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CONGRESSIONAL TESTIMONY

Oil and Gas Development: Impacts of Business as Usual on the Climate and Public Health

Subcommittee on Energy and Mineral Resources of the Committee on Natural Resources

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My name is Nicolas Loris and I am the Deputy Director and Herbert & Joyce Morgan Fellow in the Roe Institute for Economic Freedom at The Heritage Foundation. The views I express in this testimony are my own and should not be construed as representing any official position of The Heritage Foundation. Thank you for this opportunity to appear before the subcommittee to discuss the impacts of oil and gas production on climate change.

My written testimony consists of the following four sections:

1) **Negligible climate benefits from banning oil and gas production on federal lands.** The climate impacts of oil and gas production on federal lands, and of energy production in the United States broadly, are negligible. Banning or restricting oil and natural gas development on federal lands is not going to stop the domestic or global consumption of conventional fuels. Consequently, reducing domestic supplies will increase dependence from sources with far less rigorous environmental standards than the U.S.

2) **Integrated assessment models are not credible tools for calculating the social cost of carbon (SCC).** The integrated assessment models that attempt to quantify the social cost of climate change are not credible instruments for regulators and policymakers. When considering the alleged climate costs of expanded fossil-fuel production on federal lands or the alleged climate benefits of regulations that restrict energy development, policymakers should refrain from relying on these models.

3) **Economic and environmental benefits from American energy production.** Expanding energy production on federal lands will lower energy bills and create jobs without having any meaningful impact on climate. The energy industry continues to innovate, improve efficiency, and invest in state-of-the-art technology, all of which generates significant economic and environmental benefits.

4) **State empowerment and competitive auctions.** Rather than impose arbitrary restrictions and bans on energy production on federal lands, Congress should empower state governments and the private sector. Federal ownership of minerals onshore and offshore takes decision rights away from states and individuals. Short of privatization, increased state oversight and private-sector participation, including a competitive process that opens lease auctions to all interested parties, would result in more accountable, effective management. Furthermore, it would ensure that the bidding process allocates the resources to their highest valued use.

Negligible Climate Benefits from Banning Oil and Gas Production on Federal Lands

A November 2018 report from the U.S. Geological Survey (USGS) found that carbon-dioxide emissions (CO_2) fell more than 6 percent on federal lands from 2005–2014.[1] Methane emissions and nitrous-oxide emissions from fossil production on federal lands fell 10.5 percent and 20.3 percent, respectively, over the same period.[2] Nevertheless, the major takeaway from the report from environmental activist organizations was that fossil-fuel production on federal lands represents a significant portion of U.S. greenhouse-gas (GHG) emissions and therefore is a significant contributor to climate change. The USGS study found that emissions from fossil fuel production represented 23.7 percent of U.S. CO_2 emissions, 7.3 percent of U.S. methane emissions, and 1.5 percent U.S. nitrous-oxide emissions over the 10-year time period.[3]

However, emissions numbers do not provide policymakers with the pertinent knowledge to inform decision making on energy production on federal lands. A more useful tool is the Model for the Assessment of Greenhouse-gas Induced Climate Change (MAGICC).[4] Developed at the National Center for Atmospheric Research in part with funding from the Environmental Protection Agency (EPA), the MAGICC model quantifies the temperature effect and sea-level changes from increases and decreases in GHG emissions. (See the Appendix for a more detailed description.)

No matter where one stands on the urgency to combat climate change, banning natural resource production on federal lands would have no meaningful effect on global temperatures (assuming accuracy of the model). According to the MAGICC model, using a climate sensitivity of 4.5 degrees Celsius (the warming effect of a doubling of CO_2 emissions and an estimate exceeding some of the recent peer-reviewed research on the topic).

Eliminating coal, oil, and natural gas production on federal lands would result in 0.08 degrees Celsius of averted global warming by the year 2100.[5] Similarly, increases in fossil-fuel production would have negligible climate impacts. Running a high-resource case that increases CO_2, methane, and nitrous-oxide emissions 12 percent would increase global temperatures 0.03

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[1]Matthew D. Merrill, Benjamin M. Sleeter, Philip A. Freeman, Jinxun Liu, Peter D. Warwick, and Bradley C. Reed, "Federal lands greenhouse emissions and sequestration in the United States—Estimates for 2005–14: Scientific Investigations Report 2018–5131," U.S. Geological Survey, 2018, https://pubs.usgs.gov/sir/2018/5131/sir20185131.pdf (accessed July 14, 2019).
[2]Ibid.
[3]Ibid.
[4]M. Meinshausen, S. C. B. Raper, and T. M. L. Wigley, "Emulating Coupled Atmosphere-Ocean and Carbon Cycle Models with a Simpler Model, MAGICC6–Part I: Model Description and Calibration," *Atmospheric Chemistry and Physics*, Vol. 11 (2011), pp. 1417–1456, https://www.atmos-chem-phys.net/11/1417/2011/acp-11-1417-2011.html (accessed July 10, 2019), and University Corporation for Atmospheric Research, "MAGICC/SCENGEN," http://www.cgd.ucar.edu/cas/wigley/magicc/ (accessed July 10, 2019).
[5]Ibid.

degrees Celsius by the end of the century.[6] Both projected temperature effects are less than the standard deviation of the surface temperature record of 0.11 degrees Celsius. In fact, even if the U.S. eliminated its carbon footprint, the world would only be less than 0.2 degree Celsius cooler by the year 2100, and sea-level rise slowed by less than 2 centimeters.[7]

Importantly, these estimates do not take into account the emissions leakage that will inevitably occur if the federal government were to ban natural resource extraction on federal lands. Policies that restrict oil and natural gas production in the U.S. will not measurably affect energy consumption behavior. Nor will it affect which type of energy consumers buy domestically or internationally. t. Higher energy prices from constricted supply could reduce consumption marginally, but it will also provide opportunities for increased fossil-fuel production around the world where the environmental standards are not as rigorous as in the United States. Energy-intensive manufacturers that built their plants in America citing affordable energy as a reason why may choose to build their next factory elsewhere. Decisions to curtail resource extraction in the U.S. would likely have the unintended environmental consequence of increasing global GHG emissions, and would likely increase criterion pollutants that adversely affect public health and the environment.

If the purpose of regulations to curtail fossil-fuel production on federal lands is to slow warming, then regulators should measure the benefits through the regulation's project impact on warming rather than aggregate emissions reduced, which mislead the public about the benefits of the policy.[8] The MAGICC model provides information that is more useful for regulators, Congress, and the public when assessing the climate benefits of greenhouse-gas regulation.

Integrated Assessment Models Are Not Credible Tools for Calculating the Social Cost of Carbon

The social cost of carbon and the social cost of other GHG emissions is the alleged external cost from emitting CO_2, methane, and other GHG emissions into the atmosphere. The logic behind the calculation is that the emissions of greenhouse gases impose a negative externality by causing climate change, inflicting societal harm on the United States and the rest of the world. The EPA defines these "social cost" metrics as the accumulated economic damages over the course of the next 300 years that are associated with the emission of one ton of the respective emissions in any given year.[9] The EPA uses three statistical models, known as integrated assessment models, to estimate the value of the SCC and other GHG emissions.

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[6]Ibid.
[7]Ibid.
[8]See, for example, Kevin D. Dayaratna, Nicolas D. Loris, and David W. Kreutzer, "Consequences of Paris Protocol: Devastating Economic Costs, Essentially Zero Environmental Benefits," Heritage Foundation *Backgrounder* No. 3080, April 13, 2016, https://www.heritage.org/environment/report/consequences-paris-protocol-devastating-economic-costs-essentially-zero.
[9]The official definition of the social cost of carbon is the economic damages per metric ton of CO_2 emissions. For further discussion, see U.S. Environmental Protection Agency, "Social Cost of Carbon," Fact Sheet, December 2015, https://www3.epa.gov/climatechange/Downloads/EPAactivities/social-cost-carbon.pdf (accessed July 19, 2017).

Federal and state regulators use these cost estimates to justify regulations, rejecting a pipeline permit or prohibiting energy development on federal lands. The EPA estimates the amount of CO_2 that would be emitted into the atmosphere over the lifetime of that project, multiplies that figure by the SCC, and generates a "global warming cost" to justify obstructing the project. For instance, a Colorado judge rejected a coal mine expansion because the regulators failed to take into consideration the SCC from expanding some roads.[10] According to the Congressional Research Service, the use of the SCC underpins at least 150 regulations.[11]

The change in value of the SCC when subjecting the models to reasonable alternative inputs such as changes to the discount rate and equilibrium climate sensitivity demonstrate just how dependent the models are on those inputs.

Discount rates are a useful tool to compare costs and benefits when they occur at different times. As with any investment, the future benefits need to be compared to the opportunity cost, or the value of an alternative investment of the same size. When analyzing the SCC, the EPA used 2.5 percent, 3 percent, and 5 percent discount rates, ignoring the Office of Management and Budget guidance that stipulates a 7 percent discount rate be used as well. Changes in the discount rate cause the SCC to decrease by 80 percent or more. Even using a 5 percent discount rate drops the social cost considerably.[12]

For example, with regard to analyzing the Clean Power Plan, the EPA's $20 billion in projected climate benefits in the year 2030 falls to $6.4 billion when changed from a 3 percent discount rate to a 5 percent one.[13]

Another input that significantly influences that value of the SCC is climate sensitivity. Equilibrium climate sensitivity distribution probabilistically measures how the earth's temperature will change with from doubling CO_2 emissions. Recent peer-reviewed literature estimates that the equilibrium climate sensitivity is lower than the studies the EPA relied on,

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[10]Dan Elliott, "Expansion Of Colorado's Largest Coal Mine Clears A Hurdle," Associated Press, December 4, 2016, http://denver.cbslocal.com/2016/12/04/expansion-of-colorados-largest-coal-mine-clears-a-hurdle/ (accessed July 14, 2019), and *High Country Citizens' Alliance et al. v. United States Forest Service et al.*, case number 1:13-cv-01723, in the U.S. District Court for the District of Colorado, http://earthjustice.org/sites/default/files/files/91%20%20Order%20on%20Merits%20(2).pdf (accessed July 14, 2019).

[11]Jane A. Leggett, "Federal Citations to the Social Cost of Greenhouse Gases," Congressional Research Service, March 17, 2017, https://fas.org/sgp/crs/misc/R44657.pdf (accessed July 20, 2017).

[12]Kevin D. Dayaratna and David W. Kreutzer, "Unfounded FUND: Yet Another EPA Model Not Ready for the Big Game," Heritage Foundation *Backgrounder* No. 2897, April 29, 2014, http://www.heritage.org/research/reports/2014/04/unfounded-fund-yet-another-epa-model-notready-for-the-big-game; Kevin D. Dayaratna and David W. Kreutzer, "Loaded DICE: An EPA Model Not Ready for the Big Game," Heritage Foundation *Backgrounder* No. 2860, November 21, 2013, http://www.heritage.org/research/reports/2013/11/loaded-dice-an-epa-model-notready-for-the-big-game; and Kevin Dayaratna and Nicolas Loris, "Rolling the DICE on Environmental Regulations: A Close Look at the Social Cost of Methane and Nitrous Oxide," Heritage Foundation *Backgrounder* No. 3184, January 19, 2017, http://www.heritage.org/energy-economics/report/rolling-the-diceenvironmental-regulations-close-look-the-social-cost.

[13]U.S. Environmental Protection Agency, Regulatory Impact Analysis, p. ES-22, Table ES-9.

which are now more than a decade old. Using a more up-to-date equilibrium climate sensitivity distribution significantly lowers the value of the SCC.

My colleague re-ran two of the integrated assessment models and has shown that changes to equilibrium climate sensitivity distribution combined with a higher discount rate lowers the SCC by nearly 200 percent. Under the assumptions for one model, the value has a high probability of being negative, meaning there is a social benefit of increased CO_2 emissions, not a cost.[14] Yet another issue with the SCC projections is the time horizon of the models. Attempts to forecast economic damages out to the year 2300 significantly strains the credibility of these models.[15] Economic models have a difficult enough time forecasting several decades into the future, let alone centuries.

While cost-benefit analysis is a critical tool for regulatory rulemaking, the integrated assessment models that the EPA and other agencies use to calculate the social cost of GHG emissions are too dependent on subjective modeling assumptions. They are unsubstantiated tools that regulators can use to justify costly regulations or thwart new infrastructure investments. Policymakers would be wise to prohibit their use.

Economic and Environmental Benefits from American Energy Production

Energy is a key building block for economic prosperity and improved standards of living. From powering our hospitals to taking children to soccer practice, energy is a necessary component for nearly everything Americans make and do. When Americans pay more for electricity and gasoline, less money is available for health care, clothes, and food, which disproportionately harms low-income families. Even worse, higher energy bills can be the difference between life and death. Mortality rates rise in colder months.[16] A March 2019 National Bureau of Economic Research working paper emphasizes that "[e]xposure to cold is one reason that mortality peaks in winter, and a higher heating price increases exposure to cold by reducing heating use. It also raises energy bills, which could affect health by decreasing other health-promoting spending."[17]

Conversely, affordable, reliable energy saves lives. The same paper concludes "that the drop in natural gas prices in the late 2000s, induced largely by the boom in shale gas production, averted 11,000 winter deaths per year in the US."[18] Increased natural gas supplies spell more affordable, dependable power and heat for American households. In my home commonwealth of

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[14]Dayaratna and Kreutzer, "Unfounded FUND"; Dayaratna and Kreutzer, "Loaded DICE"; and Dayaratna and Loris, "Rolling the DICE on Environmental Regulations."
[15]Ibid.
[16]Olivier Deschênes and Enrico Moretti, "Extreme Weather Events, Mortality, and Migration," 2009, *Review of Economics and Statistics*, Vol. 91, No. 4, pp. 659–681, and Indur Goklany, "Wealth and Safety: The Amazing Decline in Deaths from Extreme Weather in an Era of Global Warming, 1900–2010," The Reason Foundation, September 2011, https://reason.org/wp-content/uploads/files/deaths_from_extreme_weather_1900_2010.pdf (accessed May 1, 2019).
[17]Janjala Chirakijja, Seema Jayachandran, and Pinchuan Ong, "Inexpensive Heating Reduces Winter Mortality," National Bureau of Economic Research *Working Paper Series* No. 25681, March 2019, https://www.nber.org/papers/w25681.pdf (accessed May 1, 2019).
[18]Ibid.

Pennsylvania, more residents are moving away from home heating oil for cheaper, cleaner natural gas. More than 50 percent of Pennsylvania households use natural gas for their home heating source, compared to just 17 percent using fuel oil.[19]

Cheaper energy lowers the cost of doing business, making American companies more competitive and enabling them to invest and expand. Energy production increases demand for associated manufacturing and the service economy, including more need for repair shops, menders, hardware stores, restaurants, hotels, and laundromats, among many others. In the Permian basin that spans southwest Texas and parts of New Mexico, barbers are earning well over six figures.[20] Furthermore, natural gas and butane, ethane, and propane removed from natural gas provide feedstock for fertilizers, chemicals, and pharmaceuticals. The shale gas boom resulted in more than $200 billion in new chemical manufacturing investment.[21]

Furthermore, federal and state governments produce substantial benefits from oil and natural gas production on federal and state-owned lands through revenues collected from royalties, rents, bonus bids, and overall economic activity. In February, the Bureau of Land Management announced that oil and gas lease sales alone generated $1.1 billion for fiscal year (FY) 2018.[22] States receive nearly half that money, which can help fund hospitals, schools, infrastructure, and conservation programs. Energy production on state land in New Mexico was the predominant factor in the state collecting $852 million in FY 2018 and more than $1 billion in FY 2019.[23]

With economic success occurring around the country, it is reasonable to ask: What would energy production be if Congress implemented policies that unleash America's full energy potential? In its *Annual Energy Outlook*, the federal government's Energy Information Administration (EIA) makes projections of energy production, consumption, and prices. The reference case assumes midpoint projections for energy resources and assumes that regulations follow their legislative timelines. As part of its sensitivity analysis, the EIA also produces two side cases where energy resources are assumed to be (a) 50 percent higher and (b) 50 percent lower than the reference case. Though these side cases are not intended to model policy changes, the High Resource Case offers a glimpse of what might be.

It should be noted that a 50 percent increase in resource availability is not a pie-in-the-sky fantasy. U.S. petroleum production in 2015 was about 50 percent higher than the projection the

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[19]U.S. Energy Information Administration, "State Energy Data System: Pennsylvania," https://www.eia.gov/state/?sid=PA (accessed July 14, 2019).
[20]Christopher M. Matthews and Rebecca Elliott, "In This Oil Boom Town, Even a Barber Can Make $180,000," *The Wall Street Journal*, March 2, 2019, https://www.wsj.com/articles/in-this-oil-boom-town-even-a-barber-can-make-180-000-11551436210 (accessed July 14, 2019).
[21]American Chemistry Council, "U.S. Chemical Investment Linked to Shale Gas: $204 Billion and Counting," May 2019, https://www.americanchemistry.com/Policy/Energy/Shale-Gas/Fact-Sheet-US-Chemical-Investment-Linked-to-Shale-Gas.pdf (accessed July 14, 2019).
[22]News release, "Energy Revolution Unleashed: Interior Shatters Previous Records with $1.1 Billion in 2018 Oil and Gas Lease Sales," U.S. Department of the Interior, https://www.doi.gov/news/energy-revolution-unleashed-interior-shatters-previous-records-11-billion-2018-oil-and-gas (accessed July 14, 2019).
[23]Adrian Hedden, "Oil and Gas Leads New Mexico to Earn More Than $1 Billion from State Land," *Carlsbad Current-Argus*, July 11, 2019, https://www.currentargus.com/story/news/local/2019/07/11/oil-and-gas-leads-nm-earn-more-than-1-billion-state-land/1697970001/ (accessed July 14, 2019).

EIA made for 2015 in 2008.[24] Natural gas production in 2015 was about 40 percent *higher* than the EIA's 2008 projection. The comparative pessimism on the part of the EIA was largely due to not fully appreciating the impacts of smart-drilling technology and hydraulic fracturing (fracking) at that time. Without comprehensive seismic mapping and exploration, an accurate estimate of the recoverable natural resources that are currently locked up on federal lands and the continental shelf is unlikely. However, the combination of a rational regulatory environment such as devolving responsibility to the states combined with open access would likely put a 50 percent increase within reach.

Using a clone of the U.S. Energy Information Administration's National Energy Modeling system, Heritage Foundation analysts looked at the impact of the High Resource Case on income and employment, as well as the impact on energy markets. Heritage analysis shows that lifting needless restrictions on energy production that produce little, if any, environmental benefit will increase employment by an average of 700,000 jobs through 2035. Along with the jobs comes $2 trillion in additional economic growth that translates to an additional $40,000 of income per family of four by 2035.

Even with oil's ubiquity in the economy, the environmental risk is quite small. According to the American Petroleum Institute and others, "[M]ore than 99.9995% of the oil produced, refined, stored, and transported in the United States reaches its destination safely and without incident."[25] The clean-up costs, penalties, and liability payments of the Deepwater Horizon accident of 2010 is a prime example of why companies have a strong incentive to protect against accidents. As of January 2018, the Deepwater Horizon spill has cost BP approximately $65 billion.[26] To put that into perspective, a nation whose gross domestic product equaled the costs of that spill would rank 76th out of the 198 countries the World Bank measured for 2018.[27]

The industry has strong financial and public perception reasons to strive for safety improvements continuously, thereby resulting in more innovative approaches to safety and preparedness. The industry continues to develop and share best practices, compile safety performance metrics, and identify ways to improve operations. For instance, voluntary collaborations like The Environment Partnership and the Natural Gas Supply Collaborative share best practices to improve air quality, safety, and resource management.[28] Moreover, investments in innovative technologies drive economic growth, and reduce the industry's environmental footprint. Smaller

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[24]U.S. Energy Information Administration, *Annual Energy Outlook 2008*, June 2008, https://www.eia.gov/oiaf/archive/aeo08/index.html (accessed June 20, 2016), and U.S. Energy Information Administration, *Annual Energy Outlook 2016*, July 7, 2016, http://www.eia.gov/forecasts/aeo/ (accessed July 14, 2019).

[25]American Petroleum Institute, National Ocean Industries Association, and IAGC, "Unlocking America's Offshore Energy Opportunity."

[26]Ron Bousso, "BP Deepwater Horizon Costs Balloon to $65 Billion," Reuters, January 16, 2018, https://www.reuters.com/article/us-bpdeepwaterhorizon/bp-deepwater-horizon-costs-balloon-to-65-billion-idUSKBN1F50NL (accessed January 25, 2018).

[27]The World Bank, "Gross Domestic Product 2018," World Development Indicators, https://databank.worldbank.org/data/download/GDP.pdf (accessed July 12, 2019).

[28]Lindsay Mackinson, "Event Highlights How Environmental Progress Is Being Prioritized by Oil and Gas Industry," Energy in Depth, July 15, 2018, https://www.energyindepth.org/event-highlights-how-environmental-progress-being-prioritized-oil-gas-industry/ (accessed July 14, 2019).

drill pads reduce land use. Improvements in extraction processes are not only increasing per-well productivity, but also using fewer resources in the process. Big data and artificial intelligence will likely revolutionize oil and gas extraction even more, resulting in higher levels of productivity and lower levels of environmental impact.[29] Scientists are exploring using CO_2 for hydraulic fracturing as a potential greener, cost-effective alternative to water. American entrepreneurial spirit and innovative drive will meet consumers' energy demands while making environmental strides forward.

A Better Step Forward: Empowering States and Introducing Competitive Auctions

Rather than impose arbitrary restrictions and bans on energy production on federal lands, Congress should empower state governments and the private sector. Federal ownership and control of minerals offshore (and onshore) has taken decision rights away from states.

Both economically and environmentally, states have proven to manage energy development prudently. For example, where states have authority over applications for permits to drill and conduct environmental reviews, oil and gas production has soared.[30] Energy companies have capitalized on the wealth of resources on private and state-owned lands.[31] On average, the federal processing of an application for permit to drill in the last year of the Obama Administration was 257 days, while state processing is typically 30 days or less.[32] Transferring decision rights to states and the private sector could lead to an industry that is more responsive to price changes. According to research from Utah State University economist Eric C. Edwards,

> Even though 99% of federal drilling permits are eventually approved, bureaucratic delay imposes costs through delay and dampening. Drilling response is slower, and thus wells on federal lands do not respond to high oil and gas prices as quickly as private lands. These delays also lead to lower overall price responses—fewer overall wells drilled in response to price increases. Our findings indicate that the potential for improving the responsiveness of federal lands to price signals could be achieved through a reduction in delay in the BLM [Bureau of Land Management] permitting process.[33]

State control, local governance, and private-sector participation would result in more accountable, effective management. While the federal government can simply shift the costs of mismanagement to federal taxpayers, states have powerful incentives for better management of

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[29]The Goldman Sachs Group, Inc, "Shale Innovation: Brawn to Brains to Bytes," July 23, 2017, http://www.altiragroup.com/sites/default/files/resourcesShaleInnovation.pdf (accessed July 14, 2019).
[30]Marc Humphries, "U.S. Crude Oil and Natural Gas Production in Federal and Nonfederal Areas," Congressional Research Service *Report for Congress*, No. 42432, June 22, 2016, https://fas.org/sgp/crs/misc/R42432.pdf (accessed July 14, 2019).
[31]Institute for Energy Research, "Energy Production on Federal Lands Lags Behind Private and State Lands," July 21, 2015, http://instituteforenergyresearch.org/analysis/energy-production-on-federal-lands-lags-behind-private-and-state-lands/ (accessed July 14, 2019).
[32]News release, "Zinke Signs Secretarial Order To Streamline Process For Federal Onshore Oil And Gas Leasing Permits," U.S. Department of the Interior, July 6, 2017, https://www.doi.gov/pressreleases/zinke-signs-secretarial-order-streamline-process-federal-onshore-oil-and-gas-leasing (accessed July 14, 2019).
[33]Eric C. Edwards, Trevor O'Grady, and David Jenkins, "The Effect of Land Ownership on Oil and Gas Production: A Natural Experiment," Working Paper, December 2016, https://papers.sioe.org/paper/2022.html (accessed July 14, 2019).

resources on federal lands. State governments can be more accountable to the people who will directly benefit from wise management decisions, especially as it pertains to natural resource management. While states and local communities may not always make perfect decisions, the best environmental policies are site- and situation-specific.

Additionally, one way Congress could more accurately value the land and resources is to open the lease auctions to all interested parties. Currently, only energy companies can bid on lease auctions and the federal government requires leaseholders to demonstrate intent to develop the resources. Restricting who bids and requiring the winner develop the parcels eliminates competition and fails to assess the relative value of the land. Conservationists, recreationists, alternative energy companies, ranchers, or environmentalists may value the land more for their intended use than for oil and gas development. As economist Michael Giberson and research fellow Shawn Regan write in their public comment on federal oil and gas royalties, "No method reliably integrates the variety of diverse, predominantly subjective, and sometimes conflicting values into a single, uncontroversial auction reserve price."[34]

Opening the leasing process to all interested parties would not only create more competition but also potentially more cooperation. An environmental organization could pair up with a grazer to bid on a block of land. An energy company could coordinate conservationist groups to use the land in which both parties can benefit. Natural resource extraction would likely still occur, but oil and gas production will occur because the energy companies value the land and resources more than other contending interests do. As values change (for instance, if oil prices rise), buyout programs and lease re-offerings would ensure that competing interests remain involved in current and future land-use decisions. One challenge will be to establish a mechanism to compensate taxpayers for lost royalty revenues, which the BLM could accomplish by assessing grazing, recreation, or other land-use fees. Giberson and Regan write,

> In a number of cases private conservation groups have negotiated with parties over specific grazing rights or oil and gas leases on federal lands in an effort to protect environmental values. As long ago as 1992 the Conservation Fund purchased grazing rights in the Glen Canyon National Recreation Area in southern Utah. By 2003, at least a half-dozen conservation and sportsmen organizations had grazing permit buyout programs. In 2012 the Trust for Public Land, a conservation group, worked with a variety of other groups and donors to purchase and retire oil and gas leases representing 58,000 acres in Wyoming's Hoback Basin from Plains Exploration and Production Co.[35]

Conclusion

The United States is an energy powerhouse, continually breaking new records. Domestic oil production surpassed 12 million barrels of oil per day in April, which is more than double the

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[34]Michael Giberson and Shawn Regan, "Public Interest Comment in Response to U.S. Department of Interior's Advanced Notice of Proposed Rulemaking," comment submitted in response to *Federal Register*, Vol. 80 (June 5, 2015), p. 22148, https://www.regulations.gov/document?D=BLM-2015-0002-0019 (accessed July 14, 2019).
[35]Ibid.

U.S. supply from April 2009.[36] In 2018, the U.S. produced more than one-fifth of the world's natural gas, which accounted for more than the entire production of the Middle East.[37] These are remarkable feats that we should celebrate, not demonize. The economic benefits that accrue to families and businesses are significant and widespread, while the climate impacts are barely measurable. Instead of enacting policies and regulations that restrict access to America's energy abundance, policymakers should open access and empower states to sensibly regulate energy production within their borders.

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APPENDIX

The Model for the Assessment of Greenhouse-Gas Induced Climate Change

The analysis in this *Backgrounder* also uses the Model for the Assessment of Greenhouse-gas Induced Climate Change (MAGICC) versions 5.3 and 6.[38] The MAGICC model quantifies the

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[36]Emily Geary, "U.S. Crude Oil Production Surpassed 12 Million Barrels Per Day in April," U.S. Energy Information Administration, July 8, 2019, https://www.eia.gov/todayinenergy/detail.php?id=40032# (accessed July 14, 2019).

[37]Robert Rapier, "U.S. Increases Dominance in Natural Gas, Produces More Than Entire Middle East," OilPrice.com, July 10, 2019, https://oilprice.com/Energy/Natural-Gas/US-Increases-Dominance-In-Natural-Gas-Produces-More-Than-Entire-Middle-East.html (accessed July 14, 2019).

[38]Meinshausen, Raper, and Wigley, "Emulating Coupled Atmosphere-Ocean and Carbon Cycle Models with a Simpler Model," and University Corporation for Atmospheric Research, "MAGICC/SCENGEN."

relationship between atmospheric radiative forcing, oceanic heat content, and surface temperature perturbation via the following relationship:[39]

$$\Delta Q_G = \lambda G \;\; \Delta T_G + \frac{dH}{dt}$$

where ΔQ_G is the global-mean radiative forcing at the top of the troposphere. This extra energy influx is decomposed into increased outgoing energy flux and heat-content changes in the ocean via the derivative $\frac{dH}{dt}$. The outgoing energy flux is related to the global-mean feedback factor λ_G as well as surface temperature perturbation ΔT_G.

Climate sensitivity, denoted in the MAGICC model as ΔT_{2x}, is defined as the equilibrium global-mean warming after a doubling of CO_2 concentrations and specified via a reciprocal relationship to a feedback factor λ:

$$\Delta T_{2x} = \frac{\Delta Q_{2x}}{\lambda}$$

In the above equation, ΔT_{2x} represents the climate sensitivity and ΔQ_{2x} represents the radiative forcing following a doubling of CO_2 concentrations. The time or state-dependent effective climate sensitivity S^t is defined by combining the above two equations as follows:

$$S^t = \frac{\Delta Q_{2x}}{\lambda^t} = \Delta Q_{2x} \frac{\Delta T_G^t}{\Delta Q^t - \frac{dH}{dt}|^t}$$

where ΔQ_{2x} represents the model-specific forcing for doubled CO_2 concentration, λ_t represents the time-specific feedback factor, ΔQ^t represents the radiative forcing, ΔT_G^t represents the global-mean temperature perturbation, and $\frac{dH}{dt}|^t$ represents the climate system's heat uptake at time t.

MAGICC also contains a carbon-cycle model that incorporates temperature-feedback effects. One of the *a priori* specifications pertaining to this model is a GHG-emissions trajectory. We assumed trajectories specified in the model based on the most recent Intergovernmental Panel on Climate Change (IPCC) Assessment Reports.

We ran MAGICC simulations using the two most recent versions, 5.3 and 6—5.3 provides forecasts for both temperature and sea-level rise, whereas 6 provides forecasts just for temperature. Upon modifying emissions trajectories and specifying a climate sensitivity, one can run the MAGICC model to generate these forecasts. In our simulations using MAGICC 5.3, we used and modified the A1B trajectory, specified in the IPCC's *Special Report* on "Emissions Scenarios" and used in the IPCC's "Third Assessment Report" and "Fourth Assessment Report." In our simulations using MAGICC 6, we used and modified Representative Concentration Pathway 6.0, specified in the IPCC's "Fifth Assessment Report."[40]

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[39]Discussion of the model is based on documentation for version 6, for which the authors state that version 5.3 is a special case with the exception of version 6's updated carbon cycle.

[40]U.N. Intergovernmental Panel on Climate Change, "Emissions Scenarios," *Special Report*, 2000, https://www.ipcc.ch/site/assets/uploads/2018/03/emissions_scenarios-1.pdf (accessed July 3, 2019);

Using data from the EPA, we found that the United States emitted approximately 40 percent of CO_2 emissions with respect to all Organization for Economic Co-operation and Development (OECD) member nations.[41] In our simulations, we altered OECD projections accordingly, assuming this fraction to be constant over time. We also assumed a climate sensitivity of 4.5 degrees Celsius, a level significantly higher than that assumed by the Obama Administration's Interagency Working Group.[42]

U.N. Intergovernmental Panel on Climate Change, "Climate Change 2001: Synthesis Report," 0-521-80770-0, 2001, http://www.grida.no/publications/267 (accessed July 3, 2019); U.N. Intergovernmental Panel on Climate Change, "Climate Change 2007," *Synthesis Report*, 2008, https://www.ipcc.ch/site/assets/uploads/2018/02/ar4_syr_full_report.pdf (accessed July 3, 2019); and U.N. Intergovernmental Panel on Climate Change, "Climate Change 2014," *Synthesis Report*, 2015, https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf (accessed July 3, 2019).

[41]U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2017," April 12, 2019, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2017 (accessed July 10, 2019).

[42]Interagency Working Group on Social Cost of Carbon, "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis."