

CIVE 510 – INDUSTRIAL METABOLISM & GLOBAL ENVIRONMENTAL CHANGE**Term – Fall 2020 (202009)**

We acknowledge with respect the Lekwungen peoples on whose traditional territory the university stands and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

Instructor	Office Hours
Dr. Chris Kennedy	By appointment
Phone:	
E-mail: cakenned@uvic.ca	

List all prerequisites and co-requisites: None

LECTURE DATE(S)

Days: Friday	Time: 9.30 - 11.20 pm	Location: By ZOOM
--------------	-----------------------	-------------------

Reference Materials:

See course reading list at end.

COURSE OBJECTIVES:

This course explores the environmental impacts of industrial society in broad global terms, using study of energy and material flows to understand how engineering activities stress planetary boundaries. The impacts of population growth and technology on biodiversity loss, climate change and water stresses are first examined. The challenge of feeding a growing population while avoiding massive species extinction and loss of ecosystem services is discussed. The study of industrial metabolism and the method of material flow analysis are then used to link civil engineered products or systems (e.g., infrastructure, energy systems, water, materials, buildings, structures) to global environmental change. The course wraps up with discussion of resource decoupling and elective extended topics of critical metals, water-energy nexus, megacities and the circular economy.

LEARNING OUTCOMES: At the end of this course, students will be able to:

1. Read scientific literature in the topic area of industrial metabolism and communicate their level of comprehension orally and in written form.
2. Describe in quantitative and qualitative terms how energy and material flows associated with population growth, economic growth and technology translate into global environmental stresses
3. Research the connections between civil engineered products or systems (e.g., infrastructure, energy systems, water, materials, buildings, structures) and global environmental change.
4. Write a term paper to a format and standard of a conference proceeding.

Weight & Date(s) of Assessments:	Weight	Date
Key Reading Reports:	30%	weekly
Assignments (two)	20%	Due class 5 and class 8
Research proposal and presentation	10%	Class 6
Research paper	40%	Last day of term

Key Reading Report

At the start of class each week, submit a 1-page report on the key reading (marked by *) and be prepared to discuss it (and the other readings). The report should provide your reflections on the key reading as follows; describe:

- 3 central concepts/issues of the paper, with justification
- 2 things you don't understand, and why you don't understand them
- 1 question you would like to ask the author, that goes beyond the article

NOTE

Course Withdrawal Deadlines: <https://www.uvic.ca/calendar/dates/index.php>

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Graduate Calendar.

There will be no supplemental examination for this course.

Grading: Please see the Grading information in the current calendar at: <https://www.uvic.ca/calendar/future/grad/index.php#/policies>

Course policies and guidelines

Late Assignments: No late assignments will be accepted unless prior arrangements have been made with the instructor **at least 48 hours before** the assignment due date.

Coursework Mark Appeals: All marks must be appealed **within 7 days** of the mark being posted.

Attendance: We expect students attend all lectures and labs. It is entirely the students' responsibility to recover any information or announcements presented in lectures from which they were absent.

Electronic devices in labs and lectures: No unauthorized *audio* or *video* recording of lectures is permitted.

Electronic devices in midterms and exams: Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests *unless explicitly authorized*.

Plagiarism: Submitted work may be checked using plagiarism detection software. Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the link given below for the UVic policy on academic integrity. Note that the university policy includes the statement that "A largely or fully plagiarized assignment should result in a grade of F for the course."

Academic Integrity: You must make yourself aware of the University of Victoria guidelines and policy concerning fraud and academic integrity at this link, <https://www.uvic.ca/current-students/home/academics/academic-integrity/index.php>

Policy on Academic Integrity: <https://www.uvic.ca/calendar/future/grad/index.php#/policies>

Standards of Professional Behaviour: You are advised to read the Faculty of Engineering Document Standards for Professional Behaviour in current Graduate Calendar, which contains important information regarding conduct in courses, labs, and in the general use of facilities. Please find the document at this link: <https://www.uvic.ca/engineering/assets/docs/professional-behaviour.pdf>

Notes to Students:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Secretary to set up an appointment.

University of Victoria Privacy Policy: If any student has concerns about their private information being stored or accessed outside of Canada, they are required to inform the course instructor about their concerns before the end of second week of classes.

Accommodation of Religious Observance: See entry in current Graduate Calendar.

Equality: This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Centre for Accessible Learning located in the Campus Services Building, <https://www.uvic.ca/services/cal/>.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.

Sexualized Violence Prevention and Response at UVic: UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach by visiting www.uvic.ca/svp. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:

Where: Sexualized violence resource office in EQHR; Sedgewick C119

Phone: 250.721.8021

Email: svpcoordinator@uvic.ca

Web: www.uvic.ca/svp

Policy on Inclusivity and Diversity: See the entry in the current Graduate Calendar.

Course Lecture Notes

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

Syllabus statement

A note to remind you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone.

Counselling Services - *Counselling Services can help you make the most of your university experience. They offer free professional, confidential, inclusive support to currently registered UVic students.*

<https://www.uvic.ca/services/counselling/>

Health Services - *University Health Services (UHS) provides a full service primary health clinic for students, and coordinates healthy student and campus initiatives.* <http://www.uvic.ca/services/health/>

Centre for Accessible Learning - *The CAL staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations* <https://www.uvic.ca/services/cal/>. *The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.*

Elders' Voices - *The Office of Indigenous Academic and Community Engagement (IACE) has the privilege of assembling a group of Elders from local communities to guide students, staff, faculty and administration in Indigenous ways of knowing and being.*

<https://www.uvic.ca/services/indigenous/students/programming/elders/index.php>

The [Office of the Ombudsperson](#) is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.

Phone: 250-721-8357; Email: ombuddy@uvic.ca; Web: uvicombudsperson.ca.

Course Schedule & Readings

Week 1: Industrial Metabolism

* Ayres, R. U. (1994). Chapter 1 Industrial metabolism: Theory and policy, Chapter 1 in *Industrial Metabolism: Restructuring for sustainable development*, Ayres, R. U., & Simonis, U. E., ed. Available at <http://archive.unu.edu/unupress/unupbooks/80841e/80841E00.htm>

Fischer-Kowalski, M. (1998). Society's metabolism. *Journal of Industrial Ecology*, 2(1), 61-78.

Week 2: Planetary Boundaries

*Rockström et al (2009). A safe operating space for humanity, *Nature* 461, 472-475

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223), 1259855.

Running S.W. (2012) A Measurable Planetary Boundary for the Biosphere, *Science* 337, 1458-1459.

Week 3: Population & Technology

*Chertow, M. R. (2000). "The IPAT Equation and Its Variants". *Journal of Industrial Ecology*. 4 (4): 13–29

Erismann, J. W., Sutton, M. A., Galloway, J., Klimont, Z., & Winiwarter, W. (2008). How a century of ammonia synthesis changed the world. *Nature Geoscience*, 1(10), 636-639.

Week 4: Material Flow Analysis

*Bringezu S, Moriguchi Y. Material flow analysis. In: Ayres RU, Ayres LW, editors. *A Handbook of Industrial Ecology*. Cheltenham: Edward Elgar, 2002:79–90.

Cullen, J. M., Allwood, J. M., & Bambach, M. D. (2012). Mapping the global flow of steel: from steelmaking to end-use goods. *Environmental science & technology*, 46(24), 13048-13055.

Week 5: Circular Economy

*Haas, W., Krausmann, F., Wiedenhofer, D., & Heinz, M. (2015). How circular is the global economy?: An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. *Journal of Industrial Ecology*, 19(5), 765-777.

Cullen, J. M. (2017). Circular economy: theoretical benchmark or perpetual motion machine? *Journal of Industrial Ecology*, 21(3), 483-486.

Week 6: Biodiversity

*Tilman, D., & Clark, M. (2015). Food, Agriculture & the environment: Can we feed the world & save the Earth? *Daedalus*, 144(4), 8-23.

Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Biodiversity Synthesis*. World Resources Institute, Washington DC. (p. 1-24 only)

Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O., Swartz, B., Quental, T. B., ... & Mersey, B. (2011). Has the Earth's sixth mass extinction already arrived? *Nature*, 471(7336), 51-57.

Week 7: Environmentally Extended Input-Output Analysis

*Wiedmann, T., & Lenzen, M. (2018). Environmental and social footprints of international trade. *Nature Geoscience*, 11(5), 314-321.

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L., & Geschke, A. (2012). International trade drives biodiversity threats in developing nations. *Nature*, 486(7401), 109-112.

Peters, G. P., Weber, C. L., Guan, D., & Hubacek, K. (2007). China's growing CO2 emissions a race between increasing consumption and efficiency gains. *Environmental science & technology*, 41(17), 5939-5944.

Week 8: Energy & Climate Change

*Murphy, D.J., and C.A.S. Hall, Year in Review - EROI or energy return on (energy) invested, *Annals of the New York Academy of Science*, 1185, 102-118, 2010.

Gillingham, K., Kotchen, M.J., Rapson, D.S. and Wagner, G. (2013). Energy policy: The rebound effect is overplayed. *Nature*, 493(7433), pp.475-476.

IPCC, AR5 WG3, Chapter 7 Energy Systems 7.11.3

Week 9: Water

*Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., ... & Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, 467(7315), 555-561.

Hoekstra, A. Y., & Mekonnen, M. M. (2012). The water footprint of humanity. *Proceedings of the National Academy of Sciences*, 109(9), 3232-3237.

Heistermann, M. (2017). HESS Opinions: A planetary boundary on freshwater use is misleading. *Hydrology and Earth System Sciences*, 21(7), 3455-3461.

Week 10: Infrastructure

*Kennedy, C., & Corfee-Morlot, J. (2013). Past performance and future needs for low carbon climate resilient infrastructure—An investment perspective. *Energy Policy*, 59, 773-783.

Müller, D. B., Liu, G., Løvik, A. N., Modaresi, R., Pauliuk, S., Steinhoff, F. S., & Brattebø, H. (2013). Carbon emissions of infrastructure development. *Environmental Science & Technology*, 47(20), 11739-11746.

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, 28(12), 817-830.

Week 11: Materials & Construction

*Horvath, A. (2004). Construction materials and the environment. *Annu. Rev. Environ. Resour.*, 29, 181-204.

Graedel, T. E., Harper, E. M., Nassar, N. T., & Reck, B. K. (2015). On the materials basis of modern society. *Proceedings of the National Academy of Sciences*, 112(20), 6295-6300.

Weisz, H., Suh, S., & Graedel, T. E. (2015). Industrial Ecology: The role of manufactured capital in sustainability. *Proceedings of the National Academy of Sciences*, 112(20), 6260-6264.