

**Presentation ABSTRACTS**

**Session 1: Systems-Based Approaches**

**Urban Food-Energy-Water (FEW) Nexus: A Material and Energy Flow Perspective**

Ming Xu, School for Environment and Sustainability, Department of Civil and Environmental Engineering, University of Michigan

With 66% of the world’s population expected to live in urban areas by 2050, cities around the world will face enormous challenges in sustainable provision of food, energy, and water. These challenges are particularly complex due to the interconnectedness of the food system, energy system, and water system. Policy and technology solutions addressing urban food-energy-water (FEW) challenges need to be evaluated through the lens of FEW nexus to identify co-benefits and avoid unintended consequences. This calls for innovative approaches to model the urban FEW nexus as an integrated whole, instead of examining them individually.

In this study an integrated modeling framework for urban FEW nexus is developed in collabora-tion with researchers from School of Environment at Beijing Normal University. This framework is based on the characterization of the material and energy flows within an urban area. We also applied this framework to the Detroit Metropolitan Area (DMA) as a preliminary study.

**Infrastructural Symbiosis: reciprocities among urban systems**

Hillary Brown, FAIA, Professor, and Director, MS Program in Sustainability in the Urban

Environment, Bernard and Anne Spitzer Sch. of Architecture, City College of New York, CUNY

Infrastructural symbiosis builds upon the principles demonstrated by the biological components of an eco-system, where beneficial, reciprocal exchanges take place among unrelated organisms. For urban systems, symbiosis can be achieved across water, energy, sanitation and even transportation infrastructures through their cooperative operations and management. Collocating these different systems can optimize the reciprocal cycling of wastes and the cascading of energy and water. Infrastructural symbiosis can recover nutrients, while providing renewable energy. Three case studies, two in the industrialized north and another in rural Brazil epitomize the effectiveness of innovative, systemic thinking and integrated planning.

**Urban infrastructure systems**

Osvaldo A. Broesicke, E.I.T, Graduate Research Associate, Brook Byers Institute for Sustainable Systems, Georgia Institute of Technology

Urban infrastructure systems provide basic services such as supplying energy and water enabling transportation and communication, and managing waste. Composed of multiple interconnected networks, the design and construction of these systems typically occurs in isolation with minor regard for their interdependencies. Accordingly, this neglect has spurred the emergence of undesirable effects such as traffic congestion, smog, water and air pollution, flash flooding, global warming, and socio-economic inequality. The isolated analysis of each individual system will not reveal these emergent properties. Rather, these properties reveal themselves by observing all actors as a complex, connected, dynamic, adaptive, and diverse community. The interactions between agents, firms, governments, and the infrastructure systems form an *infrastructure ecology*, which may be more dynamic and complex than natural systems. This presentation will share the various methods under investigation within the Brook Byers Institute for Sustainable Systems and its effort to quantify the interconnections of the infrastructure ecology as well as predict the benefits and drawbacks of technological adoption and policy tools.

**Session 2: End-User Perspective: What Stakeholders Want to See**

**New Governance Regime for the Evolving Urban Water Infrastructure**

Newsha Ajami, Ph.D., Director, Urban Water Policy, Senior Research Associate, Stanford Woods Institute for the Environment

Urban water is going through a paradigm shift. The conventional urban water infrastructure network is under increasing pressure due to aging infrastructure, population growth, changing societal and economic realities, and rapid climatic variability. In the meantime, implementation of distributed water solutions such as conservation and efficiency, water-reuse, green infrastructure, and gray water systems have promise to address some of these challenges and make our communities more resilient to future natural disasters such a floods and droughts. However, these solutions are slowly changing the urban infrastructure model. Cities and utilities need to rethink and revisit their infrastructure management and governance model in order to effectively incorporate these solutions in their existing systems. I will discuss some of the new tools our team has developed over the past few years to help further engage with various stakeholders in the bay area Region to help them navigate this transition.

**New York City Sustainability Projects**

John L. Lee, Deputy Director, Mayor’s Office of Sustainability, New York City Government

New York City, represented by the Mayor’s Office, is itself a major stakeholder in the planning and development of infrastructure projects and preparation for the city’s resilience in the face of extreme weather events.  The presentation discusses the kinds of projects under consideration and the decision-support tools that would help to move them forward.  The Mayor’s Office also presents a perspective on other stakeholder groups, from public agencies to citizen groups that must be incorporated into the project decision-making process.

**Infrastructure and Community**

Jason Bregman, Associate, Environmental Planning and Design, Michael Singer Studio

Jason Bregman will present the core concepts from *Infrastructure and Community*, a white paper published by the Environmental Defense Fund’s Living Cities Program in collaboration with Michael Singer Studio. *Infrastructure and Community* was created as a planning tool for policy makers, community groups, planners, and infrastructure developers to put forward concepts and ideas that can help integrate infrastructure with its surrounding community. While the paper focuses on centralized infrastructure in a large urban context where space constraints are most visible, many of these strategies are also applicable to smaller municipalities, and are applicable to any service infrastructure that is difficult to site. The goal is to provide elected officials, city planners, policy makers, engineering consultants and community leaders a document that will encourage creative thinking, spark ideas that are outside of typical considerations, and result in new approaches in siting and design of infrastructure facilities. The white paper utilizes three infrastructure case study projects by Michael Singer Studio and examines each project in-depth in terms of five main topics: site context (environment), energy, public access, water and architectural design. Mr. Bregman’s presentation will include additional recent case studies by the Studio that demonstrate the implementation of key concepts put forth in the original paper.

**Session 3. Models and Tools for Understanding the Evolution of Cities and Infrastructures**

**Data Sharing and Data-Driven Discovery for Sustainable Buildings Using Virtual Information Fabric Infrastructure (VIFI)**

Yimin Zhu, Ph.D., Professor, Pulte Homes Endowed Professor, Bert S. Turner Dept. of Construction Management, College of Engineering, Louisiana State University

Data are essential for the design, management and operations of infrastructures. Using buildings as an example, a group of multidisciplinary researchers try to understand the potential and challenges of utilizing a novel data sharing platform, called virtual information fabric infrastructure (VIFI). VIFI allows users to access data without moving data around; rather it executes data analytic packets at data sources and returns results to users. Researchers in a sustainable building community use VIFI to investigate the integration of predictive models and context-sensitive observational data to enhance predictions. Applications in the community range from building energy simulation, life cycle assessment, to social/policy modeling. Initial use cases on building energy simulation will be discussed in the presentation.

**System-of-Systems Modeling of Urban Infrastructure Resilience**

Ali Mostafavi, Ph.D., Assistant Professor, Zachry Dept. of Civil Engineering, Texas A&M

Resilience of civil infrastructure systems is one of the grand challenges facing engineers and decision makers in the 21st century. The complexity of this challenge is due to the existence of multiple, heterogeneous, distributed, and interdependent systems composed of actors and physical components embedded in networks at multiple levels. To unlock the full potential of resilient infrastructure development, holistic paradigms need to be created to facilitate an integrated assessment of extant complex adaptive behaviors, decision-making processes, and dynamic interdependencies. To this end, recent studies have proposed the use of a system-of-systems paradigm for integrated modeling and holistic analysis in civil and project systems. In this talk, the significance and elements of a system-of-systems approach for modeling complex dynamics of human-infrastructure-stressor interactions. Then, the use of the system-of-systems approach will be briefly described in studies related to resilience of transportation and water infrastructure systems under chronic and acute urban stressors.

**A Bottom-up Approach for the Analysis of Energy and Water Systems**

Vatsal Bhatt, Ph.D., Senior Energy Policy Advisor, Brookhaven National Laboratory

This presentation will focus on a unique bottom-up comprehensive synthesis and analysis approach, interconnecting both energy and water systems from individual technology to facility level financial risk to urban policies. It intends to interconnect, enhance and expand data, models and analytical capabilities addressing integrated long-term analysis (2050) focusing on crucial issues of economically deployable infrastructure for sustainable development. It establishes an integrated framework and a comprehensive analytical methodology for collecting and synthesizing multiple geographically diverse datasets for lifecycle quantity and costs of existing and future energy and water data for analysis in an ensemble of hierarchy of systems that are integrated with cascading effects for a coupled energy and water techno-economic systems analysis and decision-making for cities. It will advance our understanding and system analysis capabilities of multiscale climate change-energy-water interactions, enabling next generation simulations.

**Session 4A: Case Studies I: Urban Districts – Food & Water**

**Reinvigorating Urban Infrastructure at Food-Energy-Water nexus**

Weslynne S. Ashton, Ph.D., Associate Professor, of Environmental Management and

Sustainability, Stuart School of Business, Illinois Institute of Technology

Many rust-belt cities in the US Midwest are undergoing major transformations through technological innovations and cultural change. As manufacturing activities declined or moved away, large swaths of vacant land and buildings were left in their wake, posing a major challenge for urban regeneration. These vacated spaces lack economic activities, business interest, and social capital, and can blight their surroundings. But, they also present opportunities for novel regeneration of urban infrastructure. Technological innovations are revolutionizing the activities and choices of urban dwellers; potentially upending existing systems of production and consumption, and leading to new configurations for food, energy and water (FEW) management.

Our research seeks to understand how post-industrial production and consumption systems are being redefined to meet the evolving needs of citizens in cities and how FEW resources are being reconfigured to satisfy those needs. We focus on multiple levels of analysis –first, at the level of a single industrial facility, and later, a wider post-industrial region.

On Chicago’s Southside, *The Plant* is a former meat-packing factory that has been converted into a collaborative community of food and beverage businesses, leveraging the FDA-certified legacy of the building. Twenty small, start-up businesses lease space at the facility, and have organically established material, energy and water trades through informal agreements. Led by Bubbly Dynamics, the building owner, and Plant Chicago, an education and research non-profit, the members of this community are exploring strategies and processes to build a circular economy. This involves the creation of closed energy, water and material loops, such that materials are continuously reused, as well as the dissemination of knowledge and benefits with communities surrounding the facility, and across the region more broadly. We examine how collaborative FEW resource management has developed and continues to evolve, as well as how collaboration within this community creates a platform for similar systems attempting to utilize social and environmental innovation to rebuild resilience in cities.

**Energy Infrastructure Planning at the Hunts Point Food Distribution Center**

Adam Hinge, President, Sustainable Energy Partnerships, and Adj. Prof., Columbia University

The Hunts Point Food Distribution Center (FDC), located in the South Bronx in New York City, is a critically important regional resource that provides about 60% of the metropolitan New York region’s produce, meat and fish.  The FDC’s wholesale food markets, which currently employ more than 6,000 employees, with annual revenue over $6.5 billion, are located in a flood plain and are not equipped with backup generators, so are very susceptible to major interruptions such as recent Superstorm Sandy.  In 2015/16, a study was conducted to determine the technical and economic feasibility of developing a more resilient and sustainable energy microgrid for the FDC, including significant photovoltaic electric generation, and a modern trigeneration combined heat and power facility.  This case study presentation will review highlights of the proposed project, and the current status of development.

**Linking of the Energy and Water Sector in Urban Systems – Potential in Wastewater Treatment Plants**

Alfred Helble, Consulting Engineer, AH Consult, Stuttgart, Germany

Sustainable environmentally friendly clean cities and urban infrastructures require the development of integrated strategies within the food-water-energy sectors. One of the driving forces for the efficient sector linking is the increased implementation of renewable energies in an adopted smart grid functionality. In wastewater treatment the systematic migration from aerobic sludge stabilization in activated sludge processes towards anaerobic sludge stabilization might be designated as one strategic pillar. The utilization of the sewage gas through combined heat and power units (CHP) helps to contribute the energy efficiency share required during the renewable energy transformation process. Increasing sewage gas production by controlled excess sludge feed and by co-generation adding external highly loaded organic wastewater and waste sources, by sewage gas purification to natural gas and direct supply as biomethane after pressure boosting into the compressed natural gas (CNG) grid (with preferably renewable energy) will provide additional capacities.

A further flexibilization of energy consumption and energy production can be achieved by dynamic process control and improved automation in the wastewater and sludge treatment processes. An improved aeration and blower control for oxygen supply needed for nitrification adopted to the individual daily hydrographs in wastewater might help to better compensate natural fluctuations during renewable energy production. Thermal utilization of dried sewage sludge in mono incineration plants will be required in future for phosphorous removal. Other advanced thermal utilization processes such as pyrolysis and gasification are in development and partially already in large-scale applications on the market. However, the availability of water in the quality either for irrigation in the agriculture sector, as freshwater or process water for diverse applications and the availability of surface and ground water for drinking water supply, is a key factor in order to ensure a sustainable growth of urban infrastructures. Micro pollutants and organic persistent compounds have to be eliminated before discharge to the receiving waters and for an inevitable capacity increase in treated effluent reuse depending on the case. Overall concepts must be developed using the b*est available technologies* (BAT) for secondary wastewater treatment as a prerequisite for the efficient and economic operation of advanced and emerging techniques for tertiary and quaternary wastewater treatment. Membrane bioreactors (MBR) and emerging techniques such as advanced oxidation processes (AOP) using ozonation based on renewable electrical energy supply and pure oxygen alternatively provided from electrolysis (basically applied for hydrogen production from renewable energy) might effectively be implemented. Key figures for energy consumption and production in wastewater treatment and case studies for dynamic process control and new developments in a large-scale *advanced oxidation process* (AOP) with a combined ozone and biofiltration process are presented in the workshop.

**Jamaica Bay: Ecosystem Services**

William (Bill) Solecki, Professor, Graduate Geography Advisor, and Founder Director, Emeritus, CUNY Institute for Sustainable Cities, CUNY

Jamaica Bay in New York State has been at the center of a series of food, energy, and water system discusses and debates.  Currently, planning efforts and activities are taking place to promote ecosystem based resiliency efforts that will promote FEWs in the watershed as well.  Many of these efforts reflect a need to understand the drivers of ecological and environmental change in the bay and prospects of future climate change.  The bay serves as an excellent case study to study and evaluate the policy shifts required to develop such resiliency efforts, and the possibilities for transformative environmental management.

**Session 4B: Case Studies II: Urban Districts - Energy**

**Digitizing the Electric Power Grid**

Roberto Rojas-Cessa, Professor, Electrical and Computer Engineering, Newark College of Engineering, New Jersey Institute of Technology (NJIT)

This presentation will discuss trends on digitizing the distribution of electrical power grid and highlight some of the different approaches of this concept. It will review some of the challenges on bringing this concept to reality and some of the ongoing research on this area. We comment about scaled-down testbeds on controlling power distribution.

**Microgrids in New York City**

Ahmed Mohammed, Ph.D., Associate Professor, Electrical Engineering, Grove School of Engineering, City College of New York, CUNY

In this short talk, some of the major microgrid activities taking place in NYC will be summarized and discussed. This includes: an overview of the various microgrid demonstration projects within NYC, how microgrid sites were selected, microgrid design and control, NYC-specific regulatory and economic aspects. Moreover, the talk will discuss the opportunity of using wastewater treatment plants as microgrids, and what benefits this could result in.

**CityBES: A Data and Computing Platform for City Buildings**

Yixing Chen, Ph.D., Sr. Scientific Engineering Associate, Lawrence Berkeley National Lab

Buildings in San Francisco consumed 52% of total primary energy. Improving building energy efficiency is one of the key strategies the city is adopting towards its energy and climate goals. Urban building energy models (UBEM) can support city managers to evaluate and prioritize energy conservation measures (ECMs) for investment and to design effective incentive and rebate programs. This study provides an overview of the City Building Energy Saver (CityBES), an open web-based data and computing platform to support city-scale building energy efficiency strategic plans and programs. CityBES builds upon the CityGML data model, an international standard on 3D city models. Main features of CityBES include: (1) detailed retrofit analysis using OpenStudio and EnergyPlus simulation, (2) energy benchmarking using DOE’s Building Performance Database, and (3) visualization of buildings and their performance using 3D GIS platform. Simulated energy savings for 12 ECMs of selected 940 office and retail buildings in six districts of the northeast San Francisco were presented. The CityBES retrofit analysis feature does not require users to have deep knowledge of building systems or technologies for the generation and simulation of building energy models, which helps overcome barriers for city managers and their consultants to adopt UBEM. CityBES is freely available at CityBES.lbl.gov. Challenges of UBEM and future development of CityBES are also discussed.

**Session 5: City Data and Urban Informatics**

**Data Challenges and Autonomous Real-time Sensing Systems**

Ziqian (Cecilia) Dong, Associate Professor, Department of Electrical and Computer Engineering, School of Engineering and Computing Sciences, New York Institute of Technology

Advances in sensors and wireless sensor networks (WSNs) are enabling real-time environmental monitoring, which has the potential to provide a plethora of fine-grained data to assist in understanding the symbiosis between FEW systems. This talk discusses some of the challenges in existing water quality datasets and introduces autonomous real-time water quality monitoring system design as an alternative to conventional monitoring systems. The system provides a more cost effective environmental data monitoring approach by integrating digital and mechanical devices connected through various communication networks, both wired and wireless. A case study on data availability on Long Island water quality is presented to demonstrate the challenges on data availability for modeling and simulation approaches. A networked sensing system is proposed which serves as a valuable tool for real-time monitoring of FEW resources and can be broadly applied to efficient management of their sustainability.

**Urban Data and Workflows for building sector transformation strategies**

Ursula Eicker, Ph.D., Professor, Stuttgart University of Applied Sciences

The presentation discusses the role of urban modeling tools for decision making and monitoring of climate protection measures in a regional district.The region of Ludwigsburg is a Southern German region with small to medium sized cities in Germany. A 3D CityGML model is available for 39 communities to model scenarios, develop measures and work with the regional governance to speed up implementation of sustainable infrastructure such as maximum renewable supply, to analyze building sector efficiency potentials and to discuss costs and roadmaps for the energy transition. Results are shown for energy and CO2 reduction for different refurbishment scenarios and renewable integration.

**Continuous Monitoring of Urban Dynamics Using Remote Sensing**

Michael Flaxman, Founder and CEO, Geodesign Technologies, San Francisco, CA.

Conventional remote sensing (RS) has made relatively modest contributions to our understanding of urban dynamics.  Its spatial resolution has been too low to image individual buildings or linear infrastructure, and its temporal frequency and reliability has been sporadic.  Most limiting has been the large amount of highly-expert labor required for image classification.

Recent advances in multiple technologies have begun to overcome these limits, and the role of RS in urban dynamics is due for major reconsideration.  The baseline for free public imagery has increased by approximately 9x in spatial and 3x in temporal resolution.  Global daily commercial imagery is widely available, and even videos from space.  The most far-reaching advance is likely to be on the image classification front, where deep neural networks (DNN) are now achieving performance exceeding manual human interpretation.  In order to explore this potential, we examined three historically-hard problems in urban metabolism:  land cover classification, hydrological runoff calculations, and light pollution mitigation.  In each case, we found that current machine learning methods are roughly comparable in quality to prior professional methods, while significantly improved in cost and turn-around times.

**Masoud Ghandehari, Ph.D.**, Associate Professor, Civil and Urban Engineering; Center

for Urban Science and Progress, Tandon School of Engineering, New York University.

This presentation will focus on the structure and maturity of the New York City data inventory. Such data includes both open and confidential data, as well as privacy constraints and degrees of freedom. Selected examples will be presented, highlighting opportunities for correlative analysis with applications of value to urban health and infrastructure resilience.

**Andrew Parker**, Researcher III, Mechanical Engineering, National Renewable Energy Lab

NREL is partnering with Panasonic Corporation and Xcel Energy to simulate and optimize the energy load profile of Peña Station NEXT, a planned 382-acre mixed-use development in Denver, Colo.  This presentation will review initial findings, including how building design influences electrical grid infrastructure, distributed PV, and energy storage.