Columbia University School of Continuing Education
Master of Science in Sustainability Management

SUMA KTBD Sustainability Technology and the Evolution of Smart Cities
Summer Session X: Thursdays 6:10-8:00 PM
3 Credits

Instructor: Gregory Falco, Adjunct Professor, gjf2108@columbia.edu, cell: 917-494-1053

Office Hours: By appointment or as indicated in class
Response Policy: Students can expect a response to email within 24 hours. Alternatively, if urgent, students may text me at the above number with a quick question or to request a call and I will respond upon checking my phone.

Course Overview

Lyft, Nest, Bloom Boxes, Octopus Cards, Zinc-Air Grid Storage, Modlets and CityNext; therein lies the future of sustainability.

This is sustainability technology.

The progress of sustainability in recent years has largely been a result of the development and implementation of smart, sustainable technology solutions. This course examines opportunities to drive sustainability through technology applications where students will develop the skills to piece together a sustainable, smart city. The definition of smart cities is still being defined today, but its essence entails a network of data-enabled, connected technologies that work together to provide operational efficiency for its stakeholders. The course will prepare you to participate in evolving this dynamic field thereby accelerating the enablement of sustainability across organizations.

Companies and cities are increasingly turning to technology to fulfill their sustainability goals considering many technologies provide off-the-shelf, cost-effective and immediate savings compared to operationally invasive, resource-heavy sustainability transformation programs. Sustainability technology ranges from intelligent infrastructure in modern cities to mobile applications that enable the "sharing economy" and also facilitate energy access in remote regions of East Africa. This course will not only concern "first-world" problems; we will explore the transformative solutions currently driving growth in emerging markets and the developing world.

Successful sustainability practitioners must not only have a strong understanding of the values and methodologies of sustainable operations, but also the tools and technologies available to implement sustainability programs throughout their organization. Students will also investigate the limits to technology as a solution to sustainability problems. Identifying these limits and adjusting sustainability programs to accommodate these limits will be explored on both a practical and theoretical level.

Capabilities required for this course include critical thinking, problem-solving skills under time-pressure, and the ability to navigate ambiguity. Assessments will involve a reliance on systems thinking and the application of frameworks learned in class to solve problems. Students should come prepared with a basic understanding of sensors, big data, cloud computing, analytics and mobility tools/apps. Systems engineering principles will be addressed in this class; however there are no pre-requisites beyond an interest in learning and leaving your academic comfort zone.

Throughout this course, students will become familiar with the sustainability technologies that large organizations are actively pursuing to solve environmental problems and learn to leverage their skillset to drive organizational change with these technologies. Students will grow to value the importance of project management and integration strategies that drive sustainability technology success. Additionally, students will value sustainable systems thinking and have a new perspective of how tools and technologies can be used to enable a smart, sustainable city.

Upon completion of this class, students will possess a sufficient level of understanding to discuss sustainability technology solutions and relevant case studies with potential employers. This course will benefit anyone interested

in a career in sustainability, global development or in smart cities as it will provide them the skills and analytical capabilities to analyze which sustainability technologies are a good fit for their company's sustainability and growth strategy.

Learning Objectives

Considering individual sustainability technologies are transient in nature, the goal is not necessarily to learn about every technology on the market. The course's objective is to provide students a new level of comfort evaluating, working with and thinking about technology and the role it has in a sustainability program. By the end of the course, students will be able to:

1. build the skills to assess sustainability problems and evaluate the opportunity for technology applications
2. develop skills needed for systems thinking.
3. identify "snake oil" sustainability technologies
4. identify the different spectrums of sustainability technology including: mobile applications, dashboards, analytics engines, hardware and services (i.e. SaaS)
5. develop technology vocabulary and be able to speak intelligently about various tools and platforms
6. manage the challenges associated with technology implementation across an organization
7. establish fluency in technology systems and applications to develop a comprehensive vision for a Smart City
8. define the limits to technology for solving sustainability problems
9. evaluate the feasibility not only to purchase, but also to implement technology successfully
10. analyze problems using the People, Process, Technology framework
11. evaluate the feasibility of success of sustainability technologies based on varying cultural settings (the US vs the Netherlands, first-world countries versus emerging markets, etc.)
12. construct a smart city by merging the concepts of sustainability and technology.

Readings

Alawadhi, S., & Scholl, H. (2013). *Aspirations and Realizations: The Smart City of Seattle* (1st ed.). Seattle: 2013 46th Hawaii International Conference on System Sciences. *(Article)* Retrieved from http://www.computer.org/csdl/proceedings/hicss/2013/4892/00/4892b695.pdf

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Falco, G., Kofmehl, A., Levine, A., & Schmidt, K. (2011). *Energy-Smart Buildings* (1st ed.). Lawrence Berkeley National Labs, Accenture, Microsoft. *(Article)* Retrieved from http://download.microsoft.com/download/4/8/8/4885BBB9-2675-42CB-9CF2-F11B69C3C2FB/energy-smart-buildings-whitepaper-1.pdf
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Hannonarmstrong.com,. (2015). *Energy Efficiency*. *(Reference Cite)* Retrieved from http://www.hannonarmstrong.com/index.php?option=com_content&view=article&id=56&Itemid=92
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Intel,. (2015). *Green Cities: San Jose implements Intel IoT solutions*. *(Article)* Retrieved from http://www.intel.com/content/www/us/en/internet-of-things/videos/smart-city-san-jose-video.html
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Luken, R., & Van Rompaey, F. (2007). *Drivers for and barriers to environmentally sound technology adoption by manufacturing plants in nine developing countries* (1st ed.). Vienna: Elsevier - The Journal of Cleaner Production. *(Article)* Retrieved from http://www.sciencedirect.com/science/article/pii/S0959652607002090
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MIT Technology Review,. (2015). *Why Elon Musk Wants to Launch a Space-Based Internet Service | MIT Technology Review*. *(Article)* Retrieved from http://www.technologyreview.com/news/534361/why-the-time-seems-right-for-a-space-based-internet-service/

Mitchel, B. (2013). *Smart Cities | Microsoft Brings Smart Buildings to Seattle | Built environment, Energy, Analytics, Data management, Examples and case studies*. *Smartcitiescouncil.com*. *(Article)* Retrieved from http://smartcitiescouncil.com/resources/microsoft-brings-smart-buildings-seattle

Oracle.com,. (2015). *Oracle's Smart City Platform Solution - Overview | Oracle*. *(Article)* Retrieved from http://www.oracle.com/us/industries/public-sector/national-local-government/city-platform/index.html

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Stop Paying for Support, Start Paying for Results. (2013) (1st ed.). D.C. *(Article)* Retrieved from http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Value-Based-Deals-POV-2012.pdf

The Verge,. (2014). *Facebook is building drones with lasers to bring internet to the world*. *(Article)* Retrieved from http://www.theverge.com/2014/3/27/5555060/facebook-plans-to-bring-world-online-with-fleet-of-solar-powered-drones

Resources

Columbia University Library

Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: http://library.columbia.edu/.

SCE Academic Resources

The Office of Student Life and Alumni Relations (SLAR) provides students with academic counseling and support services such as online tutoring and career coaching: http://ce.columbia.edu/student-life-and-alumni-relations/academic-resources .

Course Requirements (Assignments)

1. Class Participation: 10% of Grade

Each class will be highly participative and designed to maximize student engagement. Considering this, participation in class discussions will be a component of the grade and assessed through bi-weekly, 5 question multiple-choice quizzes that reflect on discussion material.

2. Online Discussion/ Case Study Evaluations (CSEs): 15% of Grade

An online discussion forum will be established through the class blog where students will be required to post and evaluate articles/case studies every other week concerning sustainability technology. A template will be provided for students to evaluate technologies based on frameworks learned in class. Grades will be assigned on a 5-point scale and earned by fulfilling each of the following steps: 1) finding a relevant, in-use technology, 2) connecting the technology to a sustainability problem, 3) identifying the technology stakeholders, 4) establish the process component of technology implementation and 5) comment on a fellow students' CSE. The goal at the end of the course will be to establish an online database/repository documenting existing sustainability technologies. This database will be available to students after the course ends and can be used as a resource and asset for students' careers.

3. Tech Charrettes and Presentations: 40% of Grade

Throughout the semester, groups will be required to conduct 3-4 tech charrettes depending on class size. For tech charrettes, students will need to use skills developed in class to source a technology and establish an implementation plan for the respective technology that solves a particular problem for their organization. Class will begin each week with a presentation of those who developed a tech charrette for their organization. To ensure all students have an equal role in the tech charrettes throughout the semester, the group presenter and team lead will rotate for each assignment.

4. Smart City Hack-A-Thon and Final Presentation: 35% of Grade

Student groups will be tasked with developing a strategy for an intelligent city using available sustainability technology. Leveraging frameworks from class and incorporating skills developed from the tech charrettes, student teams will need to establish an ecosystem of sustainability technology services for a city, quantify the sustainability impact, assess the cost, and establish an implementation program. Students will be encouraged to develop their own sustainability applications from existing technology which is often what is required in cash-strapped businesses wishing to drive sustainability "boot-strap" style. The smart cities will be published online as a reference for both industry and academia. The teams will present their case studies to the class at the end of the semester.

Evaluation/Grading

The tech charrettes, the hack-a-thon report and their respective presentations will be evaluated on a 100 point scale using a grading rubric that will be provided in class. A grading rubric will be provided on reports as well as on presentations. Any score with a 9 in the ones place will be rounded up – no one likes getting 89s. Class participation and the CSEs will be evaluated on a 5 point scale where 5 = 100, 4 = 90, etc. After weighting and combining the scores on the 100 point scale, a final score will be translated to a letter grade.

The final score will comprise of the following:
Participation = 10%
CSEs = 15%
Tech Charrette Reports = 20%
Tech Charrette Presentations = 20%
Smart City Hack-A-Thon Report = 15%
Smart City Hack-A-Thon Presentation = 20%

Course Policies

Participation
Without your engagement, the course will not be as effective as intended, therefore it is of the utmost importance everyone comes with a perspective. You are expected to do all assigned readings, attend all class sessions, and engage with others in online discussions. Your participation will require that you answer questions, defend your point of view, and challenge the point of view of others. If you need to miss a class for any reason, please discuss the absence with me in advance. All students will have at least 1 checkpoint with me throughout the semester so that feedback on participation can be provided verbally.

Late work
In many ways, this class will be conducted similarly to a consulting engagement. If you are late sending something to a client, the client will either figuratively tear apart your work, or not read it at all. In other words, late work should be avoided at all times. If an extension is needed, please set expectations appropriately and be reasonable with your request.

Course Schedule/Course Calendar

Date	Topics and Activities	Readings (due on this day)	Assignments
5/28	Course Overview: • Course introduction, requirements and objectives for the class • Overview of sustainability technology and smart cities • Real-time tech charrette • Case study overview: The Smart City of Seattle	RECOMMENDED: • Alawadhi, S., & Scholl, H. (2013). Aspirations and Realizations: The Smart City of Seattle (1st ed.). Seattle: 2013 46th Hawaii International Conference on System Sciences. Retrieved from http://www.computer.org/csdl/proceedings/hicss/2013/4892/00/4892b695.pdf (9 pages) • Mitchel, B. (2013). Smart Cities | Microsoft Brings Smart Buildings to Seattle | Built environment, Energy, Analytics, Data management, Examples and case studies. Smartcitiescouncil.com. Retrieved from http://smartcitiescouncil.com/resources/microsoft-brings-smart-buildings-seattle (2 pages)	
6/4	The Basics: • Sustainability technology - what's out there? • People, Process, Technology - when is technology the solution? • Smart Cities - what's all the hype and what does this mean? • Class discussion on current readings	REQUIRED READING: • IBM,. (2015). *IBM - Smarter Cities case studies - United States*. Retrieved from http://www.ibm.com/smarterplanet/us/en/smarter_cities/article/smarter_cities_case_studies.html (4 pages, 4 videos) • Singapore Government: Safe City Test Bed. (2014) (1st ed.). Singapore. Retrieved from http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Singapore-Government-Safe-City-Test-Bed.pdf (2 pages)	
6/11	Technologies You Should Know: • Hardware - what types of hardware will I be dealing with in sustainability management? • Software - when is software the right solution to my problem and what is popular? • Data Analytics & Platforms - slicing through the jargon; what's a platform?	REQUIRED READING: • Bartels, W. (2012). Sustainability Reporting Systems (1st ed.). KPMG. Retrieved from https://www.kpmg.com/DE/de/Documents/Sustainability-Reporting-Systems-2012-kpmg.pdf (21 Pages) RECOMMENDED: • Intel,. (2015). Green Cities: San Jose implements Intel IoT solutions. Retrieved from http://www.intel.com/content/www/us/en/internet-of-things/videos/smart-city-san-jose-video.html (video) • Microsoft.com,. (2015). Microsoft CityNext Solutions, Partners, Devices, & Events. Retrieved from http://www.microsoft.com/en-us/citynext/default.aspx#fbid=YLTeTyeAJ2c • Oracle.com,. (2015). Oracle's Smart City Platform Solution - Overview | Oracle. Retrieved from http://www.oracle.com/us/industries/public-sector/national-local-government/city-	• Case Study Evaluation

		platform/index.html	
6/18	Dollars and Cents: • Developing business cases for technology - what goes into my business case? • Technology financing models - what are my options for how to pay for this stuff? • Tech charrette presentation • Class discussion on current readings	REQUIRED READING: • Dyllick, T., & Hockerts, K. (2002). Beyond the Business Case for Corporate Sustainability (1st ed., pp. 130-141). John Wiley & Sons. Retrieved from http://instruct.uwo.ca/business/bus020-mwf/acs410/reading14.pdf • Stop Paying for Support, Start Paying for Results. (2013) (1st ed.). D.C. Retrieved from http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Value-Based-Deals-POV-2012.pdf (2 pages) RECOMMENDED: • Hannonarmstrong.com,. (2015). Energy Efficiency. Retrieved from http://www.hannonarmstrong.com/index.php?option=com_content&view=article&id=56&Itemid=92	• Tech Charrette Presentation • Tech Charrette Write-Up • Case Study Evaluation
6/25	Technology Implementation & Program Management: • Implementation nightmares - now that I own the technology, what do I do with it? • Program management - unnecessary cost, or absolute necessity? • Tech charrette presentation • Class discussion on current readings	REQUIRED READING: • Epstein, M., & Buhovac, A. (2010). Solving the sustainability implementation challenge (1st ed.). Solving the sustainability implementation challenge. Retrieved from http://www.sciencedirect.com/science/article/pii/S0090261610000574 (11 Pages) RECOMMENDED: • Figliola, P., & Fischer, E. (2015). Overview and Issues for Implementation of the Federal Cloud Computing Initiative: Implications for Federal Information Technology Reform Management (1st ed., pp. 20-21). Washington DC: Congressional Research Service. Retrieved from https://www.fas.org/sgp/crs/misc/R42887.pdf • Dai, C., & Wells, W. (2004). An exploration of project management office features and their relationship to project performance (1st ed., pp. 523-532). International Journal of Project Management. Retrieved from http://www.sciencedirect.com/science/article/pii/S0263786304000377#	• Tech Charrette Presentation • Tech Charrette Write-Up • Case Study Evaluation
7/2	The Internet of Things (IoT): • Connected everything - why IoT is more than just a media buzz word • Sustainability IoT Implications - how sustainability will evolve with the IoT • Tech charrette presentation	REQUIRED READING: • Daugherty, P., Banerjee, P., Negm, W., & Alter, A. (2014). Industrial Internet of Things (1st ed.). Accenture. Retrieved from http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Driving-Unconventional-Growth-through-IIoT.pdf (17 pages) • Hobsbawm, A. (2014). The internet of things: what role will humans play?. the Guardian. Retrieved from http://www.theguardian.com/media-	• Tech Charrette Presentation • Tech Charrette Write-Up • Case Study Evaluation

	• Class discussion on current readings	network/media-network-blog/2014/feb/06/internet-of-things-humans-smart (1 page)	
7/9	Barriers to and Limits of Sustainability Technology: • Technology Downfalls – how technology sometimes causes more problems than it solves • Technology Barriers – what are barriers to organizational adoption that cause headaches? • Tech charrette presentation • Class discussion on current readings	REQUIRED READING: • Confino, J. (2013). How technology has stopped evolution and is destroying the world. the Guardian. Retrieved from http://www.theguardian.com/sustainable-business/technology-stopped-evolution-destroying-world (2 pages) • Luken, R., & Van Rompaey, F. (2007). Drivers for and barriers to environmentally sound technology adoption by manufacturing plants in nine developing countries (1st ed.). Vienna: Elsevier - The Journal of Cleaner Production. Retrieved from http://www.sciencedirect.com/science/article/pii/S0959652607002090 (10 pages) • Hawkins, T., Singh, B., Majeau-Bettez, G., & Hammer Stromman, A. (2012). Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles (1st ed.). Journal of Industrial Ecology. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2012.00532.x/pdf (9 Pages)	• Tech Charrette Presentation • Tech Charrette Write-Up • Case Study Evaluation
7/16	Smart Infrastructure: • Smart Buildings - what makes it smart and what are the sustainability implications? • Smart Grid - how does the smart grid enable sustainability on regional scales? • Tech charrette presentation • Class discussion on current readings	REQUIRED READING: • Falco, G., Kofmehl, A., Levine, A., & Schmidt, K. (2011). Energy-Smart Buildings (1st ed.). Lawrence Berkeley National Labs, Accenture, Microsoft. Retrieved from http://download.microsoft.com/download/4/8/8/4885BBB9-2675-42CB-9CF2-F11B69C3C2FB/energy-smart-buildings-whitepaper-1.pdf (20 pages) • Gungor, V., Sahin, D., Kocak, T., Ergiit, S., Buccella, C., Cecati, C., & Hancke, G. (2011). Smart Grid Technologies: Communication Technologies and Standards (1st ed.). Retrieved from http://repository.up.ac.za/bitstream/handle/2263/18406/Gungor_Smart(2011).pdf?sequence=1 (9 pages)	• Tech Charrette Presentation • Tech Charrette Write-Up • Case Study Evaluation
7/23	Technology & the Developing World: • Mini-grids and the transformation of energy markets • Cell Phones – how mobile networks have transformed developing countries	REQUIRED READING: • Kirk, M., Steele, J., Delbe, C., Crow, L., Keeble, J., & Fricke, C. et al. (2011). Connected Agriculture (1st ed.). London: Vodafone Group Plc. Retrieved from http://www.vodafone.com/content/dam/vodafone/about/sustainability/2011/pdf/connected_agriculture.pdf (32 pages) • *Chapter 1 ONLY* - Mansell, R., & Wehn de	• Tech Charrette Presentation • Tech Charrette Write-Up • Case Study Evaluation

	• Tech charrette presentation • Class discussion on current readings	Montalvo, U. (1998). Knowledge societies. Oxford: Published for and on behalf of the United Nations by Oxford University Press. Retrieved from http://books.google.com/books?id=zAwMVDmeQUcC&pg=PA6&source=gbs_toc_r&cad=4#v=onepage&q&f=false (16 pages)	
7/30	How to Be a City Hacker: • No Funding - No Problem - how to get the sustainability tech you need without paying • Class discussion on current readings • Overview of Final Project • Student group meetings	REQUIRED READING: • Falco, G., & McNamara, R. (2014). Climate Resilience Goes Digital (1st ed.). New York City: Accenture. Retrieved from http://www.accenture.com/SiteCollectionDocuments/Strategy/accenture-climate-resilience-digital-strategies-manage-risk.pdf (16 pages)	• Case Study Evaluation
8/6	How to Change the World Using Technology: • Thinking Ahead - Google and Facebook don't have to be the only ones thinking about technology in emerging countries and its impact on sustainability • Technology Development – biomimicry and other tech-design strategies • Real-time tech charrette • Student group meetings	REQUIRED READING: • The Verge,. (2014). Facebook is building drones with lasers to bring internet to the world. Retrieved from http://www.theverge.com/2014/3/27/5555060/facebook-plans-to-bring-world-online-with-fleet-of-solar-powered-drones (1 page) • MIT Technology Review,. (2015). Why Elon Musk Wants to Launch a Space-Based Internet Service | MIT Technology Review. Retrieved from http://www.technologyreview.com/news/534361/why-the-time-seems-right-for-a-space-based-internet-service/ (1 page)	• Smart City Hack Group Progress Report
8/13	Class Wrap Up: • Final class discussion • Course evaluations • Smart City Hack-A-Thon Presentations	N/A	• Smart City Hack-A-Thon Written Report Due • Smart City Hack-A-Thon Presentations

School Policies

Copyright Policy

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Academic Integrity

Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SCE holds each member of its community responsible for understanding and abiding by the SCE Academic Integrity and Community Standards posted at http://ce.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.