

CRSN 151A: Sustainability Praxis in the Built Environment (5 units)

The goal of this 5 unit class is to introduce students to the concepts, methods, practices and “tools of the trade” for conceptualizing and conducting research into sustainability praxis in the built environment, and to the quantitative and analytical tools required to conduct such analysis and research. The focus of class is on (i) learning how to analyze complex and “wicked” problems and issues; and (ii) applying this skill to understanding how energy, water, food, raw materials and waste flow through the human-built environment, with a particular concern for systemic and infrastructural relationships and how these manifest in those problems; (iii) learning how to prepare a sustainability policy analysis study; and (iv) identifying sustainability projects and the need for them. Students learn basic techniques and tools for estimating resource flows. They conduct initial surveys and assessments, perform building energy and resource auditing, learn the essentials of how to size, install, operate, and monitor energy and water supply, understand resource usage and distribution patterns. They will participate in longitudinal research regarding best-practice intensive and urban agroecology, energy monitoring and research interviews, and green building construction.

Course Objectives

1. Understanding of the basic aspects of resource flows in the built environment, and an ability to conduct basic assessments and quantification of these flows;
2. Introduction to social science aspects of human behavior, habits and practices where resource use is concerned and basic understanding of survey design and implementation;
3. Developing the skills required to specify, organize, and conduct research projects under faculty supervision, design, install and maintain monitoring equipment for ongoing sustainable systems research, and understand and analyze data;
4. Understanding and application of the analytical tools and concepts required to perform accurate assessments and quantification of sustainable systems in the human-built environment;
5. Application of statistical methods to develop and implement surveys and interviews around sustainability issues;

Course Requirements

Student work includes group and individual policy problem analysis, weekly problem sets, conduct of field assessments and research, data logging and analysis, initial development of an individual project and hands-on development of sustainable systems on one of several group projects in the field. Students will present their work in class during finals period. A research policy analysis paper is due in lieu of a final exam. There will be 3 hours of

class, 2 hours of fieldwork (to be scheduled) and about 10 hours of homework every week.

Course grading rubric

Attendance & participation: 5%
Group policy papers: 20%
Fieldwork: 20%
Individual project assignments: 20%
Final paper: 25%
Group presentation: 10%

Reading:

Readings are available on the internet or course web site.

Essential supplementary texts

David MacKay, *Sustainable Energy without the Hot Air*,
<http://www.withouthotair.com/>

Vivan Loftness & Dagmar Hasse (eds.), *Sustainable Built Environments*
(Springer), at:
<http://link.springer.com/referencework/10.1007%2F978-1-4614-5828-9>

Ellen van Bueren, et al (eds.), *Sustainable Urban Environments—An Ecosystem Approach* (Pringer), at:

Thomas Theis & Jonathan Tomkin, *Sustainability: A Comprehensive Foundation* (Connexions), at:

Class schedule & readings

Week 1: Introduction to the course

Meeting #1: Complex & “wicked” problems in sustainability & policy

Required reading:

“Social Complexity” at:

<http://understandingsociety.blogspot.com/2011/10/social-complexity.html>

Joseph Tainter, “Social complexity and sustainability,” *Ecological Complexity* 3 (2006):91-103, at: <https://ecommons.ucsc.edu/x/FWHOv0>

Meeting #2: Problem analogies in the built environment

Required reading:

D. Gentner, “Generative models as mental analogies” (1981), at:

<https://ecommons.ucsc.edu/x/40jkrS> ; “Water-Circuit Analogy,”

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/watcir.html>

“Fundamentals of Transportation/Traffic Flow, at:

http://en.wikibooks.org/wiki/Fundamentals_of_Transportation/Traffic_Flow

; “Traffic Modeling--Phantom Traffic Jams & Traveling Jamitons, at:

<http://math.mit.edu/projects/traffic/>

Additional resources:

Hall, "Traffic Stream Characteristics," <https://ecommons.ucsc.edu/x/EA84z1>; "Chasing cars," <https://ecommons.ucsc.edu/x/FyMdNt>; "When do slower roads provide faster travel?" <https://ecommons.ucsc.edu/x/q86WP2>

Assignment #1 (see detailed prompt at:

<https://ecommons.ucsc.edu/x/kivzts>)

You are a transportation intern for CalTrans, working on the solution to traffic congestion on Highway 1 through Santa Cruz. Please prepare a group report laying out options (including calculations & costs) for solving this problem.

Week 2: Designing your project & policy analysis**Meeting #1: Project considerations-- Designing, organizing, completing and reporting.**

Required reading: Amanda Roletti, "Riding Through the Redwoods: The UCSC Bike Share System," <https://ecommons.ucsc.edu/x/XXBhGs>; Warwick University Project planning & management e-guide, "Defining your project," at:

<http://www2.warwick.ac.uk/services/ldc/resource/eguides/projectplan/define>; Don Hofstrand & Mary Holz-Clause, Iowa State Extension Feasibility Study, at: <https://ecommons.ucsc.edu/x/gwkuEp>

Additional resources:

Aalborg University, "Handbook of Project Writing," at:

<https://ecommons.ucsc.edu/x/Zo5MpT>; RCC/C8 wiki on "Social Entrepreneurship," at:

<http://www.ic.ucsc.edu/college8core/c8wiki/index.php/Category:Entrepreneurship>; Soraya M. Coley & Cynthia a. Scheinberg, "Writing the Needs or Problem Statement," in: *Proposal Writing—Effective Grantsmanship*, Sage, 3rd ed., 2008, at: <https://ecommons.ucsc.edu/x/R1jMR7>

Meeting #2: Identifying an issue for your individual policy analysis paper

Required reading: Hens Runhaar, Carel Dieperink and Peter Driessen, "Policy analysis for sustainable development: The toolbox for the environmental social scientist," *International Journal of Sustainability in Higher Education* 7, #1 (2006): 34-56, <https://ecommons.ucsc.edu/x/S5Usmd>

Sustainable Santa Santa Cruz County Plan, October 2014, Part 1 (<https://ecommons.ucsc.edu/x/PyDSBt>) and Part 2

(<https://ecommons.ucsc.edu/x/Ypy8kE>)

Additional resources:

"What is an Environmental Policy Analyst?" *Environmental Science*,

<http://www.environmentalscience.org/career/environmental-policy-analyst>

Alan R. Berkowitz, Charles H. Nilon & Karen S. Hollweg (eds.), *Understanding Urban Ecosystems* (New York: Springer-Verlag, 2003),

at: <http://link.springer.com/content/pdf/10.1007%2Fb97613.pdf>

Assignment #2 (see detailed prompt at:

<https://ecommons.ucsc.edu/x/j0TgAR>): For this assignment, you are required to prepare a 500 word abstract of a specific sustainability issue of relevance to Santa Cruz and compile a bibliography of no fewer than five sources you will use in preparing your paper. Please do not simply list likely-looking sources; be sure you skim them, at a minimum, to make sure they are relevant. Do not wait until week 7 to return to research on your issue; you should be collecting materials, conducting interviews (if appropriate), doing calculations and estimates, and drafting sections.

Week 3: Evaluating complex sustainability problem strategies & solutions

Meeting #1: Basic problem solving-skills and estimation techniques

Required reading:

“Problem-Solving—Estimation and Orders of Magnitude, at:

<http://www.maa.org/press/periodicals/loci/joma/problem-solving-estimation-and-orders-of-magnitude> ; “How to Develop a Rough Order of Magnitude Estimate, at:

<http://www.pmdocuments.com/how-to-develop-a-rough-order-of-magnitude-estimate-rom-estimate/> ; Michale J. Radzicki & Robert A. Taylor, “Stocks and Flows,” Introduction to System Dynamics (DOE, 1997) at:

<http://www.systemdynamics.org/DL-IntroSysDyn/stock.htm>; “Stocks and Flows,” at: <http://public.wsu.edu/~forda/Ch%203.pdf>

Meeting #2: Stocks, flows & rectangles

Required reading:

Stocks & flows: <http://tinyurl.com/jjbzuu6> ; “Rate of change & Slope,”

http://www.montereyinstitute.org/courses/Algebra1/COURSE_TEXT_RESOURCE/U04_L1_T1_text_final.html ; “Areas under curves,”

<http://www.intmath.com/integration/3-area-under-curve.php> ;

“Introduction to models: stocks & flows,

<http://abacus.bates.edu/~raustin/FluxFlow/L2.3%20intro%20to%20modeling.pdf>

Additional resources:

Susanne Kytzia, “Material Flow Analysis as a Tool for Sustainable Management of the Built Environment,” at: <https://ecommons.ucsc.edu/x/Oh9g1K> ; “End of life PV,”

<https://ecommons.ucsc.edu/x/IBKxrY> ; Firoz Jameel, Jesse Daystar and Richard A. Venditti, “Environmental LCA,”

<https://ecommons.ucsc.edu/x/PhJy7h> ; “LCA calculator,”

<http://www.lcacalculator.com/> ; “Beginner’s Guide: How To Do An LCA For FREE, Life Cycle Assessment Tools And Data”

<http://www.linkcycle.com/beginners-guide-life-cycle-assessment-tools-and-data/#comments> ; Carnegie-Mellon, Economic Input-Output Life Cycle Assessment,

<http://www.eiolca.net/> ; “Stocks & Flows,”

<http://www.systemdynamics.org/DL-IntroSysDyn/stock.htm>

Assignment #3 (see detailed prompt at: <https://ecommons.ucsc.edu/x/h8CxE1>). This week, you are working in the Resource Recovery Department of the city of Santa Cruz. Your task is to work on ways to reduce dumping at the city's landfill on Dimeo Lane, which is likely to be full by 2040, even though a large fraction of the materials brought there are recycled (the diversion rate for Santa Cruz County as a whole is 75%). There is good reason to think, however, that the lifetime of the landfill can be extended if the city's diversion rate can be increased even more. Your report should discuss how this goal can be achieved.)

Week 4: Green & Social enterprise

Meeting #1 & 2: Applying the Business Model Canvas to your project

Required reading:

Ingrid Burkett, "Using the Business Model Canvas for Social Enterprise Design," Knode, <https://ecommons.ucsc.edu/x/xYzH7F>; Steve Blank, "The Mission Model Canvas - An Adapted Business Model Canvas for Mission-Driven Organizations," <https://steveblank.com/2016/02/23/the-mission-model-canvas-an-adapted-business-model-canvas-for-mission-driven-organizations/> ; Rita S.Y. Berry, "Collective data by in-depth interviewing," Paper presented at the British Educational Research Association Annual Conference, University of Sussex at Brighton, September 2 - 5 1999, <https://ecommons.ucsc.edu/x/cScCMe>

Additional reading

Eric G. Olson, "Creating an enterprise-level 'green' strategy," *Journal of Business Strategy* 29, #2 (2008): 22-30, <https://ecommons.ucsc.edu/x/xYzH7F>; Glenn Bachman, "Attributes of a green enterprise," RI Business Plan Competition, 2010, <https://ecommons.ucsc.edu/x/nCplRH>; Warwick University, "Project planning & management e-guide," <http://www2.warwick.ac.uk/services/ldc/resource/eguides/projectplan> Iowa State University, "Feasibility study," <https://ecommons.ucsc.edu/x/1L9aud>

Assignment #4 (see detailed prompt at: <https://ecommons.ucsc.edu/x/ob5eeY>). You are being asked to fill in the BMC for your project and conduct interviews with no fewer than five clients/audience members for your project (these should not be people whom you have previously interviewed).

Week 5: Numbers and values in sustainability

Meeting #1: Counting things that count, rather than things that can be counted

Required reading:

IPCC, “Risks of Climate Change,” <https://ecommons.ucsc.edu/x/INIFkN> ;
“Introduction to Statistics,” <https://ecommons.ucsc.edu/x/CQ6sgB> ;
“Qualitative Risk Analysis,”
http://www.cin.ufpe.br/~if717/Pmbok2000/pmbok_v2/wbs_11.3.html ;
Severity, Exposure & Probability (SEP) Risk Assessment Model,
<https://ecommons.ucsc.edu/x/xOzKLZ>; “Statistical Reasoning,”
<https://ecommons.ucsc.edu/x/cba0MT>

Additional resources:

“Identifying Hazards & Communicating Risks,”
<http://phprimer.afmc.ca/Part3-PracticeImprovingHealth/Chapter10IdentifyingHazardsAndCommunicatingRisks> ; *Statistics for Dummies*,
<https://ecommons.ucsc.edu/x/Mxzfn5> ; SCOPE, “Environmental Risk,”
<https://ecommons.ucsc.edu/x/ln7OOV> ; “Risk Identification,”
http://www.cin.ufpe.br/~if717/Pmbok2000/pmbok_v2/wbs_11.2.html

Meeting #2: What is sustainability worth? How much does it cost?

Required readings:

Marlies Wierenga, “Brief Introduction to Ecological Economics”
<https://ecommons.ucsc.edu/x/dPNtzf> ; Erik Gómez-Baggethun & David Barton, “Classifying and valuing ecosystem services for urban planning,” *Ecological Economics* 86 (2013) 235-245,
<https://ecommons.ucsc.edu/x/v3lpZW> ; “Externalities: Problems & Solutions,”
<http://www.macmillanhighered.com/Catalog/WorkArea/DownloadAsset.aspx?id=4037>
Discounting the Future,
<http://www.ejolt.org/2013/01/discounting-the-future/> ;

Additional resources:

Stefan Baumgärtner & Martin Quass, “What is sustainability economics?” *Ecological Economics* 69 (2010) 445-45; Herman E. Daly & Joshua Farley, *Ecological Economics—Principles and Applications* (Washington, DC: Island Press, 2004), <https://ecommons.ucsc.edu/x/YFSVNv> ; Calculating Present Value, <http://www.investopedia.com/calculator/pvcal.aspx> ; “How to prepare an amortization schedule in Excel,”
<http://www.wikihow.com/Prepare-Amortization-Schedule-in-Excel> ; “ECON 101: Negative Externality,”
<http://www.env-econ.net/negative-externality.html>

Assignment #5: (see prompt at <https://ecommons.ucsc.edu/x/L5264i>):
UCSC has decided to install solar PV carports on site. The campus has the choice of either paying for the system itself or arranging a leasing-

management system for which it would pay a fixed price for power. The University has signed an agreement with PG&E not to dump any excess electricity into the utility grid, but it is also committed to carbon neutrality by 2025. UCSC consumes about 55 million kWh per year and has a peak power demand of 5 kW. It also has its own cogeneration plant using a natural gas-fired turbine that needs to be operated in parallel with a solar system (for information, see

<http://mediafiles.ucsc.edu/ppc/OtherEnvdocs/Cogen/cogenfinalis.pdf>).

The cogen plant is also not allowed to feed electricity into the PG&E system. What is the optimal size for the solar installation? How much will power cost from the solar system? Does it make more sense to install the system or purchase carbon dioxide offsets? What would you recommend that UCSC do?

Week 6: Projects & Analyses redux

Meeting #1: Your sustainability project revisited

Required reading:

Kristal Johnson, "The Needs Assessment: Making the Connection between Data and the Nonprofit Story," *Journal of the Grant Professionals Association* 12, #1 (Fall 2014): 44-50, <https://ecommons.ucsc.edu/x/PF0OKx>; Healthy Teen Network, "Best Practices for Community Engagement: Tip Sheet," 2011, <https://ecommons.ucsc.edu/x/aPA8nT>; You may find useful information and videos at: <https://vimeo.com/groups/204136>

Additional resources:

International Training Center, "Project Design Manual--A Step-by-Step Tool to Support the Development of Cooperatives and Other Forms of Self-Help Organization," ILO, 2010, <https://ecommons.ucsc.edu/x/TFHHqY>
Aalborg University, "Handbook of Project Writing," 2005, <https://ecommons.ucsc.edu/x/8Uscnf>; US AID, "The Entrepreneurship Toolkit," Sept. 2011, <https://ecommons.ucsc.edu/x/GvDhjS>; Green for All, "The Green Business Plan Guide," n.d., <https://ecommons.ucsc.edu/x/IMKFwp>

Meeting #2: Your policy analysis paper revisited

Required reading:

Luciana Herman, "Tips for Writing Policy Papers," SLS, 2013, <https://ecommons.ucsc.edu/x/q6jJxT>; Florence Morestin, "A Framework for Analyzing Public Policies: Practical Guide," National Collaborating Centre for Healthy Public Policy, Quebec, Sept. 2012, <https://ecommons.ucsc.edu/x/fm8kRo>; Carl V. Patton and David S. Sawicki, "Basic Methods of Policy Analysis and Planning," <https://ecommons.ucsc.edu/x/EnLwuB>

Additional resources:

Emery Roe, " *Policy Analysis and Formulation for Sustainable Livelihoods*,"
New York: United Nations Development Programme, 1998,
<https://ecommons.ucsc.edu/x/5RGc7K>.

Assignment #6: For this assignment, you need to interview at least five more people who belong to or work for your potential partners (listed in the first box on the BMC). In these interviews, you need to determine whether the partner already provides some version of the good or service you proposed project is intended to deliver, or why the partner has not proceeded on this (for example, if your project is focused on composting food waste and you were to interview one of the people who works in Refuse & Recycling (<http://recycling.ucsc.edu/>), you would ask about what the campus currently does with food waste, what it plans to do in the future, how your project might fill a hole or need in existing programs, and whether R&R would be interested in working with you. **Note that this is not about identifying client segments or audiences; it is about not reinventing the wheel and determining whether and where your project can make a contribution.** You can find a partner interview template here (<https://ecommons.ucsc.edu/x/qFyOFv>). Please record (if possible) and transcribe, and upload your materials to your Drop Box.

Week 7: People & sustainability

Meeting #1: What is "social behavior" and why does it matter?

Required reading: Ronnie Lipschutz, Kevin Bell & Dominique De Wit, "Practicing Energy," <https://ecommons.ucsc.edu/x/VdjaFt> ; S. Higginson, E. McKenna & M. Thomson, "Can practice make perfect (models)? Incorporating social practice theory into quantitative energy demand models," Loughborough University Institutional Repository," 2014, at: <https://ecommons.ucsc.edu/x/WWoYjt>; Tim Jackson, "Motivating Sustainable Consumption: a review of evidence on consumer behavior and behavioural change," University of Surrey, Jan. 2005, pp. 19-98, at: <https://ecommons.ucsc.edu/x/9pvjJF>; Thomas Collins, "A Research Protocol for a Field Study of Behavior, Comfort, and Energy Consumption in Student Residence Halls," <https://ecommons.ucsc.edu/x/YtzcNZ> ; Karen Henwood, "Energy Biographies: Understanding the Dynamics of Energy Use for Demand Reduction," <https://ecommons.ucsc.edu/x/kmNJaV>; Martin Cames & Bettina Brohmann, "Options and potentials of energy diaries," <https://ecommons.ucsc.edu/x/7LAJRU>

Meeting #2: Applied environmental & social justice in sustainability

Required reading:

Assignment #7: By now, you should have a pretty good handle on your policy issue and have collected the materials necessary to write it. You can find useful guidelines to writing such papers in the readings above. A template for your paper's organization can be found on pp 7-9 of Luciana Herman, "Tips for

Writing Policy Papers," SLS, 2013, <https://ecommons.ucsc.edu/x/q6jJxT>. A draft paper of a minimum of 7 pages plus bibliography is due via email.

Week 8: Energy in the built environment

Meeting #1: What is energy, what does it do, how is it measured, how does it move through buildings?

Required Readings: Kostic, *Physics of Energy*, <https://ecommons.ucsc.edu/x/w0TAnS> ; Engineering Toolbox, *Heat Loss from Buildings*, <https://ecommons.ucsc.edu/x/cYLS5T>; Nordic Folkecenter, *Energy Efficiency of Buildings and Renewable Energy*, <https://ecommons.ucsc.edu/x/n07O9r>, pp. 9-26; Sustainability Site Assessment Handbook, <https://ecommons.ucsc.edu/x/3N9wik>; "Calculating energy loss from buildings," <https://ecommons.ucsc.edu/x/327f01>

Additional resources:

Brown, "Energy Accounting,"
Klaus, "Thermodynamics,"
Cengel, "Heat Transfer,"

Meeting #2: Working with design & modeling programs

Reading: National Renewable Energy Lab, "PVWatts calculator," at: <http://pvwatts.nrel.gov/index.php>; "Building design," at: <https://ecommons.ucsc.edu/x/LXMqnw>; "Heat Loss Calculation Worksheet," <https://ecommons.ucsc.edu/x/8titd5>; Colorado Governor's Energy Office, "Energy Modeling: A Guide for the Building Professional," at: <https://ecommons.ucsc.edu/x/9ntKVP>

There is no assignment for this week. Please work on your policy analysis paper and project interviews.

Week 9: Urban agriculture research design

Meeting #1: How much food?

Reading: Kathryn Colsanti, et al., "Growing Food in the City," CS Mott Group, at: <https://ecommons.ucsc.edu/x/G2r8Et>; Sam Wortman & Sarah Taylor Lovell, "Environmental Challenges Threatening the Growth of Urban Agriculture in the United States," *Journal of Environmental Quality*, Sept. 2013, at: <https://ecommons.ucsc.edu/x/am7Anh>; Composting Guru, <https://www.planetnatural.com/composting-101/>

Meeting #2: What do you need to find out?

Reading: Pam Peirce, *Golden Gate Gardening*, at: <https://ecommons.ucsc.edu/x/GvGFXH>; Mara Gittleman, et al., "Using Citizen Science to Quantify Community Garden Crop Yields," *Cities and the Environment* 5, #1, article 4 (8-21-2012), at: <https://ecommons.ucsc.edu/x/hiuiT0>; Hannah Koski, ed., "Guide to Urban

Farming in New York State,” Cornell Small Farms Program, 2012, at: <https://ecommons.ucsc.edu/x/f7UA5n> (skim this document); Steve Upson, “Permanent Raised Bed Gardening,” at: <http://www.noble.org/ag/horticulture/raised-bed-gardening/>

Assignment #8: Please be sure all of your interviews are uploaded to your Drop Box. Write a 500 summary of your findings and conclusions regarding the need or demand for your project.

Week 10: Water, water everywhere, but not a drop to...

Meeting 1: Hydrology & hydrogeology on campus

Reading: UCSC Campus hydrology, <https://ecommons.ucsc.edu/x/cgYYie>;

“Where does your water come from?”

<http://www.cityofsantacruz.com/departments/water/where-does-our-water-come-from>

“Campus Water Reuse Study,”

<https://ecommons.ucsc.edu/access/content/group/d743cc9d-d7d2-4955-9835-a8219feaff42/Week%2008%20-%20Water%20Resources%2C%20part%20I/CampusWaterReuseStudys.pdf>

Meeting 2: Graywater system design & precipitation capture

Reading:

Greywaterwateraction.org, “Residential Greywater Irrigation Systems in California, <https://ecommons.ucsc.edu/x/DnAF7D>; Drought Survival in Australia, <https://ecommons.ucsc.edu/x/2JBz2x>; “Campus Water Reuse Study,” <https://ecommons.ucsc.edu/x/Q0kjrj>

Reading: Texas A&M Agrilife Extension, “Rainwater Harvesting,” at: <http://rainwaterharvesting.tamu.edu/>; Russell Thomas, et al, “Rainwater Harvesting in the United States: a survey of common system practices,” *Journal of Cleaner Production* 75 (2014): 166-73, at: <https://ecommons.ucsc.edu/x/KIsBOP>

Final exam period: Students will give brief talks on projects and policy analysis papers.

Final Papers must be submitted via email by 6 PM on the Wednesday of Finals Week.