UNITED STATES DISTRICT COURT
DISTRICT OF WYOMING

STATE OF WYOMING, et al., Petitioners, v. UNITED STATES DEPARTMENT OF THE INTERIOR, et al., Respondents, and WYOMING OUTDOOR COUNCIL, CENTER FOR BIOLOGICAL DIVERSITY, CITIZENS FOR A HEALTHY COMMUNITY, DINÉ CITIZENS AGAINST RUINING OUR ENVIRONMENT, ENVIRONMENTAL DEFENSE FUND, ENVIRONMENTAL LAW AND POLICY CENTER, MONTANA ENVIRONMENTAL INFORMATION CENTER, NATIONAL WILDLIFE FEDERATION, NATURAL RESOURCES DEFENSE COUNCIL, SAN JUAN CITIZENS ALLIANCE, SIERRA CLUB, THE WILDERNESS SOCIETY, WESTERN ORGANIZATION OF RESOURCE COUNCILS, WILDERNESS WORKSHOP, AND WILDEARTH GUARDIANS, Respondent-Intervenors.	)	Civil Case No. 2:16-cv-00285-SWS [Lead] [Consolidated With 2:16-cv-00280-SWS] Assigned: Hon. Scott W. Skavdahl

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF WYOMING

DECLARATION OF MICHAEL HANEMANN
Submitted In Support of Intervenor-Respondents' Response to Motions for Preliminary Injunction

I, Michael Hanemann, declare as follows:

1. I am a Professor of Economics and the Julie A. Wrigley Professor of Sustainability in the Department of Economics and the School of Sustainability at Arizona State University. I am a Professor of the Graduate School and Chancellor's Professor Emeritus at the University of California, Berkeley in the Department of Agricultural & Resource Economics and the Goldman School of Public Policy.
2. I have a BA in Philosophy, Politics and Economics from Oxford University; an MSc in Economics from the London School of Economics; and an MA and a Ph.D in Economics from Harvard University. My Ph.D, and my subsequent teaching and research, have been in the field of economics known as environmental and resource economics. Among the topics on which I have conducted research, published, and taught is the economics of climate change. I have worked on this topic for about twenty-five years.

3. I have received a variety of honors over the course of my academic career, including being elected a member of the U.S. National Academy of Sciences.

The Social Cost of an Externality Such as the Emissions of Methane is a Well-Recognized and Accepted Economic Principle

A. It is an established principle in economics that governments should intervene when a harmful externality is being caused to reduce the amount of harm generated.

4. Both the concept of an externality and the term "social cost" date back to 1920, when Arthur Pigou, the Professor of Economics at Cambridge University, published a book, *The Economics of Welfare*. In that work, Pigou defined an economic externality as arising when a person takes an action that imposes costs or benefits not only on himself but also on other people. Pigou referred to the costs and benefits accruing to the actor as *private costs* and *private benefits*. Pigou used the terms *social cost* to denote the sum of the private costs of an activity plus the external costs (the costs borne by others), and *social benefit* to denote the sum of the private and external benefits (the benefits conferred on others). When private and social costs diverge, or when private and social benefits diverge, there is said to be an *externality*.

5. Pigou elucidated the consequences that follow when there is an externality: an externality leads to what has since become known as a "market failure." In the case of a harmful externality such as the emission of a pollutant, because the external cost imposed on others is not adequately weighed, the market failure is that *too much* of the pollutant is emitted compared to what would be in the best public interest.
6. Pigou's analysis of what constitutes an excessive level of emissions is based on his comparison of the social cost and social benefit of a potential increment in emissions. His key notion is that it is the social cost of the emissions that should be considered, not just the private cost to the emitting party.
7. Pigou's analysis quickly attracted the attention of other economists in England and America. There followed a long discussion in the peer-reviewed literature covering various details and nuances of Pigou's analysis. By around 1953, his argument had been clarified and formalized mathematically. The concept that there is a social cost attached to a harmful externality became part of the standard canon of economics, with special reference to the field of microeconomics known as *public economics*.

B. As a matter of economics, the emission of greenhouse gasses (GHGs), including methane, is an instance of a harmful externality.

8. As a matter of economics, what matters is the existence of harm to another person rather than the specific pathway of the harm. It is the harm to others that creates an external cost. Therefore, from an economic perspective, the emission of GHGs is a harmful externality no less than the emission of mercury, lead, fine particulates or carbon monoxide.

9. However, there is a conceptual distinction between GHGs and these criteria pollutants. The criteria pollutants just mentioned create what is known as a *flow* externality. The harm comes, essentially, contemporaneously as the emissions are being released. If no emissions occur over the course of a year, say, then no harm occurs during that year. GHGs are a *stock* externality: the harm comes from the *accumulated stock* of emissions, including past as well as present emissions. If no emissions occur over the course of a year, harm still occurs during that year due to the stock of pollutants which has accumulated from past emissions. With a stock pollutant, the harm continues for a span of time, until the stock of pollutants has dissipated.

10. It is also important to note that GHGs differ from the criteria pollutants not only in the temporal nature of their damages but also in the *spatial* nature of their damages. Greenhouse gasses emitted at a particular location on the

earth are rapidly mixed in the atmosphere with GHGs emitted from other locations on earth. How GHG emissions work to influence climate, and the consequent impacts on human wellbeing, plays out on a global scale. This contrasts with other pollutants such as mercury, lead, and fine particulates whose effects have a much more limited geographic scope than GHGs. A molecule of GHGs emitted contributes to damages from climate change experienced everywhere around the globe, regardless of where it is emitted. This is not the same with other pollutants. The social cost of GHGs, therefore, covers the globe.

C. Economists have made measurements of the social cost of GHGs, including methane, for several decades.

11. As soon as economists became aware of the issue of climate change, they immediately recognized it as an example of a harmful externality and focused attention on the measurement of its social cost. Without going into great detail and describing the history of publications on this topic since 1991, I can affirm that the social cost of methane employs an economic model that has been well understood and accepted in economics for about 65

years, and has been applied empirically to the externality associated with the emission of GHGs for at least twenty five years.[1]

There is a Clear Rationale in Economics for Estimating the Global Economic Benefits from Methane Reductions as Opposed to Solely the Domestic Benefits

12. I noted above that GHGs differ from criteria air pollutants in both the temporal and spatial scales of their impacts. With regard to spatial scale, GHGs emitted at a particular location on the earth mix in the atmosphere with GHGs emitted from all other locations on the earth. A molecule of GHGs contributes to damages from climate change experienced everywhere around the globe, regardless of where it was emitted. The harmful externality is experienced on a global scale.

13. From an economic perspective, there is no justification for ignoring the distinctive spatial nature of the externality associated with the emission of GHGs any more than one would ignore the distinctive temporal nature of the externality – that it is a stock externality, not a flow externality.

[1] The first economic assessment of the social cost associated with an aspect of climate change was conducted by Professor Ralph D'Arge in 1975 and funded by the US Department of Transportation. Soon thereafter, D'Arge (1982) and Professor William Nordhaus (1980, 1982) developed conceptual analyses of the control of global CO2 emissions. Early examples of empirical estimates of the social cost of CO2 emissions include Nordhaus (1991, 1992, 1993); Cline (1992); and Peck and Teisberg (1992). Papers translating the Pigouvian economic analysis from CO2 to methane include Reilly and Richards (1993), Fankhauser (1994) Kandlikar (1995, 1996), Hammitt et al. (1996), Reilly et al. (1999), Tol et al. (2003), Hope (2005, 2006), Waldhoff et al. (2011), and Marten and Newbold (2012) as well as the analysis by Marten et al. (2015) that forms the basis for the Interagency Working Group's present estimate of the social cost of methane (IWG, 2016).

14. The Interagency Working Group reviewed the question of whether global damages are appropriate for inclusion in the context of the social cost of CO_2. In its Response to Comments, it observed that "there is no bright line between domestic and global damages. Adverse impacts on other countries can have spillover effects on the United States, particularly in areas of national security, international trade, public health and humanitarian concern" (IWG 2015a, p. 31). The IWG noted that " accounting for global benefits [from emission reduction] can encourage reciprocal action by other nations, leading ultimately to international cooperation that increases both global and U.S. net benefits relative to what could be achieved if each national considered only its own domestic costs and benefits when determining its climate policies." And it asserted, correctly in my view, that "the only way to achieve an efficient allocation of resources for emissions reduction on a global basis is for countries to base their policies on global estimates of damages" (IWG, 2015a, p. 32).

The BLM's Use of the IWG's Estimate of the Social Cost of Methane Was Reasonable; It is the Best Available Measure with Which to Assess the Environmental Cost of Emissions of Methane.

15. I have reviewed the methodology employed by the IWG when it estimated the social cost of CO_2 in its 2010, 2013 and 2015b reports, and its estimate

of the social cost of methane in its 2016 report. I am very familiar with the economic literature on the impacts of climate change, with the estimates of the social cost of carbon developed in the literature, and with the Integrated Assessment Models used in the literature to obtain those estimates.

16. In my opinion, the IWG's estimate of the social cost of methane is reasonable, as is its estimate of the social cost of CO_2. It was therefore reasonable for BLM to employ the IWG's estimate of the social cost of methane.

17. To my knowledge, at the present time, the IWG's estimate of the social cost of methane is the best available estimate of the environmental cost of an additional unit of methane emissions. The IWG's estimate of the social cost of CO_2 is the best available estimate of the environmental cost of an additional unit of CO_2 emissions.

I declare under penalty of perjury that the foregoing is true and correct.

Michael Hanemann.

Michael Hanemann

Dated December 14, 2016

Cited Sources

Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (February 2010) (IWG (2010)).

Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (May 2013, revised November 2013) (IWG (2013)).

Interagency Working Group on Social Cost of Carbon, United States Government, *Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (July 2015) (IWG (2015a)).

Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (May 2013, revised July 2015) (IWG (2015b)).