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17th Annual

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2017 SyracuseCoE Symposium

Student Poster Competition Abstracts

Arranged by degree level

UNDERGRADUATE STUDENTS

1. Water Storage on the OnCenter Green Roof

Yang Hu, Cliff I. Davidson, Yige Yang
Syracuse University, Civil Engineering

Green roofs are known for their capacity to store stormwater runoff. In Summer 2011, a green roof with several species of sedum was installed as part of a roof retrofit at the Onondaga County Convention Center (the OnCenter). This green roof has 7.6 cm of growth medium over a waterproof membrane. The peak of the roof runs along the North-South centerline, with a -1% slope in the east and west directions. Drain conduits, which are essentially perforated pipes, run along the waterproof membrane at the bottom of the growth medium. Rainwater infiltrates these conduits and is channeled to the roof drains at the east and west sides of the roof. The goal of this experiment is to characterize the water flow through this green roof using data on the water content of the growth medium ("soil moisture") and water flow through the roof drains. To record the soil moisture data, 5 Campbell Scientific Water Content Reflectometers (CS616) have been installed in the growth medium. Two of the sensors are installed on either side of a drain conduit. Data from these two sensors can provide information on water flow through the drain. By analyzing data from different intensities of rainstorms, the performance of the green roof can be evaluated. Data from the sensors will not only diagnose problems associated with the current green roof, but will also assist green roof modeling to contribute to existing green roof maintenance and future green roof design.

2. Analysis of Rainwater Runoff from Green Roofs

Kimberly Fitzgerald, Dr. Cliff I. Davidson, Alex Johnson
Syracuse University, Environmental Engineering Bachelor's Degree

During dry weather, pollutants will settle on surfaces such as the roofs of buildings. The rain that follows will wash the pollutants off the buildings, which can affect the surrounding environment and sewer system. Rainwater runoff samples were collected from the water that broke through the green roof during a rain event. During this time, multiple precipitation samples were also collected. All samples were analyzed using the ion chromatograph, which measured sulfate and nitrate concentrations. Additionally, green roofs can help with the reduction and management of rainwater runoff, especially in cities, which have many impermeable surfaces. It is also likely that the growth medium of the green roof affects the chemical content of the runoff by either filtering out or adding different pollutants. Samples taken from the green roof were analyzed and the resulting data were compared to samples from fresh precipitation. The green roof was shown to filter nitrate from the runoff while contributing sulfate. This information can be used both to make improvements on the growth medium

and in future analysis on the effect of dry deposition on urban infrastructure.

3. Adaptive Reuse Shenzhen

Peder Ulven, Alice Gorodetsky, Khairi Reynolds with Prof. Fei Wang
Syracuse University, Architecture

From its origin, the urban village was developed as an affordable residential oasis amongst rampant speculative development. As the market generated a huge demand for housing, the urbanization of Nantou meant the displacement of the original uses of the land, its economies, and its culture. The new urban typology, which used to almost exclusively provide housing, has now evolved to offer a wide variety of rudimentary commercial services: from florists, butchers, restaurants, barbershops, etc. Even though the urban village has been praised for its self-sustained economy, one of the aspects in which it falls short is tied directly to its rural past€”the production of food. This project aims to reinstate farming as symbol of the cultural heritage of Nantou, and as novel economic driver for the urban village.

The main aim of the project is to promote the notion of coexistence: old and new, organic and manmade, and economy and culture in order to balance the needs of a rapidly growing population. The renovation reuses the existing concrete structure as a framework for the new pixelated building volumes. Not only does this project attempt to illustrate the historical collision between the village and its rapid urban development, but to showcase agriculture as a timeless mediator between the two. The volumes are placed according to the grid of the existing structure and optimized for maximum daily southern sun exposure. The center atrium is carved to introduce passive natural ventilation and passive cooling. The pixelated volumes contain different programs such as community gardening classes, food education, cooking classes, food market, restaurant and outdoor terraces and platforms ideal for urban farming in practice. This project bridges the gap amongst heightened cultural, educational, and economic factors as the urban village typology looks towards the future

4. Heat Mapping Drones

Alice Gorodetsky, Amanda Liberty, Burak Kakillioglu, Tarek Rakha, Senem Velipasalar
Syracuse University, Architecture

Unmanned Aerial Systems (UAS a.k.a. drones) have evolved over the past decade as both advanced military technology and off-the-shelf consumer devices. There is a gradual shift towards public use of drones, which presents opportunities for effective remote procedures that can disrupt a variety of built environment disciplines. UAS equipment with remote sensing gear present an opportunity for analysis and inspection of existing building stocks, where architects, engineers, building energy auditors as well as owners can document building performance, visualize heat transfer using infrared imaging and create digital models using 3D photogrammetry. This poster

presents a standard procedures for operating a UAS for energy audit missions. The presented framework is then tested on a university campus site based on the literature review to showcase: 1) pre-flight inspection procedure parameters and methodologies; 2) during-flight visually identified areas of thermal anomalies using a UAS equipped with Infrared (IR) cameras and; 3) 3D CAD modeling developed through data gathered using UAS. A discussion of the findings suggests refining procedure accuracy through further empirical experimentation, as well as study replication, as a step towards standardizing the automation of building envelope inspection.

5. Orange Goes Green: Teaching Energy Ideals

Josh Hintz, Emily Bartos, Julia Jesse, Alexandria McDonnell
Syracuse University, Engineering Management

Energy savings projects are most commonly found to be invested in industrial settings, however residential and commercial settings can also benefit from these efforts as well. The goal of this project was to search for general areas where K-12 schools can reduce their energy consumption. This was done by searching for both opportunities for the schools to invest in simple energy savings projects and to promote energy savings practices to the student body and faculty. The team took a tour of Corcoran High School, located in Syracuse, NY, and conducted an energy audit. During the energy audit, the areas that were noted where energy savings could be made were areas in which the team suggests all New York State K-12 schools could benefit. The areas the team focused on were the energy consumption for lighting and heating the building. On top of conducting the energy audit, the team decided to speak with upper classmen at Corcoran High School to promote the importance of having an energy conscious attitude. The team also provided the students with information on career fields in which energy efficiency, sustainability, and environmental conservation are focused, as well as provided information on the work conducted by the Syracuse University Industrial Assessment Center, and feedback from the energy assessment of the high school. A survey was taken at the end of the class discussion to identify how much of the information was new to the students, how many students were already interested in energy and sustainability before the discussion, and how many students gained an interest after the discussion. With the budget provided to the team through this project, the team also hung up posters around the high school to further promote simple individual contributions that can be made on a daily basis to save energy for the school.

6. High Capacity Lithium Ion Batteries Composed of Cobalt Oxide Nanoparticle Anodes and Raman Spectroscopic Analysis of Nanoparticle Strain Dynamics in Batteries

Joshua Willson, Mohammad A. Islam, Mateusz Zuba, Vincent Debiase, Nicholas Noviasky, and Christopher J. Hawley
State University of New York at Oswego, Electrical and Computer Engineering

Cobalt nanoparticle thin films were electrophoretically deposited on copper current collectors and were annealed into thin films of hollow Co3O4 nanoparticles. These thin films were directly used as the anodes of lithium ion batteries without the addition of conducting carbons and bonding agents. Lithium ion batteries thus fabricated show high gravimetric capacities and long cycle lives. For approximately 1.0 Î¼m thick Co3O4 nanoparticle films the gravimetric capacities of the batteries were more than 800 mAh/g at a current rate of C/15 which is about 90% of the theoretical maximum. Additionally, the batteries were able to undergo 200 charge/discharge cycles at relatively fast rate of C/5 and maintain 50% of the initial capacitance. In order to understand the electrochemistry of lithiation in the context of nanoparticles, Raman spectra were collected at different stages of the electrode cycles to determine the chemical and structural changes in the nanomaterials. Our results indicate that initially the electrode nanoparticles are under significant strain and as the battery undergoes many cycles of charging/discharging the nanoparticles experience progressive strain relaxation.

7. Solid Oxide Fuel Cells Replacement of Catalytic Converter in Automotive Exhaust

Thomas Welles, Ryan J Milcarek, Jeongmin Ahn Ph.D.
Syracuse University, Aerospace Engineering

Replace the current catalytic converter and alternator system with a Solid Oxide Fuel Cell stack in the exhaust stream of an internal combustion engine. This will provide the necessary hydrocarbon and carbon monoxide scrubbing while generating sufficient electrical power for the vehicle. This system will utilize the hydrocarbons and carbon monoxide in the exhaust stream and the fresh air from the secondary air systems already in place to produce electrical power. This will increase the overall efficiency and fuel economy of all internal combustion engine vehicles.
The exhaust gases will then flow through the tubular anode of the fuel cell stack, while heated air is injected to the cathode side of the fuel cell stack. This creates a highly efficient, dual chambered design for the fuel cell stack in order to deliver larger power outputs. Electrical power will then be carried away from the fuel cell stack to provide electrical energy to the vehicle and charge the battery.
Recent work has shown that SOFCs in a comparable setup described above can operate with only limited amount of fuel. Electrical power can be achieved even without any optimization of the setup. The performance can be significantly improved by using fuel cell materials that are better suited to the temperatures expected in this setup. The data provides an initial proof of concept for operation in combustion exhaust with limited hydrocarbons and carbon monoxide in the exhaust.
Current automotive exhaust characterization work indicates a favorable environment for the operation of SOFC's. A multitude of hydrocarbons ranging from H2 up to un-burned gasoline have been found in the exhaust prior to a catalytic converter or any type of reforming system. Electrical power may be generated by consuming the

hydrocarbons present, while decreasing harmful emissions of automobiles.

8. Novel Solar Cells: the Inkjet Printed Nanocrystalline Inorganic Perovskite Films

Benjamin Swanson, Ian Evans, Andrew J. Yost F. Guzman, M. Shekhirev, N. Benker, S. Sikich, A. Enders, P. Dowben, A. Sinitskii, Carolina C. Ilie
SUNY Oswego, Physics

We discuss herein the halide based perovskite solar cells (HPSCs). This type of solar cells have low cost, impressive power conversion efficiency, and long carrier lifetimes and diffusion lengths, which are remarkable results. Unfortunately organic based HPSCs have a few drawbacks including being sensitive to heat, moisture, and radiation induced degradation. A novel approach is to use inorganic based HPSC materials, which bring a variety of advantages. CsPbBr3 quantum dot (QD) inks have been used in an inkjet printer to print photoactive-perovskite QD films. The current-voltage I(V) and capacitance-voltage C(V) transport measurements indicate that the photocarrier drift lifetime can exceed 10 milliseconds for the CsPbBr3 quantum dot printed perovskites films. The successful printing of photoactive-perovskite QD films of CsPbBr3, shifts the paradigm towards the rapid prototyping of various perovskite inks and multilayers as an optimal solar cell type of the future.

MASTER'S STUDENTS

9. Point Source Heat Pollution: A Study of the Effects of Artificially Channelized Inputs on Urban Stream Temperature

Samuel Caldwell, Christa Kelleher
Syracuse University, Earth Science

It has long been known that temperature in a stream varies in three dimensions: across the stream, down its flow path, and by depth in the channel. However, most studies of stream temperature use one-dimensional, point measurements to assess how stream temperature varies in space in time. While this can be helpful in many contexts, it does not provide a continuous assessment of temperature, and therefore may miss certain features or trends in space. For our study, we are examining stream temperature variation along urban streams in Syracuse, NY using a 6km stretch of Onondaga Creek in Syracuse, NY. We are in the process of instrumenting the reach and collecting data to understand (1) how much stream temperature varies longitudinally and (2) which characteristics affect the temperature along the stream such as percent of urbanization, riparian buffer, and stream orientation. Our goal is to understand if differences in stream temperature emerge across different flow states. Our broad goal is to improve understanding of urban stream temperature in central NY.

10. Linear Discriminant Analysis as a Regional Screening Tool to Fingerprint Sources of Chloride Contamination in Groundwater

Nathaniel Chien
Syracuse University, Earth Sciences

Concern over access to safe drinking-water supplies in areas that may be impacted by anthropogenic activities has led to an increasing number of baseline groundwater quality surveys intended to provide context for interpreting water quality data. Flexible screening tools that can parse through these large regional datasets to identify changes in water quality are becoming more important to effectively monitor water supplies. One such tool, developed from previous work by the authors, makes use of linear discriminant analysis (LDA) to identify the most probable source of chloride salinity in groundwater samples based on their geochemical fingerprints. By quantifying the most likely source of chloride salinity, the model provides users a way to assess the impacts of regional development in the context of changing geochemistry. For this work, we applied the LDA model to a dataset of shallow groundwater with known sources of contamination compiled from two studies of groundwater quality in Illinois: Panno et al., Illinois State Geol. Survey, Open File Series 2005-1 and Hwang et al., Environ. & Eng. Geosci., 11: 75-90 (2015). By predicting the source of salinity in groundwater samples for which sources of contamination are known, we validated model predictive-accuracy. Results show high classification accuracy (>80%) for groundwater samples impacted by formation brines or road salt, with diminishing success for samples impacted by organic waste. Posterior probabilities, a statistic inherent to LDA, provides a proxy for prediction confidence that enables the model to be used for assessment and accountability measures. LDA is complementary to fingerprinting using halogen ratios (e.g. Cl/Br) because it implicitly relies on halogen ratios for classification decisions while providing a clearer, more quantitative classification of contamination sources. Our model is ideal for regional assessment or initial screening of salinity sources in shallow groundwater because it makes use of commonly measured solute concentrations in publicly available water quality databases. The validation process highlighted here underscores the importance of testing newly proposed quantitative frameworks under realistic conditions.

11. Total and Methyl Mercury in Ground and Surface Waters in Restored and Natural Wetlands in Northern New York

Ting Wang
Syracuse University, Environmental Engineering

Among various mercury species, methylmercury is one of the most toxic, and strongly bioaccumulates in the aquatic food chains and territory. Elevated inputs of Hg threaten human and ecological health. Wetlands are important environments for biogeochemical transformations and cycling of mercury, especially for the methylation process. There has little research on how restored wetlands, comparing with natural wetlands,

interfering of the processing of Hg cycling. In this project the twenty-one study wetlands sites are along the St. Lawrence River, five of them are natural wetlands and the remainders are restored wetlands.
In this project, we found that there is not obvious different between natural and restored wetlands based on comparison concentrations of mercury. The percent methylmercury (%MeHg) in restored wetlands is little higher than in natural wetlands (about 7.0% in surface water; and 1.9% in ground water). Concentrations of mercury change seasonally in both surface and ground waters, and is obviously higher in surface than in ground waters. Seasonal concentrations of total and methyl mercury are higher in summer and late spring, and lower in early spring and early fall, likely due to the influence of DOC, SO4, NO3, the natural retention of mercury in sediments, as well as the temperate and the amount of rainfall. The value of %MeHg is higher in summer (53.3% in surface water, and 48.6% in ground water), and lower in fall and spring because the increasing temperature enhances microbial activity and net methylation rates. The influences of watershed land cover and water stage to concentrations of mercury are not that obvious in this study.

12. Overview of the upper watershed conditions in the Aral Sea basin for the last half of century

Timur Sabitov
SUNY ESF, Environmental Resource Engineering - Geospatial Engineering

Streamflow modelling has been a topic of interest of many scientists due to a broad interest in the impact of climate change on streamflow conditions and the accurate estimation from the available climatic data. In this work, a hydrologic model based on popular SCS runoff curve number method was developed for the Pskem river watershed a major tributary of Syr-Darya river that flows into the upper part of the Aral Sea in Kazakhstan. The developed model was used to estimate streamflow conditions for the water years from 2013 to 2015 based on average daily precipitation, average daily air temperature at the average elevation of the watershed, and other physical characteristics of the watershed such as unsaturated and saturated layer capacity, drainage area, evapotranspiration, landcover characteristics as glaciers and the area of the glaciers, and antecedent moisture content. The major parameters for streamflow modelling were estimated and reported for use in the watersheds having similar characteristics. The coefficient of determination is 0.91.
The data involved a most comprehensive collection about streamflow, temperature and precipitation at Pskem watershed. The average monthly streamflow analysis revealed no impact of changes in the landscape on the streamflow conditions for the annual average flows. Seasonal Mann-Kendall test revealed changes in the streamflow conditions when we observed decreasing trends in the May, July and August monthes. This results are correlated with a decreasing area of the glaciers over the last half of century. Therefore, we included glacier runoff in our model as it is the major source of water during the summer months. Other work included the determination of landcover classification. It was clear that water, rocks and glacier surfaces have sometimes similar

spectral response due to correlation of sheer flow during the glacier melt and water in the ponds. Therefore, we conducted the landcover classification utilizing a high resolution imagery and reported classification having an accuracy is equal to 0.84.

13. A Stochastic Techno-Economic Analysis of Shrub Willow Production using EcoWillow 2.0

Jenny Frank, Tristan Brown, Tim Volk, Justin Heavey and Bob Malmsheimer
SUNY ESF, Sustainable Energy/M.S.

New York State has established a Clean Energy Standard that requires 50% of its electricity to be derived from renewable resources by 2030. The closing of substantial nuclear power capacity in the near future is expected to create additional demand for renewable baseload power in the interim. Upstate New York is characterized by large tracts of unproductive former pasture and cropland on which shrub willow has been demonstrated as a potential cellulosic bioenergy feedstock that has the additional potential to rebuild soil carbon via net carbon sequestration. Shrub willow is used as a feedstock for baseload heat and power at small commercial-scale projects throughout New York State. Researchers at SUNY College of Environmental Science & Forestry have developed a stochastic techno-economic analysis model of shrub willow plantations in the U.S. Northeast to quantify the economic feasibility of the biomass as a bioenergy feedstock. This research, which is being funded by the USDA's Biomass Research and Development Initiative, is part of a broader project that will determine the economic and environmental feasibility of multiple forms of cellulosic bioenergy in the region in pursuit of state energy goals (Massachusetts has also implemented ambitious renewable electricity targets). This poster will provide an overview of the stochastic techno-economic model, results and the model's potential applications in regions outside of the U.S. Northeast.

14. Microalgae Treatment of Anaerobic Digester Effluents from a Food Waste to Energy Digester

Ryan McMullan, Daniel Baah, Tim Snyder, and Dr. Jeff Lodge
Rochester Institute of Technology, BS/MS Environmental, Health & Safety Management

CH4 Biogas runs an anaerobic digester in Wyoming County, NY that is used to digest Greek yogurt and cheese why with dairy manure to produce methane for electricity and heat. After digestion is complete, the effluent is pressed to remove solids and then released to a storage lagoon. Over time, the effluent moves through several lagoons before its used as a fertilizer for corn crops. The problem is that the effluent contains as much as 2000ppm of Nitrogen, 200-300ppm of Phosphate, and 50ppm of Iron. These high levels make it difficult to surface-apply this as a fetilizer, so it must be injected. Our lab is working on using microalgae to treat the effluent wastewater to reduce the nutrient levels such that surface applications may be used without threats

to contaminating groundwater. Out lab is utilizing the green microalgae, Chlorella, to treat diluted effluent on site. Lab experiments showed that Chlorella is able to reduce nutrient levels significantly by as much as 90%. We set up a 1000 gallon algae tank on-site at CH4 Biogas to treat the effluent. Several runs were done and significant nutrient reduction was seen and the algae biomass contained lipids that could be used for biodiesel production.

15. VIS-SIM: A Framework for Designing Neighborhood Energy Efficiency through Data Visualization and Calibrated Urban Building Energy Simulation

Sou Fang, Sarah Ritchey, Beilei Ren, Camila Andino, Elizabeth Krietemeyer, PhD (Principal Investigator), Tarek Rakha, PhD (Co-PI), Jason Dedrick, PhD (Co-PI), Camila Andino, Sarah Ritchey, Beilei Ren, Ehsan Sabaghain, Sheida Soleimani, Akshat
Syracuse University, Master of Architecture (M.Arch)

A new generation of urban building energy models (UBEMs) are currently being developed to estimate neighborhood-scale hourly energy demand loads. The goal for such tools is to explore "what if" scenarios for various design strategies, and to prioritize the most effective solutions. The objects of this research are to visualize the relationships between three critical and closely related subjects that are not yet integreated within existing UBEMS: 1) the functioning of the electrical grid and how it can be made clearner, more efficient and more resilient, 2) the use of energy by buildings and how this can be minimized while also improving building functionality and the comfort of occupants, 3) the dynamic external available natural resources of solar and wind energy for matching resource with demand. Using currently acquired energy-use datasets from the Pecan Street Institute for residential buildings in Austin, TX, combined with our current visualization techniques and urban building simulation tools, a new UBEM will be developed to simulate, test and visualize future scenarios and strategies.

PhD STUDENTS

16. Temporal Variability Of Naturally Occurring Methane In Groundwater Wells In The Marcellus Shale Region Of New York

Amanda Campbell, Laura Lautz, Greg Hoke
Syracuse University, Earth Science

Although much has been learned about the impact of unconventional hydraulic fracturing in the Marcellus Shale region, little is known about the natural variation of dissolved methane prior to production. Few studies have collected baseline methane data over time and month-to-month natural variability is relatively unexplored in the Marcellus Shale Play. Limited opportunities remain for baseline data collection in northeastern Pennsylvania and other areas of the play, where shale gas production has

proliferated, but opportunities remain in New York (NY), where hydraulic fracturing is currently banned. The objective of this study is to characterize temporal variability of naturally-occurring methane in shallow groundwater in the Marcellus region. We are working with homeowners to sample 11 domestic groundwater wells monthly in the Marcellus Shale region of NY for dissolved methane concentrations. Samples were initially collected using an open-system, overflow method for yearly sampling (n=4) and more recently using a closed-system, evacuated container (IsoFlask) for monthly sampling (n=10). For wells with sufficiently high concentrations of methane to do isotopic analyses (‰¥0.90 mg/L), the predominant methane source is informed by Î´13C-DIC, Î´13C-CH4, and Î´D-CH4 isotopes, allowing us to evaluate thermogenic versus microbial sources of methane. These data provide information on inter- and intra-year variability of naturally-occurring methane, as well as spatial variability between wells. Results of this study provide context for interpreting the spatial and temporal variability of methane concentrations in domestic wells that may be impacted by proximal natural gas production from the Marcellus Shale.

17. Hydrologic Monitoring and Seasonal Performance of the Oncenter Green Roof in Syracuse, New York

Yige Yang, Cliff Davidson
Syracuse University, Civil and Environmental Engineering

Syracuse is one of about 770 communities in the nation with a combined sewer system. During wet weather events, stormwater flows into the local combined sewer system, sometimes causing heavy flow periods that overflow the system. Green roofs are regarded as a sustainable technology for capturing stormwater runoff. In addition, they have benefits including the possibilities of improving water quality; reducing building energy consumption; expanding lifetime of roofing membranes; and enhancing aesthetic value.
Studies have demonstrated that green roofs can retain significant amount of stormwater, but have also shown variation in seasonal performance. This study investigates the hydrologic performance of an extensive green roof in Syracuse with over two years of monitoring data. In addition, this research shows how seasons of the year impact the hydrologic performance of the roof considering the covariates of antecedent dry weather period (ADWP), storm event size, soil moisture content, temperature and humidity.

18. Characterization of Total Nitrosamines in Wastewater Treatment Plants

Changcheng Pu, Teng Zeng
Syracuse University, Civil and Environment Engineering

N-Nitrosamines are a group of contaminants of public health concern. Current focus on N-nitrosamines in drinking water systems has forced the impression that N-nitrosamines are disinfection byproducts. However, other upstream processes, especially

wastewater treatment plants, can serve as direct sources of N-nitrosamines. Numerous studies have documented the fate of volatile N-nitrosamines (e.g., N-nitrosodimethylamine) at conventional and advanced wastewater treatment plants (WWTPs), but these species only represent a small fraction of the total N-nitrosamine (TONO) pool. To fill the gaps in our understanding of the unknown fraction of TONO, we combine chemiluminescence detection and high resolution mass spectrometry (HRMS) to characterize the fate and composition of wastewater-derived TONO and their precursors. We applied a previously developed chemiluminescence method to study the variation of concentrations of TONO across the treatment trains at six municipal WWTPs in New York. Out of the six WWTPs investigated, five exhibited higher TONO concentrations in the effluent prior to the final disinfection than those in the plant influent. Aerobic biological treatment (e.g., activated sludge or aerated filters) resulted in elevated TONO levels to various degrees, with the highest concentration reaching up to ~32,000 ng/L as NDMA. Secondary clarification at two WWTPs also led to a significant increase in TONO concentrations. Final disinfection with ultraviolet light or sodium hypochlorite reduced TONO levels in most WWTPs. Our ongoing work is focused on quantification of specific N-nitrosamines. We coupled dual-cartridge solid-phase extraction with HRMS for simultaneous determination of volatile and non-volatile N-nitrosamines, with the goal to identify the relative importance of volatile versus non-volatile species in the TONO pool.

19. Lifecycle Greenhouse Gas Emissions Impact of Cellulosic Ethanol Production from the Fermentation of Willow Hot Water Extract

Obste Therasme, Marie O. Fortier, Timothy A. Volk and Thomas Amidon
SUNY ESF, Forest and Natural Resources Management

The use of cellulosic biofuels is projected to increase in order to offset greenhouse gas emissions from the combustion of non-renewable fuels. Hot water extraction (HWE) is a potential pretreatment step for multi-pathways biorefinery to yield natural, wood-based chemicals and materials. A cradle-to-grave life cycle assessment (LCA) was performed to assess the greenhouse gas (GHG) emissions associated with the production of 1 MJ of ethanol by fermentation of sugars derived from HWE of willow biomass. Two conversion scenarios were considered. In the first scenario, electricity and heat required for the processes are cogenerated on site by the combustion of a fraction of the extracted willow biomass. In the second, electricity for the processes is supplied exclusively by the national grid. A sensitivity analysis and Monte Carlo analyses were performed for each scenario. The results show a net GHG emissions of -94.9 g CO2eq MJ-1 for Scenario 1 and 63.6 g CO2eq MJ-1 for Scenario 2.

20. Modeling Biogas Production from the Anaerobic Digestion of Cow Manure

Autumn Elniski, Siddharth Chatterjee, Chanchal Mondal, Klaus Doelle

SUNY ESF, Bioprocess Engineering

Research on renewable energy sources has become a priority as we attempt to reduce our dependence on non-renewable materials. Anaerobic digestion is a biologically-driven process that can produce energy, heat, and fuel in the form of methane-containing biogas. Cow manure can be used to drive the digestion process and models of this degradation can assist engineers and operators in the implementation of large scale digestion facilities. Biogas production from cow manure at three total solids contents (6, 5, 4%) and two temperatures (33.0, 38.°C) was monitored for fifteen days. Four simple models were compared to the experimental data. It was determined that the system operating at 6% total solids and 38.5°C generated the most biogas in mL Biogas/g VS (volatile solids). The Time-Lag model best represented all treatments in terms of visual fit and a low root mean square error between the experimental data points and the model curve. This information will be useful for implementing new technologies to substitute non-renewable fuel sources.

21. Enhancements of Pellets from Lignocellulosic Biomass: Installation of Pelheat Pelletizer and Preliminary Research - POSTER NOT JUDGED

Autumn Elniski
SUNY ESF, Bioprocess Engineering

Pellet production from biomass has become a topic of increasing interest. Modifications to the process of making pellets from lignocellulosic materials are at the forefront of current research to improve properties of the pellets during storage and operation. Research suggests that the use of hot water extracted biomass in pellet production could improve pellet properties in comparison to raw materials. In a preliminary effort to conduct research on the feasibility of using hot water extracted biomass to make pellets, a small-scale Pelheat Pelletizer and Hammermill were installed at the Department of Paper and Bioprocess Engineering at SUNY-ESF in January 2017. The die-ring pelletizer has been used in subsequent months to create pellets from raw and hot water extracted willow biomass. While pelletizing parameters are still being tweaked, the preliminary comparison between the two types of pellets is promising. Further work will focus on optimizing pellet production from hot water extracted and raw materials with the Pelheat Pelletizer and comparing the effect of using hot water extracted biomass on pellet properties, such as ash content, durability, calorific value, and carbon monoxide production.

22. Efficient Personal Cooling and Heating Terminal Design

Meng Kong, Dr. Jensen Zhang, Dr. Thong Dang, and Dr. H. Ezzat Khalifa
Syracuse University, Mechanical and Aerospace Engineering

Micro-environment is defined as the air space and environment around a person that directly impacts his/her thermal sensation. Most existing HVAC systems condition

the air of the entire room including the unoccupied space, which leaves a big potential to save energy. This study aims at evaluating the performance of three existing air terminal devices (ATDs) and two heating delivering devices (HDDs) to manage the thermal balance so as not to sacrifice thermal comfort when the ambient unoccupied space temperature is expanded from 21.1-23.9 °C to 18.9-26.1 °C to reduce HVAC load. A 20-segment thermal manikin was put in a full-scale stainless-steel chamber to test with selected ATDs and HDDs. Results show that all the three ATDs with only 50 W cooling power and the heating mat with a reflective box using 60 W heating power were able to recover the thermal comfort in a room of expanded temperature set-point. The cooling performance of the jet was increased more by increasing the supply air flow rate than reducing the supply temperature, and 17 cfm flow rate could remove more than 23 W from the manikin. A heating mat which heated the feet by conduction was more efficient than the heating bulb, and with 60 W heating power, it could reduce the heat loss from the manikin by more than 18 W.

23. Chemically Functionalized Acoustic Wave Devices for Indoor Air Quality Monitoring

Harvey Mosher, Elizabeth Clifford, Stephen Shepherd, James T. Spencer
Syracuse University, Chemistry

In enclosed building spaces, carbon dioxide or other volatile organic compounds (VOC) can rapidly accumulate if proper ventilation is not achieved. It is desirable to have a mechanism in which CO2 and VOC levels in ambient air can provide feedback information to control room ventilation, in order to optimize energy efficiency and comfort. Given the dynamic nature of building usage, however, a rapid method for measuring these gases is first required. Our work is focused on the use of chemically modified piezoelectric substrates in a quartz crystal microbalance (QCM) to address the monitoring of air quality. These modified QCM systems are expected to provide selective and sensitive monitoring of carbon dioxide, as well as other gases of interest. When integrated with a building's HVAC system, the QCM devices would allow for controlled ventilation to occur only when air quality falls outside of the desired parameters. The results from our initial work on the design and fabrication of new QCM-based chemical sensors will be presented.

24. Increasing light capture in silicon solar cells with encapsulants incorporating air prisms to reduce metallic contact losses

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Silicon solar cells are the most widely deployed modules owing to their low-cost manufacture, large market, and suitable efficiencies for residential and commercial use. However, around 6 % of light input is blocked by the metallic front contacts. Our encapsulated prism structure to recycle the blocked light is easily integrated into

module fabrication. We perform a theoretical and experimental study on the light collection properties of an encapsulant that incorporates a periodic array of air prisms, which overlay the metallic front contacts of silicon solar cells. We show that the light collection efficiency induced by the encapsulant depends on both the shape of the prisms and angle of incidence of incoming light. The changes in collection efficiency are elucidated in terms of the ray paths and reflection mechanisms in the encapsulant. In addition, we fabricated the encapsulant from a commercial silicone and studied the change in the external quantum efficiency (EQE) on an encapsulated, standard silicon solar cell. We observe efficiency enhancements, as compared to a uniform encapsulant, over the visible to near infrared region for a range of incident angles. This work demonstrates exactly how a periodic air prism architecture increases light collection, and how it may be designed to maximize light collection over the widest range of incident angles.

25. Polymer Encapsulants Incorporating Light-Guiding Architectures To Increase Optical Energy Conversion In Solar Cells

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We report on a significant increase in optical energy conversion in solar cells by the fabrication of a new type of thin-film solar cell encapsulation architecture comprising a periodic array of step-index waveguides. The thin-film inherits the light collection and guiding properties of the waveguide ensemble, whereby modulations to light transmission may be attained. The waveguides are fabricated through patterning with light in a photoreactive binary blend of crosslinking acrylate and urethane, wherein phase separation induces the spontaneous, directed formation of broadband, cylindrical waveguides. This microstructured material efficiently collects and transmits optical energy over a wide range of entry angles. Silicon solar cells comprising this encapsulation architecture show greater total external quantum efficiencies and enhanced wide-angle light capture and conversion. To the best of our knowledge, this is the first proof-of-concept demonstration of processing broadband optical waveguide arrays for solar energy collection, and constitutes a new approach for achieving wide-angle solar energy conversion, and opens opportunities for significant improvements in cell performance.

26. A novel, light induced photo-polymerization based approach towards developing enhanced battery anodes

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Li-ion batteries power the majority of electronic devices and electric vehicles today. As non-renewable energy sources continue to deplete, Li-ion rechargeable battery systems will also be critical to efficiently store the energy generated from solar and

wind sources, ultimately contributing to the goal of achieving an effective smart grid. Battery size, however, is a limiting factor, and as the demand for power increases, there can be no trade-off between size and performance. Therefore, it is essential to develop materials that can enhance the capacity and performance of such batteries. To approach this challenge, we develop a novel materials synthesis method based on the self-trapping effect of light in photo-reactive media. As light is passed through such media in a controlled manner, polymerization occurs, leading to change in refractive index of the material. Due to this, as the light beams travel through the sample depth, they inscribe solid, permanent, cylindrical waveguides. Our goal is to develop micro-structured, Carbon/Silicon composites as high performance anode materials using this optics technique. The reduced Graphene Oxide (rGO) form of Carbon provides for electrical conductivity, and the Silicon particles facilitate Li-ion storage, thereby increasing the storage capacity and cyclic ability of our structures.

27. Design and Experimental Validation of a Ducted Wind Turbine

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A properly designed duct placed around a wind turbine can increase the power output by increasing the mass flow rate through the rotor. In order to have an economically feasible ducted wind turbine, the cost per kWh of energy produced from a ducted wind turbine should be lower than that of an open wind turbine with the same annual energy output. Although ideally a ducted wind turbine, for a given annual energy output, should be designed to minimize the $/kWh, relevant but simpler design objectives can also be useful in exploring the design space and finding the most feasible design. Two different power coefficients, the rotor power coefficient (based on the rotor area) and the total power coefficient (based on the exit area of the duct) were used as design objectives. An axisymmetric model in ANSYS Fluent was created with the airfoil E423 as the cross-section of the duct and the rotor modeled as an actuator disc. The design variables included the thrust coefficient of the rotor, the angle of attack of the duct cross-section, the radial gap between the rotor and the duct and the axial location of the rotor. The velocity profile at the rotor and thrust coefficient of rotor were used in the blade element momentum method code mRotor to design the rotor blades. The curved flat plate airfoil GOE417a was used as the cross-section of blades. The duct with a 2.5 m rotor was built and tested in a wind tunnel . There was a very good agreement between predicted power output of the rotor from simulations and that obtained in the wind tunnel tests. A new ducted wind turbine with an aft 3 m rotor, based on the total power coefficient as the design objective, was designed to be built in near future.

28. A Novel All-Porous Solid Oxide Fuel Cell

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Fuel cells provide a clean and versatile means to directly convert chemical energy to electricity. Among the many types of fuel cells, solid-oxide fuel cells (SOFCs) have received considerable attention owing to their simplicity (no moving parts), fuel flexibility and use of inexpensive catalytic materials. Typical SOFCs contain porous anode and cathode layers with a dense electrolyte layer. We herein propose a novel method for producing all porous SOFCs (including the electrolyte layer) which allow for a single stream of fuel/air mixture to be fed to the cell producing not only electricity, but also syngas.

29. Oxygen Transport Membranes for Oxy-fuel Combustion

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As climate disruption from heightened emission levels threatens global production and safety, there is a growing need to find cleaner energy production methods. One proposed resolution that has been gaining interest is oxygen transport membrane reactors (OTMs), which can be retrofitted into current power plants to mitigate emissions and minimize additional energy costs. In this work, OTM performance is investigated using a sweeping gas mixture of fuel (methane) and carbon dioxide (CO2). Results were then combined to comment on OTM's overall performance.

30. Power system interface design for enhanced Situation Awareness

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The goal of this research work is to design a resilient power grid to improve operators' response to critical events. Timely and accurate power system operation decisions are necessary to ensure grid resiliency. Critical operation decision-making predominantly depends on the information displayed to operators. Accordingly, power system interfaces should provide the required information in the appropriate format, and at the right time, to promote adequate situation awareness (SA). When information is delivered in this way, system operators are more likely to take appropriate and timely corrective actions. In this research, information requirements of power system visualization were identified from a systematic review of current literature. Then, based on the information requirements and SA principles, different overview interfaces were designed. Finally, a questionnaire was developed to assess the validity of each interface design with practitioners from the power industry. Future work will be to validate the interfaces through both direct measure(SAGAT technique) and indirect measure(usability testing) of SA.