RMES 520; Climate Change: Science, Technology and Sustainable Development

Course Syllabus

Instructor: Milind Kandlikar, IRES/Liu Institute
Email: mkandlikar@ires.ubc.ca (personal); rmes.520@gmail.com (course)
Office: Liu Institute 101; AERL 417
Office Hours: Monday 10 AM to noon and by appointment

Course Overview
This course will introduce students to the policy debates and responses created by climate change, which has emerged as the most complex environmental challenge facing the planet. On the one hand, changes in global climate are likely to have significant impacts in many parts of the world, and while a small number of regions / sectors may benefit many others could be devastated. On the other hand, reducing greenhouse gas emissions poses significant technological, economic and political challenges. Reductions of greenhouse gas gases will be made in the presence of incomplete information and continued scientific and economic uncertainty. Changes in human behaviour and technological innovations of the magnitude needed to significantly reduce greenhouse gas emissions may be difficult to achieve.

Learning Outcomes:
By the end of this course, students should be able to:

1. Apply basic scientific knowledge about the climate systems and human impacts
2. Demonstrate working familiarity with technological approaches to the climate change mitigation (including renewables and nuclear technologies)
3. Explain basic economic concepts in climate policy
4. Apply course concepts to 'real-world' cases of climate policy
5. Analyze the synergies and trade-offs between development and climate policy

Course Format:
The course consists of two ninety-minute sessions each week, involving lectures, seminar-based discussions, and case studies. The class sessions are divided into five modules, each requiring readings and leading into a case study session developed and run by students. Students will work in groups to either develop a new case study or to modify an existing case, and then lead the class through an exercise. The cases will provide students with the opportunity to examine global issues in a very specific and local context and learn how to analyze these problems.

Course Outline
By the end of this course, students should have a strong understanding of the fundamental climate change issues ranging from the basic science through technology options and economic impacts.

- **Module 1** provides a **general overview of climate science and impacts**, highlighting the current state of knowledge and remaining uncertainties.
- **Module 2** focuses on **carbon emissions reduction options**: mitigation and energy system changes; efficiency options; and "end-of-pipe" solutions (e.g. carbon capture).
- **Module 3** will explore **carbon economics,** covering the various ways in which the externality of greenhouse gas emissions can be monetized, including taxes, cap and trade systems, and international transfers.
- **Module 4** will examine how **renewable/non-fossil energy** sources might help mitigate the climate problem- the focus will be innovation and diffusion of on wind, solar and nuclear power

- **Module 5** focuses on the nexus between climate change and development. We will examine the role of major developing country emitters in climate mitigation, as well the ability of developing countries to engage in adaptation

Course Requirements
This course is open to all UBC graduate students. Students will be required to apply concepts from a variety of disciplines. Hence, prerequisite knowledge of basic microeconomics and environmental science is encouraged.

Evaluation Criteria and Grading
The course is graded on a numeric basis, and evaluation will be based on different forms of assessment. This will include:

1. A short writing assignment (1500-2000 words) on each of the five modules **(5x7 = 35 points)**

2. Each student will individually take the lead on presenting and discussing a paper in class **(10 points)**

3. A final paper or project **(40 points);** you will also make presentation related to the project (**5 points**)

4. Class participation (**10 points**)

1. Short writing assignments:
Each short paper should be focused on a specific issue related to the content of a module. All papers should be well argued and well presented. They should try to include quantitative evidence where possible. Writing assignments will be due on the Tuesday start of the next module. You will send the papers to me by email.

2. Class Presentations:
Each student will present a paper from the syllabus to the class. I expect you to summarize the paper and to critique its findings. The presentation should take no longer than 20 minutes, and will be followed by a 10 minute Q&A session. Resources for how to make present papers are here
http://web.stanford.edu/~jacksonm/present.pdf and here
http://www.cs.rpi.edu/courses/spring99/robotics/paperdiss.html

3. Final paper:
Each student is expected to write a high-quality final paper or project on the topic of their choosing. You will need to provide me with two short write-ups about your paper. A 1-page short proposal will be due by mid-October for feedback, and a 2-page extended abstract by mid-November. The paper will be due on Friday December 4.

4. Participation in Lectures and Seminar Discussions (10%):
The remainder of the course grade (10%) will be determined by each student's active and constructive participation in class sessions apart from the exercises/case studies. Students are expected to attend each class session, to prepare for each session by completing the weekly readings, and to participate actively and constructively in class discussions.

Course Schedule

Week #	Session 1 Topic	Session 2 Topic	Readings
Module 1: Climate Science and Impacts			
Week 1	Course Organization and Introduction	Long-Term Environmental Issues	**Read: Schneider (2001); Solow (1993)** Skim: Surowiecki (2007); Kolbert (2006)
Week 2	Biogeochemistry and Greenhouse Gas Cycles	The Climate System	**Read: Mackay (2009); World Bank (2012)** Skim: IPCC (2014); Myhre (2013)
Week 3a	Climate Science and Policy	–	Read: **Oreskes (2004); Weber (2010)**
Module 2: Carbon Emissions Reduction			
Week 3b	–	Technological Change: Theory and Models	**Read: Pacala & Socolow (2004); Grübler (2003**); **Waggoner & Ausubel (2002); Solow (1993)**
Week 4	Technology Options (I)	Transport	TBD
Week 5a	Technology Options (II)	Fuel Switching; Carbon Sequestration	TBD
Module 3: Carbon Economics			
Week 5b	–	The Economics of Carbon Mitigation (I)	**Read: Nordhaus (2007); Stern (2007); Goulder and Schein (2013);** Skim: Gupta et al. (2007);
Week 6	The Economics of Carbon Mitigation (II)	Carbon Markets	**Read: Ellerman & Joskow (2008); Ellis et al. (2007); Rivers and Schaufele (2014)** Skim:Hepburn (2006);
Week 7	Integrated Assessment Models (IAM)	(IAM) Models, insights and limitations	**Mastandrea and Schneider (2004); Morgan et al (1999)**
Module 4: Renewables + Nuclear			
Week 8	Solar Power		TBD
Week 9	Wind and Nuclear		TBD
Module 5: Climate and Development			
Week 10	Climate Equity		Chakraborty. S. et al 2010
Week 11	Climate Change Mitigation and co-benefits in Developing Countries		TBD
Week 12	Climate Impacts and Development		TBD

Week 13	Student Presentations	Student Presentations	

Required Readings

There is no single text for this course. Readings are listed below and are drawn from a variety of articles, books and reports.

Akhurst, M., et al. 2003. Greenhouse gas emissions trading in BP. *Energy Policy*, vol. 31, pp. 657-663. http://dx.doi.org/10.1016/S0301-4215(02)00150-7

Ellerman, A.D., and P. L. Joskow. 2008. *The European Union's Emissions Trading System in perspective*. Washington, DC: Pew Center on Global Climate Change. http://www.pewclimate.org/docUploads/EU-ETS-In-Perspective-Report.pdf

Ellis, J. et al. 2007. CDM: Taking stock and looking forward. *Energy Policy*, vol. 35, pp. 15-28. http://www.sciencedirect.com/science/article/B6V2W-4HK5SYC-1/2/9c57567bd5793356b8bd9d5a6e9f46ce

Enkvist, P.-A., et al. 2007. A cost curve for greenhouse gas reduction. *The McKinsey Quarterly*. http://www.berc.berkeley.edu/flyers/McKinseyQ.pdf

Fairless, D. 2007. Renewable energy: Energy-Go-Round. *Nature*, vol. 447, pp. 1046-1048. http://dx.doi.org/10.1038/4471046a

Füssel, H.-M., and R. Klein. 2006. Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change*, vol. 75, pp. 301-329. http://dx.doi.org/10.1007/s10584-006-0329-3

Goulder, L. H. and A.R. Schein. 2013. Carbon Taxes vs. Cap and Trade: A Critical Review.

J. Sumner, L. Bird, and H. Smith. 2009. *Carbon Taxes: A Review of Experiences and Policy Design Considerations.* U.S. National Renewable Energy Laboratory.

Grübler, A. 2003. Technology: Concepts and Definitions. In *Technology and Global Change*. Cambridge, UK: Cambridge University Press. pp. 19-89.

Gupta, S., et al. 2007. Policies, Instruments and Co-operative Agreements. Climate Change 2007: Mitigation. *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. B. Metz, et al. Cambridge, UK: Cambridge University Press. pp. 745-807. http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter13.pdf

Hepburn, C. 2006. Regulation by Prices, Quantities, or Both: A Review of Instrument Choice. *Oxford Review of Economic Policy*, vol. 22, pp. 226-247. http://oxrep.oxfordjournals.org/cgi/content/abstract/22/2/226
http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID902357_code561150.pdf?abstractid=902357&mirid=1

IPCC 2014 *Climate Change A Synthesis Report, Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
http://ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

Jaccard, M., and N. Rivers. 2007. Canadian Policies for Deep Greenhouse Gas Reductions. In. J. Leonard, et al., *A Canadian Priorities Agenda: Policy Choices to Improve Economic and Social Well-Being*. http://www.emrg.sfu.ca/EMRGweb/pubarticles/2007/jaccard-rivers%20The%20Policy%20Challenges.pdf

Jaffe, A.B., R.G. Newell, and R.N. Stavins. 2005. A tale of two market failures: Technology and environmental policy. *Ecological Economics*, Vol. 54, pp. 164-174. http://dx.doi.org/10.1016/j.ecolecon.2004.12.027

Kolbert, E. 2006. *The Curse of Akkad. Field Notes from a Catastrophe*. London, Bloomsbury: 93-102.

D. MacKay (2009). Sustainable Energy – Without the Hot Air. UIT Cambridge Ltd. http://www.inference.eng.cam.ac.uk/sustainable/book/tex/sewtha.pdf (Chapter 1 motivations pages 2-18)

Mckinsey 2007. Reducing U.S. Greenhouse Gas Emissions: How much at what cost?" [Pay particular attention to Exhibit B on page xiii]

Mills, E. 2005. Insurance in a Climate of Change. *Science*, vol. 309, pp. 1040-1044. http://www.sciencemag.org/cgi/content/abstract/309/5737/1040

Morgan, M. G. et al. 1999. Why Conventional Tools for Policy Analysis Are Often Inadequate for Problems of Global Change. *Climatic Change*, vol. 41, pp. 271-281. http://dx.doi.org/10.1023/A:1005469411776

Myhre, G., et al. 2013. Anthropogenic and Natural Radiative Forcing. In T.F. Stocker et al. (Eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment. Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.

NAS (2010) Climate Stabilization Targets: Emissions, Concentrations, and Impacts Over Decades to Millennia (2010) : Division on Earth and Life Studies." Accessed September 8, 2015. http://dels.nas.edu/Report/Climate-Stabilization-Targets-Emissions-Concentrations/12877?bname=.

Nemet, G.F. 2006. Beyond the learning curve: factors influencing cost reductions in photovoltaics. *Energy Policy*, vol. 34, pp. 3218-3232. http://www.sciencedirect.com/science/article/B6V2W-4GSC2NM-1/2/f42bc3300970b9f16d7fb04654723b70

Nordhaus, W. 2007. Economics: Critical Assumptions in the Stern Review on Climate Change. *Science*, vol. 317, pp. 201-202. http://www.sciencemag.org/cgi/reprint/317/5835/201.pdf

Oppenheimer, M., et al. 2014. Emergent Risks and Key Vulnerabilities. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment. Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.

Oreskes, N. 2004. Beyond the Ivory Tower: The Scientific Consensus on Climate Change. *Science*, vol. 306, p. 1686. http://dx.doi.org/10.1126/science.1103618

Pacala, S., and R. Socolow. 2004. Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. *Science*, vol. 305, pp. 968-972. http://www.sciencemag.org/cgi/content/abstract/305/5686/968

Pew (2008). The Causes of Global Climate Change. Washington, DC, Pew Center on Global Climate Change: 6. http://www.c2es.org/docUploads/climate101-overview.pdf

Point Carbon. 2008. Carbon 2008: Post-2012 is now. K. Roine, et al., Point Carbon: 60. http://www.pointcarbon.com/polopoly_fs/1.912721!Carbon_2008_dfgrt.pdf

Rivers, Nicholas, and Brandon Schaufele (2014) “Salience of Carbon Taxes in the Gasoline Market.” SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, October 22, 2014. http://papers.ssrn.com/abstract=2131468.

Rivers, N., and M. Jaccard. 2005. Canada’s efforts towards greenhouse gas emission reduction: a case study on the limits of voluntary action and subsidies. *International Journal of Global Energy Issues*, vol. 23, pp. 307-323. http://www.emrg.sfu.ca/EMRGweb/pubarticles/2005/03%20Rivers.pdf

Schneider, S.H. (2001). What is 'dangerous' climate change? *Nature*, vol. 411, pp. 17-19. http://dx.doi.org/10.1038/35075167

Stern, N. 2007a. Beyond Carbon Markets and Technologies. In *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University Press. pp. 377-402. http://www.hm-treasury.gov.uk/media/0/F/Chapter_17_Beyond_Carbon_Markets_and_Technology.pdf

Stern, N. 2007b. Economic Modelling of Climate-Change Impacts. In *The Economics of Climate Change: The Stern Review*. Cambridge, UK: Cambridge University Press. pp. 161-190. http://www.hm-treasury.gov.uk/media/5/6/Chapter_6_Economic_modelling_of_climate-change_impacts.pdf

Surowiecki, J. 2007. Better and Better: The Myth of Inevitable Progress. *Foreign Affairs*, vol. 86. https://www.foreignaffairs.com/reviews/review-essay/2007-07-01/better-and-better-myth-inevitable-progress

Waggoner, P.E., and J.H. Ausubel. 2002. A framework for sustainability science: A renovated IPAT identity. *Proceedings of the National Academy of Science*, vol. 99, pp. 7860-7865. http://www.pnas.org/content/99/12/7860.abstract

Wara, Michael. “Is the Global Carbon Market Working?” *Nature* 445, no. 7128 (2007): 595–96.

Weber, Elke U. “What Shapes Perceptions of Climate Change?” *Wiley Interdisciplinary Reviews: Climate Change* 1, no. 3 (2010): 332–42.

World Bank (2012). “Turn down the heat.” [Read Executive summary, and skim Chapters 1-3]

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President’s Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

A more detailed description of academic integrity, including the University’s policies and procedures, may be found in the Academic Calendar at http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,0.

Access & Diversity:

Access & Diversity works with the university to create an inclusive living and learning environment in which all students can thrive. The university accommodates students with disabilities who have registered with the Access & Diversity unit: [http://www.students.ubc.ca/access/drc.cfm]. Students must register with the Disability Resource Centre to be granted special accommodations for any on-going conditions.

Religious Accommodation:
The university accommodates students whose religious obligations conflict with attendance, submitting assignments, or completing scheduled tests and examinations. Students should let their instructor know in advance, preferably in the first week of class, if they will require any accommodation on these grounds. Students who plan to be absent for varsity athletics, family obligations, or other similar commitments, cannot assume they will be accommodated, and should discuss their commitments with the instructor before the course drop date. UBC policy on Religious Holidays:
http://www.universitycounsel.ubc.ca/policies/policy65.pdf

UBC Statement on Respectful Environment for Students, Faculty and Staff
The University of British Columbia envisions a climate in which students, faculty and staff are provided with the best possible conditions for learning, researching and working, including an environment that is dedicated to excellence, equity and mutual respect. The University of British Columbia strives to realize this vision by establishing employment and educational practices that respect the dignity of individuals and make it possible for everyone to live, work, and study in a positive and supportive environment, free from harmful behaviours such as bullying and harassment.