ER 100 / 200 and Pub Pol C184 / C284
Energy and Society

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326 Barrows Hall
Energy and Resources Group & Goldman School of Public Policy
Email: kammen@berkeley.edu
Office Hours: Wednesdays mornings in 326 Barrows Hall – schedule times via http://www.wejoinin.com/sheets/kmjsk

Lectures ER100 (cc # 27365) & ER200 (cc # 27434)
Lectures Pub Pol C184 (cc # 77130) & Pub Pol C284 (cc # 77280)
Tues & Thurs, 2:00 – 3:30 PM, A1 HEARST ANNEX (Pacific Film Archive)

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<thead>
<tr>
<th>ER100 / 184 Sections</th>
<th>ER200 / 284 Sections</th>
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<tbody>
<tr>
<td>Section</td>
<td>Day/time</td>
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<td>108</td>
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Course websites - [http://bSpace.berkeley.edu](http://bSpace.berkeley.edu) (course internal) | [http://er100200.berkeley.edu](http://er100200.berkeley.edu) (open)

Among the questions we will address in this course are:

- In what ways has fossil-fuel use defined the 20th Century? What about the 21st?
- What role is there for renewable energy and energy efficiency today and in the future?
- What is the role of nuclear power in our present and future energy mix?
- Could fuel cells or the hydrogen economy cause a revolution in the automotive industry?
- Is the U. S. ready to acknowledge and address global warming?
- How are energy issues different in developing nations from those in the ‘North’?
- What tools do you need to address these questions from an interdisciplinary perspective?

Interested in these questions? Then Energy and Society is for you.
Each of these questions about the use and impacts of energy systems requires an interdisciplinary understanding that explores the scientific, technical, economic, social, political and environmental opportunities and impacts of our energy system.

In this course, you will develop an understanding – and a technically and socially deep working knowledge – of our energy technologies, policies, and options. This will include analysis of the different opportunities and impacts of energy systems that exist within and between groups defined by national, regional, household, ethnic, gender distinctions. Analysis of the range of current and future energy choices will be stressed, as well as the role of energy in determining local environmental conditions and the global climate.

ER200c/GSPP284 are graduate versions of ER100c/GSPP184, and their lectures and sections are held in common. ER200/GSPP284 includes additional material, and added analytic tools and problems on both the problem sets and the examinations. Grading for the undergraduate and graduate courses are separate. Undergraduates must enroll in ER100/GSPP184, and graduate students must enroll in ER200/GSPP284.

Course Goals
This course is designed to provide you with the methods, tools and perspectives to understand, critique, and ultimately influence the management of technical, economic, and policy choices regarding the options for energy generation and use. We will focus equally on the technical, socioeconomic, political, and environmental impacts of energy.

Topically, we will examine the full ‘life cycle’, or ‘cradle to grave to cradle again’ of energy, from the stage of raw materials, or inputs, to generation, conversion, distribution, consumption, recycling, waste, impacts, and ethnic, racial, gender, and economic inequities. This work is inherently interdisciplinary, and will involve a fascinating but extensive effort to understand, critique and integrate tools and perspectives from anthropology, cultural and ethnic studies, economics, engineering, physics, politics, sociology, and who knows what else.

The challenge of this integration is not simply one of learning and applying methods from very diverse disciplines, but more importantly is one of understanding how and when different types of analysis, disciplinary and political perspectives, and “voices” are heard, unheard, ignored, or discredited. Energy is both a fundamental resource for society, the control of which reflects and shapes interactions within society, and between humans and the natural environment.

Coverage
Over the semester we will take a roughly chronological tour of the major fuel types used in human civilization. From there we will begin a broad-ranging analysis of the energy resource, combustion or conversion processes, application, waste, economic, social, political, cultural and environmental impacts and options associated with these fuels and with the changing mix of fuels used within and across societies around the globe.
Assignments
There will be seven problem sets and a policy memo (in total 30% of the grade), a mid-term examination (25%), and a final exam (35%). Participation in sections counts for 10%.

Problem sets are distributed every other Tuesday, and due back, in class, the Thursday of the following week. You may also turn the assignment in at the box located in the hallway outside the ERG office (310 Barrows) BEFORE 5pm Thursday. Late assignments will be penalized 20% if turned in by 5pm on Monday, or 50% if turned in by 5pm on the following Thursday. No credit will be given for assignments turned in more than one week late.

You will get the most out of the problem sets if you make an initial effort to work through all of the problems on your own. After attempting to solve the problems on your own, you may then work with other students to discuss different approaches. It is vital that you do your own work. It is a violation of the Code of Student Conduct to copy answers from anyone.

As part of your participation in the course, you are encouraged to use the bSpace discussion board to make comments and/or ask questions related to the readings or lectures. We will also post the answers to questions about the problem sets on bSpace, so be sure to check bSpace regularly.

Required Texts


Note: it does not matter what version of the texts you have; they have not changed significantly from year to year.

Web-based readings: A number of readings, both required and supplemental, are available on-line. In order to download some of these, you will need to use an on-campus computer or set up your home computer or laptop with the campus proxy service. This is straightforward and useful for doing research from home for all of your classes, just go to http://proxy.lib.berkeley.edu/ for directions. Readings are available at the course website and on the course bSpace site.

Required Reading assignments should be completed before the lecture for which they are assigned. While I recognize that this is not always possible, you need to try; the material in lecture does not simply review the readings; we use it as a basis for exploration of the course material and ideas.
Optional Field Trips

There will be several field trips during the semester. Each will be 3 - 6 hours (including travel time), and all will generally be Friday mornings. The list will depend on availability, but will likely include:

- The Pittsburgh Energy ‘Park’, a 2200 MW fossil-fuel power plant (gas and oil);
- The High Winds wind farm in Solano (near Sacramento);
- Moscone Center in San Francisco, site of the 675 kW solar photovoltaic array and a set of energy efficiency projects.

Graduate Student Instructors:

<table>
<thead>
<tr>
<th></th>
<th>Luke Dodds</th>
<th>Fermin Reygadas</th>
<th>Deepa Lounsbury</th>
<th>Rebekah Shirley</th>
<th>Maggie Witt</th>
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<tbody>
<tr>
<td>Office</td>
<td>399 Barrows</td>
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<tr>
<td>Office Hours</td>
<td>10 – 12 Mon.</td>
<td>10 – 12 Wed.</td>
<td>4 – 5 Tues.</td>
<td>11 – 1 Tues.</td>
<td>3-5 Wed.</td>
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<tr>
<td>Email</td>
<td>reygadas</td>
<td>deepa.lounsbury</td>
<td>rebekah.shirley</td>
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Email [at] berkeley.edu

The best way to reach us is by email or by coming to the office hours.

Section meetings begin in Week 2 (i.e. starting 9/1). Be sure to sign up for a section on-line.

Lecture Notes

Lecture notes (pdf files) will be available for each lecture, and will be posted on the course website generally a week before the lecture. You should download the files and bring them to lecture so that you have all of the graphs and diagrams right in front of you.
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<thead>
<tr>
<th>Wk</th>
<th>Date</th>
<th>Lecturer</th>
<th>Lecture #/Topic</th>
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<tbody>
<tr>
<td>1</td>
<td>8-23</td>
<td>Kammen</td>
<td>1. How Energy Use Shapes Society &amp; the Environment</td>
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<td></td>
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<td>8-30 Guest</td>
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<tr>
<td>3</td>
<td>9-4</td>
<td>Kammen</td>
<td>4. Energy for ‘the South’ I: Energy Transitions and Development</td>
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<td></td>
<td>9-6</td>
<td>Kammen</td>
<td>5. Energy for ‘the South’ II: Biomass, Households and Gender</td>
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<tr>
<td>4</td>
<td>9-11</td>
<td>Kammen</td>
<td>6. Hydrocarbon Man: Coal, Oil, Industry &amp; Society</td>
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<td></td>
<td>9-13</td>
<td>Kammen</td>
<td>7. Energy Toolkit III: Energy Thermodynamics</td>
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<tr>
<td>5</td>
<td>9-18</td>
<td>Kammen</td>
<td>8. Energy Toolkit IV: Thermodynamics of Modern Power Plants</td>
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<tr>
<td>7</td>
<td>10-2</td>
<td>Horvath</td>
<td>12. Energy Efficiency</td>
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<tr>
<td></td>
<td>10-4</td>
<td>Kammen</td>
<td>13. The Grid</td>
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<td></td>
<td>10-11</td>
<td>Friedman</td>
<td>15. Carbon capture and storage / Shale gas</td>
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<tr>
<td>9</td>
<td>10-16</td>
<td>GSIs</td>
<td>In class mid-term review (optional)</td>
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<tr>
<td></td>
<td>10-18</td>
<td>You!</td>
<td>Midterm Exam, In class</td>
</tr>
<tr>
<td>11</td>
<td>10-30</td>
<td>Kammen</td>
<td>18. Energy and Environmental Justice</td>
</tr>
<tr>
<td>12</td>
<td>11-6</td>
<td>Kammen</td>
<td>20. Renewable Energy II: Wind and Water Power</td>
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<tr>
<td>13</td>
<td>11-13</td>
<td>Friedman</td>
<td>22. New fossil fuels: CCS and fracking</td>
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<td>14</td>
<td>11-20</td>
<td>Lipman</td>
<td>24. Transportation systems and policies</td>
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<td>11-22</td>
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<td>HOLIDAY THANKSGIVING</td>
</tr>
<tr>
<td>15</td>
<td>11-27</td>
<td>Kammen</td>
<td>25. Climate Change I: Energy and Climate</td>
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**Final Exam Group:** 5: TUESDAY, DECEMBER 11, 2012, 8-11A
<table>
<thead>
<tr>
<th>Problem Set #</th>
<th>Assigned</th>
<th>Due</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8/28</td>
<td>9/6</td>
<td>Short warm-up problems; analysis of utility bills; making unit analysis your friend, and getting comfortable with the myriad of energy units. These problems may be unfamiliar in style for many of you; if necessary use the GSI’s and study groups to ‘get into the swing’ of these calculations/estimates. You must, however, do your own work.</td>
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<tr>
<td>2</td>
<td>9/11</td>
<td>9/20</td>
<td>Energy use at household and national scales; basic thermodynamics; combustion.</td>
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<tr>
<td>3</td>
<td>9/25</td>
<td>10/4</td>
<td>Thermodynamics of energy systems, combustion of various fuels; comparisons of energy conversion efficiencies, emissions, financial analysis of power plants. Energy economics.</td>
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<td>4</td>
<td>10/4*</td>
<td>10/11</td>
<td>Life-cycle analysis; learning curves; energy efficiency, evolution of the modern energy system.</td>
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<tr>
<td>5</td>
<td>10/23</td>
<td>11/1</td>
<td>Environmental justice; energy efficiency and conservation; the grid; nuclear energy.</td>
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<tr>
<td>6</td>
<td>11/6</td>
<td>11/15</td>
<td>Nuclear energy and waste, renewable energy systems, fuel cells and hydrogen.</td>
</tr>
<tr>
<td>7</td>
<td>11/15*</td>
<td>11/29</td>
<td>Biomass energy, transportation, energy and climate, and climate policy.</td>
</tr>
</tbody>
</table>

* Note: non-standard assignment dates (mid-term & thanksgiving). No late assignments accepted for PS #4.

Problem sets are posted on the web, not physically distributed in class.

**Do not leave problem sets for the final few days. They are not hard if started early; they can be an unpleasant experience if left for the night before they are due ...**

Problem sets are due in class or can be turned in to the problem set drop-off box outside of the Energy and Resources Group, 310 Barrows Hall. Problem sets are late after 5:00 PM.

Problem sets cannot be turned in electronically or by fax.
Week 1 – Introduction to Energy Systems and Society


**Recommendation:** Try getting into the habit of looking for energy articles in newspapers and begin to get a feel for how ubiquitous and far-reaching energy issues are in society. In addition, check the opinion (“OpEd”) and editorial pages of your favorite newspapers. As your last assignment of the course, you will be writing a ‘policy memo’ that in most cases can and should be submitted as an Op Ed yourself!


*Plus, read a selection – you decide how many -- of these energy-related op-eds:*

Read these ‘classic’ energy op eds:


http://www.washingtonpost.com/wp-dyn/content/article/2009/08/02/AR2009080201563.html

Robert Bryce “The gas is greener” (6/7/12)
http://www.nytimes.com/2011/06/08/opinion/08bryce.html?_r=1&adxnnl=1&adxnnlx=1345464020-cfQA/NYdTrT+la88mBAVug

Ban Ki-Moon (2012) “Powering sustainable energy for all” (1/11/12)
http://www.nytimes.com/2012/01/12/opinion/powering-sustainable-energy-for-all.html
Week 2 – Methods in Energy Analysis

Lecture 2 (8/28) Energy Toolkit I: Units, Forecasts, and the Back-of-the-Envelope:

Rubin, EE, Rates of Technology Adoption, Pages 669 – 677.


ER reader:
Chapter 1 (a review and refresher) – optional/reference for those who have done these sorts of problems before.

Supplemental: A bit more than back of the envelope, applied to scaling-up technologies:
http://www.gigatonthrowdown.org/
A nice commentary on the Lovins paper from The New York Times:
http://www.nytimes.com/2008/10/07/science/07tier.html?_r=1&8dpc&oref=slogin

Lecture 3 (8/30) Energy Toolkit II: Basics of Combustion:

Rubin, EE, Chapter 1, pages 3 – 17.


ER reader: Chapter 2, pages: xx - yy
Week 3 – Energy and Development

Lecture 4 (9/4) – Energy for ‘the South’ I: Energy Transitions and National Development:


ER200: Rubin, EE, 15.3, Pages 639 – 659 (section on population, demographics and economic growth).

ER Reader: Chapter 1, pages zz – pp.

Lecture 5 (9/6) – Energy for ‘the South’ II: Households and Gender:


Supplemental:

Week 4 – Hydrocarbon Energy

Lecture 6 (9/11) – Hydrocarbon Man: Coal, Oil, Industry & Society:


**Supplemental:**

*Highly recommended online collection debating the impacts of Oil: The Long Goodbye, Foreign Policy, 2009, [http://www.foreignpolicy.com/node/47222](http://www.foreignpolicy.com/node/47222)*


**Lecture 7 (9/13) Energy Toolkit III: Energy Thermodynamics:**


**ER Reader**

Week 5 – Thermodynamics & Energy Systems

Lecture 8 (9/18) Energy Toolkit IV: Thermodynamics of Modern Power Plants:

Rubin, EE, Sections 5.1 - 5.4 (except 5.2.2 & 5.2.3); Pages 162 – 175, 179 – 196.


Anderson (2005), Sections 3.3-5.6, pp. 33-84. [Anderson_2005.pdf]


Dirty Coal, Clean Future, The Atlantic Monthly (November 2010)

Lecture 9 (9/20) – Evolution of the Modern Energy Economy:

Week 6 – Energy Economics and Life-Cycle Methods


Rubin, *EE*, Chapter 13, Pages 545 – 577

Lecture 11 (9/27) – *Life-cycle and Cost-Benefit Analysis*


Rubin, Section 13.4, Life-cycle cost, 556 – 562.

Week 7 – Energy Efficiency and the Grid

Lecture 12 (10/2) – Energy Efficiency:

Rubin, EE, Chapter 7, and Section 13.8 of Chapter 13, Pages 281 – 314, 577 – 583.


Executive summary & Chapter 1 (pages 6 - 27)

Supplemental: Energy efficiency is perhaps the most important, yet least discussed and taught component of our energy system. These websites, and energy use calculators provide a range of materials on energy efficiency. We will provide more information later about what specific sections of these websites you should focus on.

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<th>Contents</th>
<th>URL</th>
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<tr>
<td>LBL Energy Efficiency Standards</td>
<td><a href="http://eappc76.lbl.gov/">http://eappc76.lbl.gov/</a></td>
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<tr>
<td>LBL’s Energy Use Forecasting</td>
<td><a href="http://enduse.lbl.gov/">http://enduse.lbl.gov/</a></td>
</tr>
<tr>
<td>Scenarios for a Clean Energy Future</td>
<td><a href="http://www.ornl.gov/sci/eere/cef/">http://www.ornl.gov/sci/eere/cef/</a></td>
</tr>
</tbody>
</table>

Lecture 13 (10/4) – Electricity Grids: Managing the Network:


Reference: Glossary of electricity terms. [Electricity_Glossary.pdf]
Week 8 – Buildings as Energy Systems and Carbon Capture and Storage

Lecture 14 (10/9) – Buildings as Energy Systems

David B. Goldstein (2008) Extreme Efficiency: How Far Can We Go If We Really Need To? ACEEE Summer Study Paper.

Chapter 3 (buildings, pages 52 – 85)

And for a look at why it is so hard, ask Dilbert:

Lecture 15 (10/11) – Carbon Capture and Storage

Chapters 2 and 3 (pages 5 – 42)

References:
and
CCSRegs project - http://www.ccsreg.org/
Specifically the Policy Brief: http://www.ccsreg.org/policy_briefs.html
Week 9 – Mid-Term Exam

Class (10/16) – Midterm examination review

Class (10/18) – Midterm examination
Week 10 – Nuclear Power

Lecture 16 (10/23) – Nuclear Energy Physics and Engineering – Fission/Fusion:


Supplemental: Excellent online material on reactor types and performance is available at http://www.nrc.gov/reactors/power.html
In particular, review ‘About the NRC’, ‘Nuclear security’, and read about the events (power production and management) at one of the featured reactors, such as Diablo Canyon (under nuclear reactors) that provides power to northern California.

Lecture 17 (10/25) – Nuclear Waste, Risk & Economics:

Rubin, EE, pages 63-68, 175-178.


Week 11 – Energy and Environmental Justice & Renewables

Lecture 18 (10/30) – Energy and Environmental Justice:


An Environmental Justice Resource: A sampling of EJ websites includes:

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<thead>
<tr>
<th>Contents</th>
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<tbody>
<tr>
<td>The EJ Information Page</td>
<td><a href="http://eelink.net/EJ/">http://eelink.net/EJ/</a></td>
</tr>
<tr>
<td>Climate Justice and People of Color</td>
<td><a href="http://www.ejrc.cau.edu/climatechgpoc.html">http://www.ejrc.cau.edu/climatechgpoc.html</a></td>
</tr>
<tr>
<td>Ken Saro-Wiwa and Shell Oil (Nigeria)</td>
<td><a href="http://uk.oneworld.net/guides/nigeria/development">http://uk.oneworld.net/guides/nigeria/development</a></td>
</tr>
<tr>
<td>EJ Case Studies</td>
<td><a href="http://www.umich.edu/%7Esnre492/cases.html">http://www.umich.edu/%7Esnre492/cases.html</a></td>
</tr>
<tr>
<td>Center for Science and Environment (India)</td>
<td><a href="http://www.cseindia.org/">http://www.cseindia.org/</a></td>
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</tbody>
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Lecture 19 (11/1) – Renewable Energy I: Solar Energy:


Week 12 – Renewable Energy II: Wind and Water Power

Lecture 20 (11/6) – Wind and Water Power


EERE / NREL (2008) 20% Wind Energy by 2030
URL: www1.eere.energy.gov/windandhydro/pdfs/41869.pdf

ER100: pages 1 – 20

ER200: read either Chapter 2 “Turbine Technology” or Chapter 6 “Markets” and *skim* the other chapter based on your interest.


ER200 Examine in detail one of the case studies in the World Commission on Dams website at http://www.dams.org/kbase/studies/.


Lecture 21 (11/8) – Hydrogen and Fuel Cells:


Supplemental:
Week 13 – Bioenergy and International Energy Policy

Lecture 22 (11/13) – Industrial Bioenergy

USDA - Billion Ton Vision (http://feedstockreview.ornl.gov/pdf/billion_ton_vision.pdf)

Rubin, EE, Chapter 3, Pages 83-123.


Supplemental:
Special Report on Renewable Energy Systems: Modern biofuel (Ch 2)

Lecture 23 (11/15) – International Energy Policy


Skim the initial chapters after you review the energy policy metric (Chapter 1), and specifically read pages, 48 – 63.

Week 14 – Transportation Systems

Lecture 24 (11/20) – Transportation systems and policy:


Selection from Two Billion Cars?

Chapter 2 Transportation: pages 22 - 51

Schipper, L. et al. (2009) “Cash for clunkers is a lemon” Washington Post, August 9, 2009 [Example policy memo]

Week 15 – Energy and the Global Environment

Lecture 25 (11/27) – Climate Change I: Energy and Climate:

Rubin, EE, Chapter 12, Pages 470 – 537.


And for an example of the arguments against, see: http://cliffmass.blogspot.com/2012/08/climate-distortion.html


Copenhagen Climate Change Synthesis Report: http://climatecongress.ku.dk/


Lecture 26 (11/29) – Climate Change II: Energy Policy:


C-ROAD http://climateinteractive.wordpress.com/2008/09/19/pangaea-our-decision-maker-oriented-uclimate-simulator/

Review the simulator and develop a scenario to maximize emissions growth in ‘the South’, subject to the constraint that total global emissions stabilize under 450 ppmv.


ER200: Supplemental:

National Security and the Threat of Climate Change (2007)
http://securityandclimate.cna.org/report/
