
SB Power Solutions Inc.	Domestic	yes: SEB Seaboard	p. 2 of http://www.fossil.energy.gov/programs/gasregulation/authorizations/Orders_Issued_2012/ord3105.pdf	0.07 Bcf/d	Approved (12-50-LNG)	#N/A
Carib Energy (USA) LLC	Domestic	privately held	http://companies.findthecompany.com/l/21346146/Carib-Energy-Usa-Llc-in-Coral-Springs-FL	0.03 Bcf/d: FTA 0.01 Bcf/d: non-FTA (f)	Approved (11-71-LNG)	#N/A