

ENGINEERING 9614: Renewable Energy and Resource Conservation

Instructor	Dr. Cynthia Coles
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Communication *Is easiest in person right after class or by MUN email.*

COURSE DESCRIPTION:

Energy efficiency and conservation in the transportation sector, and renewable energy including wind, hydro, solar, geothermal, hydrogen, and biomass are studied. Problems related to wind turbine design, insolation reaching solar devices, and photovoltaic panel design are introduced.

PREREQUISITES: Engineering or Science undergraduate degree

SCHEDULE: LECTURE: Mon. & Wed., 2:00 -3:15 pm Room: EN 4035

CREDIT VALUE: 3 credits

RESOURCES:

TEXT BOOKS

- *Renewable Energy and Climate Change*, V. Quaschnig, Wiley, 2010 (TJ 808 Q36513 2010, Hard Copy on Reserve in QEI Library and Online Access available)
- *Energy Systems Engineering: Evaluation and Implementation*, F.M. Vanek, L.D. Albright, and L.T. Angenent, 3rd Edition, McGraw-Hill Education, 2016 (Online Access available)

REFERENCES - BOOKS

- *The Leap: How to Survive and Thrive in the Sustainable Economy*, 2011, C. Turner, Random House Canada (some energy related details, HC 79 E5 T84 2011)
- *Simon & Schuster Handbook for Writers*, Fourth Canadian Edition, 2005, L. Q. Troyka and D. Hesse, Prentice Hall (for help with your writing, PE 1408 T696 2006)
- *Field Guide for Science Writers: The Official Guide of the Nat. Assoc. of Science Writers*, 2005, D. Blum, M. Knudson and R.M. Henig, Oxford University, Press. (online)

- *Perlmutter, D.D., Rothstein, R.L., 2010, The Challenge of Climate Change: Which Way Now?, Wiley-Blackwell, p. 73, 91,*
- *Shrader-Frechette, K., 2011, What Will Work? Fighting Climate Change with Renewable Energy not Nuclear Power, Oxford University Press, QC 903 S57 2011*

REFERENCES – JOURNAL PAPERS (AND CONFERENCE PAPERS)

- *Abbott, D., 2011, Is Nuclear Power Globally Scalable, Proc. of IEEE, 99(10), 1611-1617*
- *Devabhaktuni, V., Alam, M., Depuru, S.S.S.R., et al., 2013, Solar energy: Trends and enabling technologies, Renewable and Sustainable Energy Reviews 19: 555–564*
- *Dominguez, R., Powers, S.E., Burken, J.G., Alvarez, P.J., 2009, The water footprint of biofuels,..., Environ. Sci. & Tech., 43(9):3005-3010.*
- *Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerber, J.S., Johnston, M. et al., 2011, "Solutions for a cultivated planet", Nature, Vol. 478:337-342.*
- *Fridleifsson, I.B., Bertani, R., et al., 2008, The possible role and contribution of geothermal energy to the mitigation of climate change, In: Hohmeyer, O. and Trittin, T. (Eds.) IPCC Scoping Meeting on Renewable Energy Sources, Luebeck, Germany, 20-25 Jan., p. 5.*
- *Fuchs, H., Hager, C., Firgo, H., Lamien-Meda, A., Zitterl, K., Franz, C., 2009, Identification of plant compounds in Lenzing fibers, Lenzinger Berichte, 87:117-123.*
- *Hanova, J., Dowlatabadi, H., 2007, GHG reduction through the use of ground source heat pump technology, Environmental Research Letters, 2, 044001, p.2.*
- *Herrando, M., Markides, C.N., Hellgardt, K., 2014, A UK-based assessment of hybrid PV and solar-thermal systems for domestic heating and power... Applied Energy 122:288–309*
- *Lior, N. 2008. Energy resources and use: The present situation and possible paths to the future, Energy, 33:842-857.*
- *Murphy, D.J., Hall, C.A.S., 2010, "Year in Review – EROI or Energy return on (energy) invested", Ecological Economics Reviews, 1185:102-118.*
- *Poudenx, P., Merida, W., 2007, "Energy demand and greenhouse gas emissions for urban passenger transportation versus availability of renewable energy...", Energy, 32(1):1-9.*
- *Reddy, V.S., Kaushik, S.C., Tyagi, S.K., 2013, "Exergetic analysis and performance evaluation of parabolic dish Stirling engine ...", International Journal of Energy Research, 37:1287–1301*
- *Sarbu, I., Sebarchievici, C., 2014, "General review of ground-source heat pump systems for heating and cooling of buildings", Energy and Buildings, 70:441-454.*
- *Self, S.J., Reddy, B.V., Rosen, M.A., 2013, "Geothermal heat pump systems: Status review and comparison with other heating options", Applied Energy, 101:341-348s*
- *Tait, J., 2011, "The ethics of biofuels", GBC Bioenergy, 3, 271-5.*
- *Yettou, F., Azoui, B., Malek, A., Gama, A., Panwar, N.L., 2014, "Solar cooker realizations in actual use: An overview", Renewable and Sustainable Energy Reviews, 37, 288-306*

REFERENCES - VIDEOS

- http://www.youtube.com/watch?v=CxmgyF5M_rw
- <http://www.cbc.ca/news/canada/newfoundland-labrador/cross-country-tesla-trailer-1.3750104>
- <http://www.theguardian.com/environment/2015/nov/04/the-future-is-here-mass-market-hydrogen-cars-take-to-britains-roads>
- <http://www.bbc.co.uk/news/business-19867229>

- <http://www.youtube.com/watch?v=-KteGf8oXMY>
- <http://www.bbc.com/news/av/world-europe-34498871/dutch-cyclists-have-longer-lives-say-researchers>
- <https://www.youtube.com/watch?v=HD-0QnUILOQ>
- <http://www.cbc.ca/news/canada/newfoundland-labrador/roadway-revolutions-roundabout-opens-at-the-st-john-s-airport-1.3790862>
- <http://www.bbc.com/news/world-latin-america-37157529>
- <http://www.cbc.ca/news/technology/clean-disruption-renewable-energy-canada-1.3470590>
- <https://www.youtube.com/watch?v=WPbTkd5oru0>
- <http://www.aiche.org/chenected/2014/08/new-bird-friendly-wind-turbines-come-california>
- <https://www.youtube.com/watch?v=EXxA-RkwuRY>
- <https://m.youtube.com/watch?v=84BeVq2Jm88> (construction stages)
- <http://www.youtube.com/watch?v=tPOivsKavQo> (offshore wind farms)
- <https://www.youtube.com/watch?v=qJr-KqupQrw> (Scotland offshore wind farm)
- http://www.youtube.com/watch?v=Z4joQSkQ1_M
- <http://www.darvill.clara.net/altenerg/tidal.htm>
- <https://www.youtube.com/watch?v=Px4avDpiTsM>
- <http://www.youtube.com/watch?v=90AcxxwoPu0> (wave power)
- <https://www.youtube.com/watch?v=HJiLWQnRMYI>
- <http://www.cbc.ca/news/canada/newfoundland-labrador/dawe-s-pond-man-uses-wind-solar-panels-to-power-home-1.2493049>
- <http://solarwall.com/en/products/solarwall-videos.php>
- <http://www.youtube.com/watch?v=C-EvV90MeDY> (demonstration solar tower)
- <http://www.theguardian.com/science/video/2011/feb/11/spain-solar-towers>
- <http://www.youtube.com/watch?v=Hd5ENIdJzOQ>
- <http://www.bbc.com/news/science-environment-38296251>
- <http://www.theguardian.com/environment/2015/nov/04/the-future-is-here-mass-market-hydrogen-cars-take-to-britains-roads>

REFERENCES - WEBSITES

- <https://www.theguardian.com/environment/2016/may/25/global-clean-energy-renewable-employment-rose-5-in-2015-figures-show>
- <https://www.theguardian.com/environment/2016/jun/01/renewable-energy-smashes-global-records-in-2015-report-shows>
- <http://sdq.iisd.org/news/solar-energy-projections-rise-for-2017/>
- <http://www.ren21.net/status-of-renewables/global-status-report/>
- https://en.wikipedia.org/wiki/Renewable_energy
- <https://www.theguardian.com/world/2016/dec/21/india-renewable-energy-paris-climate-summit-target>
- <https://www.theguardian.com/environment/2016/jun/01/make-building-standards-top-priority-for-tackling-climate-change-says-iea-chief>
- <https://www.theguardian.com/sustainable-business/2015/may/04/india-renewable-energy-population-density-pollution-environment>
- http://en.wikipedia.org/wiki/File:Brampton_Zum_1074b.JPG
- <https://www.theguardian.com/business/2017/feb/06/new-uk-car-sales-electric-vehicle-drives-12-year-sales-high>

- <http://www.cbc.ca/news/canada/newfoundland-labrador/roundabouts-for-prince-philip-1.4238060>
- <http://www.bbc.com/news/world-us-canada-31542317>
- <https://www.theguardian.com/environment/2016/may/25/un-expert-calls-for-tax-on-meat-production>
- <http://news.nationalgeographic.com/news/energy/2012/12/121211-sewage-heat-recovery/>
- http://www.unionegeotermica.it/What_is_geothermal_en.html
- <https://www.theguardian.com/environment/2016/feb/16/us-states-renewable-energy-green-economy>
- <https://www.theguardian.com/environment/2017/jun/26/hundreds-of-us-mayors-vow-not-to-wait-for-trump-on-clean-energy>
- <http://www.qwec.net/global-figures/wind-energy-global-status/>
- <http://www.windpowermonthly.com/10-biggest-turbines>
- <http://www.rddenengineering.com/ncwtc.shtml> (wind rose)
- http://www.engineeringtoolbox.com/density-air-d_680.html (air density)
- <http://www.theguardian.com/environment/2015/oct/09/africas-largest-windfarm-set-to-connect-remote-kenya-to-the-grid>
- <https://www.theguardian.com/environment/2015/jul/10/denmark-wind-windfarm-power-exceed-electricity-demand>
- <http://www.ossberger.de/cms/pt/hydro/ossberger-turbine/>
- <http://www.canadianconsultingengineer.com/features/storing-power-at-bella-coola/>
- <https://www.theguardian.com/environment/2015/aug/07/revolutionary-tidal-fence-set-to-trap-seas-power>
- <http://www.theguardian.com/environment/2015/aug/07/undamming-rivers-can-offer-a-new-source-for-clean-energy>
- <http://www.universetoday.com/129513/earth-at-aphelion/#>
- <https://www.geolounge.com/latitude-longitude/>
- [https://en.wikipedia.org/wiki/Air_mass_\(astronomy\)](https://en.wikipedia.org/wiki/Air_mass_(astronomy))
- http://www.ren21.net/wp-content/uploads/2016/06/GSR_2016_KeyFindings1.pdf
- <https://www.theguardian.com/environment/2016/oct/25/renewables-made-up-half-of-net-electricity-capacity-added-last-year>
- <http://www.bbc.com/news/business-37767250>
- <http://www.mrdowling.com/601-grid.html>
- <https://www.eia.gov/todayinenergy/detail.php?id=31452>
- <http://www.alternative-energy-tutorials.com/solar-power/pv-panel.html>
- http://solarcellcentral.com/cost_page.html
- <http://reneweconomy.com.au/citigroup-how-solar-module-prices-could-fall-to-25c-watt-41384/>
- <https://cleantechnica.com/2017/03/20/japanese-floating-solar-farm-helps-apple-push-100-renewable-energy/>
- <https://www.japantimes.co.jp/news/2017/06/11/asia-pacific/science-health-asia-pacific/floating-solar-farm-reflects-chinas-clean-energy-ambitions/#.Wa1sorKGN0w>
- http://www.teslamotors.com/en_AU/powerwall
- <http://www.cbc.ca/news/canada/new-brunswick/tesla-battery-nb-pilot-project-1.3783619>
- <https://www.theguardian.com/environment/2016/aug/05/adelaide-charges-ahead-with-worlds-largest-virtual-power-plant>

- <http://www.cbc.ca/news/technology/solar-power-trends-1.3763520>
- <https://www.theguardian.com/environment/2017/jan/12/solar-power-to-rise-from-chernobyls-nuclear-ashes>
- <http://www.sciencephoto.com/media/341232/enlarge>
- <http://www.sollab.eu/doctoralcolloquium6/>
- <http://www.theguardian.com/environment/2015/aug/24/south-african-team-may-have-solved-solar-puzzle-even-google-couldnt-crack>
- <http://www.bine.info/en/topics/renewable-energy-sources/others/news/direktverdampfung-fuer-effizientere-sonnenkraftwerke/>
- http://www.dlr.de/sf/en/desktopdefault.aspx/tabid-10436/12676_read-44506/
- <http://www.businessinsider.com/best-solar-power-countries-2016-3/#japan-23409-megawatts-8>
- <http://mozlo.com/platinum/residential/concentrated-photovoltaics/>
- <https://www.theguardian.com/environment/2016/feb/04/morocco-to-switch-on-first-phase-of-worlds-largest-solar-plant>
- <https://www.theguardian.com/environment/2015/may/13/could-this-be-the-worlds-most-efficient-solar-electricity-system>
- <http://www.futurity.org/geothermal-energy-iceland-979782/>
- <http://icelandmag.visir.is/article/nine-fascinating-facts-about-geothermal-energy-and-reykjavik>
- <http://www.nrstor.com/energy-storage-solutions/large-electricity-users/>
- <https://www.theguardian.com/world/2016/nov/15/climate-change-canada-fossil-fuel-subsidies-carbon-trudeau>

MAJOR TOPICS:

- Introduction, saving energy at home, in transportation, and by the consumer, becoming carbon free, nuclear energy synopsis, cogeneration plants, energy cascading, renewable energy potential
- Wind power, chargers and grid connected systems, horizontal axis wind turbines, onshore and off-shore wind farms, evaluating wind data, effect of hub height, estimating turbine output, analysing blade design (Chapter 13 from Vanek et al., 2016)
- Hydropower plants, types of water turbines, run-of-river plants, storage and pumped storage plants, tidal power and tidal fence, wave and ocean current plants, global development status, removal of old dams
- Availability of solar energy, geometric angles to locate the sun in terms of the geographic location, time of day, and time of year, estimating daily energy reaching an inclined solar device (Chapter 9 from Vanek et al., 2016)
- Photovoltaic energy, semiconductors, solar cells, PV cell losses, maximum power output, islanded and grid connected, design of small scale PV systems, design of large scale PV systems (Chapter 10 from Vanek et al., 2016)
- Solar thermal energy, absorbers and collectors, systems, supplying hot water, heating and cooling, solar cookers, small scale concentrated solar power plants introduction, corporate social responsibility example

- Large scale solar electric plants from solar thermal and solar photovoltaic systems, parabolic trough plants, tower plants, dish-Sterling plants, solar chimneys or updraft towers, concentrating photovoltaic plants, energy from photosynthesis
- Geothermal energy, capacity factors, types of power plants, costs, development, grid free energy, heat pumps, sources of heat, coefficient of performance
- Biomass heating, biofuels and controversy, hydrogen fuel cell technology

ASSESSMENT:

Term paper

Paper presentation

Class test

Two assignments in class

Final Exam (within exam period)

Last class

Site visit

Proposed Due Dates

30% Wed., Oct. 11th at 2:00 p.m.

15% Mon., Nov. 20th & Wed, Nov. 22nd

20% Wed. Oct. 25th

10% Mon., Sept. 25th and Mon., Nov. 6th

25% Wed., Dec. 6th to Fri., Dec. 15th

Wed., Nov. 29th

The two assignments will be on the journal papers listed below:

- 1) Advances in wind energy resource exploitation in urban environments: A review, Ishugah, T.F., Li, Y., Wang, R.Z., and Kiplagat, J.K., 2014, *Renewable and Sustainable Energy Reviews*, 37:613-626.
- 2) Review of passive PCM latent heat thermal energy storage systems towards buildings' energy efficiency, Soares, N., Costra, J.J., Gaspar, A.R., and Santos, P., 2013, *Energy and Buildings*, 59:82-103.

The final exam will have an open book numerical part with scientific calculators permitted and a closed book theory part. The paper is to be submitted as an electronic Word file and students must ensure images are printable.

Personal laptops and recording or other electronic devices should be turned off during class. One exception is cell phones which may be used to photograph images in the class notes.

ACADEMIC INTEGRITY AND PROFESSIONAL CONDUCT:

Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity and should consult Memorial University's Code of Student Conduct at <http://www.mun.ca/student/conduct/>

Any student found to commit an academic offence will be dealt with according to the practices as outlined by the School of Graduate Studies. The related calendar information is available at <http://www.mun.ca/regoff/calendar/sectionNo=GRAD-0029>

INCLUSION AND EQUITY:

Students who require physical or academic accommodations are encouraged to speak privately

to the instructor so that appropriate arrangements can be made to ensure full participation in the course. All conversations will remain confidential.

Diversity of viewpoints, values, and backgrounds can enrich the university experience. For insightful and comprehensive discussion among class participants there is an expectation that dialogue will be collegial and respectful across disciplinary, cultural, and personal boundaries.

STUDENT ASSISTANCE: Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at www.mun.ca/student.

The Writing Centre, at SN 2053, will assist students with their writing. To make an appointment refer to <http://www.mun.ca/writingcentre/>, call 864-3168 or email ennisd@mun.ca.

ADDITIONAL INFORMATION:

FALL 2017 SCHEDULE, Dr. C. A. Coles

TIME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
9:00					
9:50					
10:00					
10:50		ENGI 9601 10:30 – 11:45 am EN 4008		ENGI 9601 10:30 – 11:45 am EN 4008	
11:00					
11:50					
12:00		OFFICE HOUR 12:00 – 12:50 am EN 3004		OFFICE HOUR 12:00 – 12:50 am EN 3004	
12:50					
1:00					
1:50					
2:00	ENGI 9614 2:00 a.m. – 3:15 p.m. EN 4035		ENGI 9614 2:00 a.m. – 3:15 p.m. EN 4035		
2:50					
3:00					
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4:50					

Engi 9601: Environmental Pollution and Mitigation

Engi 9614: Renewable Energy and Resource Conservation