Princeton University
Woodrow Wilson School of Public and International Affairs
Graduate Program

WWS 591g Policy Workshop
Methane Mitigation: Technical and Policy Opportunities

Fall Term - 2012

Mondays, 1:30-4:30 pm, Robertson Hall 020

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INTRODUCTION, CLIENT, AND ASSIGNMENT

Climate change is a global environmental threat that will have increasingly undesirable effects around the world in our lifetimes. International negotiations to limit the emissions of long-lived greenhouse gases (GHG) have stalled. There is a very real possibility that current emissions of GHG have already committed the world to "dangerous anthropogenic interference with the climate system".

There are, however, cooperative initiatives to reduce methane. Methane is a powerful short-lived greenhouse gas (approximately 20 (50) times as potent as carbon dioxide over 100 (20) years with lifetime of about 12 years) that also contributes to the formation of surface ozone that harms human health, agriculture and ecosystems.

The Global Methane Initiative (GMI, http://www.globalmethane.org/index.aspx) is a partnership of over 40 countries, including the US, China and India, that are high emitters of methane. The partners work together to facilitate methane capture and use projects primarily in five areas: agricultural sources, municipal solid waste (landfills), coal mines, oil and natural gas systems, and municipal wastewater systems. In addition, a new international initiative called the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC, http://www.unep.org/ccac/) currently has 17 country partners including the US. The goal of CCAC is "to protect human health and the environment, and slow the rate of near-term climate change, by catalyzing rapid reductions in [methane, black carbon and HFCs]".

The workshop's task is to develop creative yet realistic, well-reasoned and supported policy recommendations that describe feasible domestic and international actions that will rapidly and cost-effectively reduce methane emissions both at present and in the future.

Our clients are Mr. Paul Gunning, Director of the Climate Change Division at the US Environmental Protection Agency (EPA) and a leader of the Global Methane Initiative (GMI) and Dr. Pamela Franklin, Chief of the non-CO2 programs branch in the Climate Change Division of the US EPA. Our clients emails are franklin.pamela@epa.gov and gunning.paul@epa.gov.

COURSE REQUIREMENTS AND PROCESS

The workshop will prepare a coherent, integrated, collective final report, with a one-page executive summary, findings, recommendations, and supporting rigorous analyses, emphasizing policy recommendations (15-20 single-spaced pages, plus exhibits and supporting individually- or collectively-written appendices). In addition, a concise PowerPoint presentation for briefing the clients and perhaps other relevant audiences will also be prepared.

Initial background readings, lectures, discussions, an introductory meeting with the EPA clients in Washington D.C., and informal briefings by pertinent governmental, scientific, and NGO experts will take place during Weeks 1-6. Additional day trips for meetings with key experts may also be arranged.

Each workshop member will research and write a 10-15 page (double-spaced), well-referenced background paper on one key methane mitigation sector/option during Weeks 1-6. The written paper will be submitted to the faculty director and fellow workshop students by the Wednesday before fall break. The key findings and recommendations from the papers will be presented orally by each workshop member to the entire group in Week 6, assisted by a concise PowerPoint presentation. Possible background paper topics will be distributed in the second week of class. Workshop members should select, define, and refine the individual paper topic in consultation with the clients, workshop members and the professor. Ideally these individual papers will provide background guidance for field research conducted during fall break and will contribute to the final report.

The workshop's final collective report will not simply be a compendium of the individual background papers however, although the content of some background papers, with rewriting, may be included in chapters or appendices of the final report.

An interim workshop report outline is due at the end of Week 6, before the fall recess, in order to help structure research during break week. The outline will be shared with EPA clients and rapid turn-around comments requested.

During the fall recess (October 30 - November 7, 2010), small groups of students may travel to various domestic and foreign destinations, e.g., Washington DC, California, China, etc., to conduct interviews and gather information relevant and helpful for the workshop's assignment.

Weeks 7-12 will be devoted to the workshop's collective effort to develop a coherent final report and PowerPoint presentation. Additional speakers and field trips may be arranged as needed during Weeks 7-12

Throughout the semester, workshop members are expected and encouraged to share information with each other via Blackboard, DropBox, etc. as well as via e-mail and memos, on research leads, findings, etc. that will contribute to the group's deliberations and collective final report.

A draft of the workshop's final report is due Monday December 10, 2012 with a **presentation to EPA scheduled for early January 2012** in Washington D.C. Revisions to the report responding to EPA comments can be made during reading period and are encouraged. The final report is due to the instructor and clients by the end of the semester.

EVALUATION

The final course grade and written evaluation of a student's performance in the workshop will be based upon:

Workshop participation	20%
Individual paper	25%
Student presentations	15%
Final report	40%

READINGS

Most reading material for this course will be posted on Blackboard. Other readings are accessible on the Web through links in this syllabus. Books listed in this syllabus are on reserve in the Stokes Library. Additional material may be distributed during the semester. Students are encouraged to share useful documents, papers and websites with each other as they find them. Such exchanges can be done via Blackboard so that they are available to all in a central location.

Workshop members are urged to do as much reading as possible in advance of the weekly workshop meeting, and recognize that the readings listed by week are also a resource for use throughout the semester. In addition to readings listed by week, this syllabus closes with lists of additional resources on reserve in Stokes Library and helpful web sites.

WEEKLY SCHEDULE (Readings, Assignments, and Guest Speakers)

WEEK 1. September 17, 2012.
General introduction/organization.
Climate Science and the role of Methane.

Introduction to workshop assignment. Basic background information. Discussion of workshop process. Fall recess travel. Organizational matters and logistics for the semester. Selection of student liaisons with Graduate Program Office.
Introduction to current state of understanding of climate change science. Role of methane in climate change and air pollution formation.

Required Readings:
Climate Change 2007 Synthesis Document: Summary for Policymakers, Intergovernmental Panel on Climate Warming. See the sections on methane.

http://www.ipcc.ch/pdf/assessment

DL Mauzerall, Methane mitigation – Benefits for air quality, health, crop yields and climate, IGAC Newsletter, pp. 17-18, October 2011.
http://www.princeton.edu/~mauzeral/papers/Mauzerall_CH4_IGAC_Newsletter_Oct11.pdf

Shindell et al (2012) Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security. Science 335, 183-189. This is a synthesis of the UNEP report.
http://www.sciencemag.org/content/335/6065/183.full.pdf?sid=d88ec356-e93f-4af8-a1c6-cd50f32ea51e

The full report is a very valuable resource which goes into detail on specific mitigation options for methane. For the full report see:
UNEP. Near-term climate protection and clean air benefits: Actions for controlling short-lived climate forcers. http://www.unep.org/publications/ebooks/SLCF/

Reay, D. P. Smith, and A. van Amstel (Eds.). 2010. Chapter 1, Methane Sources and Budget and chapter 3 Options for Methane Control in: Methane and Climate Change. Washington, DC: Earthscan. These chapters are available on Blackboard. The full book, containing much useful information, is on reserve in Stokes.

West, JJ, Fiore AM, Horowitz, LW, Scenarios of methane emission reductions to 2030: abatement costs and co-benefits to ozone air quality and human mortality, Climatic Change, 2011.

http://www.springerlink.com/content/3102n71v233p74w6/fulltext.pdf

Recommended Background Readings:

This is the web site where you can find all of the 2007 IPCC reports in .pdf format: http://www.ipcc.ch/ Depending on your interests you can look at relevant sections of the detailed reports on "Science", http://www.ipcc.ch/ipccreports/ar4-wg1.htm and "Mitigation", http://www.ipcc.ch/ipccreports/ar4-wg3.htm.

WEEK 2. Monday September 24. Methane Mitigation Strategies and link to UNEP Climate and Clean Air Coalition (continued from week 1).
As we will be spending all day on Friday travelling to and from Washington DC, the Monday class meeting will end at 3:00.

We will have a brief meeting on Monday September 22, 2008 to finish business from week 1, continue discussing key sources of methane emissions and possible mitigation strategies, and to prepare for our trip to Washington D.C. on Friday October 1, 2010.

Required Reading – these readings will be particularly useful background for our meeting with our client Paul Gunning who is head of the Global Methane Initiative.

Information on the Global Methane Initiative:
http://www.globalmethane.org/index.aspx

Information on the Climate and Clean Air Coalition:
http://www.unep.org/ccac/

Global Methane Initiative. US Government Global Methane Initiative Accomplishments (2011). http://www.epa.gov/globalmethane/pdf/2011-accomplish-report/usg_report_2011_full.pdf

Methane to Markets Partnership wide Accomplishments Report (2004 - 2009).
http://www.globalmethane.org/documents/par_110609.pdf

US Climate Action Report 2010. Fifth National Communication of the United States of America under the United Nations Framework Convention on Climate Change.

International Energy Agency. 2009. Energy Sector Methane Recovery and Use: The Importance of Policy. http://www.iea.org/papers/2009/methane_brochure.pdf

US EPA's Greenhouse Gas Reporting Tool.
http://www.epa.gov/climatechange/emissions/ghgdata/index.html
Caveat: certain key sectors (oil & gas systems, coal mines) that are important sources of methane will not report their data until this September, with the first tranche of data for these two sectors to be published in January 2013 - so this won't be as useful for all the methane sectors. Landfill data for 2010 is available.

EPA. Greenhouse gas emissions reporting from the petroleum and natural gas industry, Background technical support document. 2010?

Heimann, Martin. Methane Emission Enigma, *Nature*, 476; August 2011.

Friday September 28, 2012: meeting with EPA clients in Washington D.C.

WEEK 3. October 1, 2012
Guest Speaker: Dr. David McCabe, Clean Air Task Force.

The Montreal Protocol is widely viewed as the most successful global environmental treaty, phasing out production of nearly 100 ozone depleting substances (ODS). These chemicals are also strong greenhouse gases that contributed 20% of net anthropogenic forcing in 2005 (IPCC, 2007). Some chemical replacements for the phased-out ODSs are also strong greenhouse gases, and one fast action climate mitigation approach would be to limit or prohibit their production. Dr. Andersen has been a leader in facilitating industry-government cooperation in the phase-out as both the co-chair of the TEAP of the Montreal Protocol and as head of special climate projects at EPA. He will discuss possible opportunities for additional climate protection through the Montreal Protocol.

Required reading:

Alvarez, RA, Pacala, SW, Winebrake JJ, Chameides, WL, Hamburg, SP. Greater focus needed on methane leakage from natural gas infrastructure. *Proceedings of the National Academy of Science*, 109:17, April 24, 2012.

McCabe, D. EPA's New Standards for Oil and Gas: What they do, and Don't do. Clean Air Task Force, Fact Sheet, 2012.

International Energy Agency. Golden Rules for a Golden Age of Gas, Special Report on Unconventional Gas, 2012.

Banks, Jonathan. Barriers and Opportunities for Reducing Methane Emissions from Coal Mines, Clean Air Task Force, White paper. 2012.

TRAVEL PROPOSALS DUE FRIDAY OCTOBER 5, 2012.

WEEK 4. October 8, 2012 – Methane from Hydrofracking
***Guest Speaker*: Professor Robert Howarth, Cornell**

The reading below ranges from a WWS 2008 policy workshop report to policy papers to very technical research articles. Please read the abstract of all the articles below and then pick and choose the areas you'd like to read in greater depth. Readings are arranged in order of importance.

Reading:

General description of fracking in pictures: http://www.cnbc.com/id/47834540?slide=1

"Should fracking stop? Point and Counterpoint", *Nature*, Vol 477, 15 September 2011.

This paper got a lot of attention:
Howarth, RW, Santoro, R, Ingraffea, A. Methane and the greenhouse-gas footprint of natural gas from shale formations, *Climatic Change* 106:679-690, (2011)
http://www.springerlink.com/content/e384226wr4160653/fulltext.pdf?MUD=MP

And was contested by:

Cathles III, LM, Brown L, Taam, M., Hunger A. A commentary on "The greenhouse-gas footprint of natural gas in shalre formations" by Howarth et al., *Climatic Change* 113:525-535 (2012).

Kargbo, DM, Wilhelm, RG, Campbell, DJ, Natural gasplays in the Marcellus Shale: Challenges and Potential Opportunities, *Environmental Science and Technology*, 44, 5679-5684, 2010.

Wigley, Tom, Coal to gas: the influence of methane leakage, *Climate Change*, 108:601-608, 2011.

Tollefson, Jeff. Air sampling reveals high emissions from gas field. Methane leaks during production may offset climate benefits of natural gas. *Nature / News*. February 2012.

Freeman, Jody. The Wise Way to Regulate Gas Drilling. *New York Times,* OpEd, July 5, 2012.

Proposed and Promulgated Hydraulic Fracturing Regulations:

EPA:
Targeting emissions of VOCs (with methane included as one of the captured gases):
http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/c742df7944b37c50852579e400594f8f!OpenDocument

New York State Department of Environmental Conservation:
http://www.dec.ny.gov/regulations/77353.html

Department of Interior:
http://www.doi.gov/news/pressreleases/Interior-Releases-Draft-Rule-Requiring-Public-Disclosure-of-Chemicals-Used-in-Hydraulic-Fracturing-on-Public-and-Indian-Lands.cfm

Targeting safe drinking water:
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroreg.cfm

WEEK 5. October 15, 2012

Guest speakers:
Mr. Andrew Eil, US Department of State, Climate and Clean Air Coalition.
Prof. Zhu TONG, Peking University, key contact for students traveling to China.

Reading:
Natural Resources Defense Council (NRDC). Lessons Learned: A Path Toward Responsible Development of China's Shale Gas Resources, August 2012.

See also, shale gas contacts in China

Price Forecast and Risk Assessment of Methane Projects and Methodologies, A delivery to the Global Methane Fund Point Carbon, DRAFT final report. June 2010

Clean Air Task Force white paper on methane:
http://www.catf.us/resources/whitepapers/files/Methane-Tapping_the_Untapped_Potential.pdf

WEEK 6. October 22, 2012. **Student Presentations and Discussions**

Assignments: First papers due. Ten minute oral presentations of individual papers. Workshop initial outline of final report due for discussion and submission to client for comments. Discussion of proposed field research during recess.

FALL RECESS, October 27 - November 4, 2012: Field Research

WEEK 7. November 5, 2012

Discussion of findings from field research during fall recess. Finalizing of workshop final report organization and workshop member responsibilities. Feedback from client on initial outline of final report.

WEEK 8. November 12, 2010

Discussions and decisions on joint recommendations. Planning the workshop's final report. Assignments of remaining work.

WEEK 9. November 19, 2010

Discussions and decisions on joint recommendations. Planning the workshop's final report. Assignments of remaining work.

WEEK 10. November 26, 2010

Draft final report completed, circulated within the workshop for comment, and discussed.

WEEK 11. December 3, 2008

Revisions to draft final report. Provide draft report to clients for comment.

WEEK 12. December 10, 2008

Rehearsal of PowerPoint presentation to client and panel of experts.

Work on revisions in response to comments received from clients.

Reading period in January (week of January 7): Presentation of draft final report to EPA and panel of experts. Date TBD.

Final report due to instructor and EPA clients by end of semester.

BACKGROUND / SUPPLEMENTARY MATERIAL

Some Web Sites on Climate Change, Energy, Mitigation strategies, etc.:

Intergovernmental Panel on Climate Change. Includes all of the 2007 reports on Science, Adaptation and Mitigation as well as a variety of special reports http://www.ipcc.ch/ . These reports come from the flagship international assessment effort of climate change which shared the Nobel Peace Prize with Al Gore in 2007.

Tyndall Center for Climate Change Research. http://www.tyndall.ac.uk/index.shtml

International Energy Agency. www.iea.org

U.S. Environmental Protection Agency, Global Warming.

http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

U.S. Department of Energy, Energy Information Administration, Independent statistics and analysis http://www.eia.doe.gov/emeu/iea/contents.html

BP. Statistical Review of World Energy 2010. http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

U.S. Department of Energy, Energy Information Agency. International Energy Outlook, 2010. http://www.eia.doe.gov/oiaf/ieo/index.html

Climate Change Futures: Health, Ecological and Economic Dimensions. http://www.climatechangefutures.org/

An Inconvenient Truth movie web site. http://www.climatecrisis.net/

The Energy Foundation. http://www.ef.org/programs.cfm?program=climate

Pew Center for Global Change. http://www.pewclimate.org/

CERES, Investors and Environmentalists for Sustainable Prosperity (coalition of investors, environmental and public interest organizations addressing climate change). http://www.ceres.org/

Environmental Defense. Global Warming Undo It campaign. http://www.undoit.org/home.cfm and Fight Global Warming campaign. http://fightglobalwarming.com/

Natural Resources Defense Council. Solving Global Warming. http://www.nrdc.org/globalwarming/solutions/now.asp

Climate Compass. European-based local climate protection initiatives. http://www.climate-compass.net/

Real Climate web site (real science from climate scientists). http://www.realclimate.org/

IEA Greenhouse Gas R&D Programme. http://www.ieagreen.org.uk/publications.html

National Oceanic & Atmospheric Administration. http://www.noaa.gov/

Investor Network on Climate Risk. http://www.incr.com/

CERES, Investors and Environmentalists for Sustainable Prosperity. http://www.ceres.org/

Climate Institute. http://www.climate.org/climate_main.shtml

Clinton Global Initiative. http://www.clintonglobalinitiative.org/home.nsf/pt_cmt_topic?open&cat=climate

Heinz Center for Science, Economics and the Environment.
http://heinzctr.org/index.shtml

Subscribe to CLIMATE-L list serve (moderated, world-wide submissions on climate change issues, about 2-3 per day on average):
http://www.iisd.ca/email/subscribe.htm

Another useful list serve to consider is Climate Change Information Service, for various daily news clippings. Register at: http://www.climatewire.org/login.cfm

Additional Material on Reserve in Stokes Library:

Andersen, SO; Sarma KM; Taddonio, KN. Technology Transfer for the Ozone Layer: Lessons for Climate Change. EarthScan, 2007.

Flannery, Tim. The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth. New York: Atlantic Monthly Press, 2006. ISBN 10: 0-87113-935-9.

Gore, Al. An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It. Emmaus, PA: Rodale, 2006. ISBN 13:978-1-59486-567-1

Tester, Jefferson W., Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, and William A. Peters. Sustainable Energy: Choosing Among Options. MIT Press. 2005. This tome is a comprehensive quantitative introduction to energy technologies, with extensive discussion of non-technical issues

Deutch, John and Richard K. Lester, Making Technology Work: Applications in Energy and the Environment. Cambridge: Cambridge University Press, 2004. Deutch and Lester have written a set of case studies dealing with energy and environmental topics. The emphasis is on teaching the techniques of the policy analyst to the undergraduate engineer.

Speth, James Gustav. Red Sky at Morning: America and the Crisis of the Global Environment. New Haven: Yale University Press, 2002.