

Sustainable Research and Training Program

Research Grants Awarded September, 2014

This program is a result of the agreement between the University of California, Davis (UC Davis) and Diamond Developers of Dubai, UAE to conduct research and training relating to technologies, systems, social conditions and experiences entailed in building, living in, and maintaining communities that are designed for sustainable living.

1. Sequential Energy and Compost Production from Organic Residues

Research Team

- Jean VanderGheynst, Professor, Biological and Agricultural Engineering, UC Davis, Principal Investigator
- Dr. Christopher Simmons, Assistant Professor, Department of Food Science and Technology, UC Davis, Co-Principal Investigator
- Dr. Ramin Yazdani, Assistant Professional Researcher, UC Davis Air Quality Research Center, Co-Principal Investigator
- Dr. Alissa Kendall, Associate Professor, Department of Civil and Environmental Engineering, UC Davis, Co-Principal Investigator
- Dr. Mutasem El-Fadel, Professor, Department of Civil and Environmental Engineering, American University of Beirut
- Sara Pace, PhD student in Biological Systems Engineering at UC Davis

Abstract

Composting and amendment of compost to soil can improve the sustainability of an ecosystem and community. However, composting processes, especially those treating wastes that are readily degradable, require energy to aerate and water to maintain biological activity, and can emit greenhouse gases (GHG). Some organic residue sources, including many that originate from food processing and handling operations contain organic matter fractions that can be readily converted to energy through anaerobic digestion. The overall goal of the proposal is to develop tools that allow organic waste management specialists to evaluate digestion and composting conversion scenarios to sustainably convert organic residues to valuable soil amendment. This goal will be met through coordinated research and training efforts at UC Davis and the American University of Beirut that will involve laboratory studies to elucidate the potential for methane and heat production from organic wastes followed by validation studies in the field. Scientific knowledge will be advanced through joint publications of the collaborators, development of educational materials and activities for the living laboratory of The Sustainable City in Dubai, and development of models to assess sustainability of waste management scenarios.

2. Developing Co-Products from Anaerobic Digestion: Application of Composted Anaerobic Digestate to Soil to Enhance Sustainable Agriculture and Waste Management

Research Team

- Dr. Christopher Simmons, Assistant Professor, Department of Food Science and Technology, UC Davis, Principal Investigator
- Dr. Jean VanderGheynst, Professor, Department of Biological and Agricultural Engineering – Co-Principal Investigator
- Dr. Ramin Yazdani, Assistant Professional Researcher, UC Davis Air Quality Research Center, Co-Principal Investigator
- Dr. Yigal Achmon, Postdoctoral researcher, Department of Food Science and Technology, UC Davis
- Dr. Mutasem El-Fadel, Professor, American University of Beirut

Abstract

New strategies are needed to advance sustainable management of food, agricultural, and green wastes while promoting sustainable agriculture. Capitalizing on the warm climate of the Gulf region, we propose development of a green technology that will use passive solar heating in conjunction with microbial production of volatile acids in the soil to inactivate pathogens and weed seeds in agricultural soils on rural and urban farms. Soil microbial activity will be driven by soil amendment with composted digestate from anaerobic digesters. Our preliminary data has shown that this technique is more effective than solar heating alone and leads to rapid inactivation of weed seeds, with no detriment to subsequently planted crops. Our technology provides a sustainable method to manage organic residues from anaerobic digestion, making anaerobic digestion more economically viable, while also creating opportunities to maintain soil health and safety without the need for harmful chemical fumigants.

3. Developing an Integrated Approach for Assessment and Utilization of Biomass for Improving the Sustainability of a City

Research Team

- Dr. Pramod Pandey, Assistant Specialist, Department of Population Health and Reproduction, UC Davis, Principal Investigator
- Dr. Salma Talhouk, Professor, Department of Landscape Design and Ecosystem Management, American University of Beirut, Lebanon, Research Partner
- Dr. Ali Chalak, Assistant Professor, Department of Agricultural and Food Sciences , Agribusiness, American University of Beirut, Lebanon, Research Partner
- Dr. Rashed Al-Sa'ed, Associate Professor (partner), Department of Sanitary & Environmental Engineering, Birzeit University, Research Partner
- Dr. Makaram Suidan, Professor/Dean, Department of Civil and Environmental Engineering, American University of Beirut

- Dr. Shadi Hamadeh, Chairman, Environment and Sustainable Development, American University of Beirut

Abstract

Here we propose to carry out research, outreach, training, and demonstration studies for recycling organic waste (i.e., food waste, turf grass clippings, and tree waste), and converting these multiple waste streams into soil amendment for community farms of the Sustainable City. The proposed research aims to develop a supply chain model which is capable of calculating the availability of organic waste, conversion efficiencies (from feedstock C, N, P to C, N, P of digestate), and soil amendment yields and demands of a city engaged in urban agriculture. We will evaluate three composting processes: aerated composting (powered), vermicomposting, and windrow composting. In addition, outreach and training activities will be conducted in Dubai to disseminate the research findings, and to enhance the understanding of sustainability among potential stakeholders of the Sustainable City. The research will be performed at three different locations: University of California, Davis, USA; American University of Beirut, Lebanon; and Birzeit University, Palestine. We anticipate that the proposed research will be crucial for enhancing the sustainability of the Sustainable City and will help in deriving the strategies for recycling urban waste, developing an improved urban agriculture system, and protecting the urban environment, hence mitigating public health risk.

4. Demonstration of Novel Water Technology at TSC – Dubai

Research Team

- Bassam Younis, Professor of Hydraulics and Fluid Mechanics, Civil and Environmental Engineering, UC Davis, Principal Investigator
- Yusuf Abou Jawdah, Professor, Agriculture and Food Sciences, American University of Beirut, Partner

Abstract

To construct a newly-designed reactor for water disinfection using UV light, to test this reactor at various facilities at UC Davis including at a greenhouse and at a recreational pool, to use solar panels to power this reactor, to transport this reactor to TSC - Dubai and install it at the grey-water treatment plant to demonstrate its potential role in achieving the community's targets in the sustainable use of energy and water and to participate in outreach and education activities that highlight Diamond Developers' support for research on sustainability.

5. Assessment of the Hybrid Solar Technologies for Air Conditioning in the Sustainable City of Dubai

- Pieter Stroeve, Director UC Davis California Solar Energy Collaborative and Distinguished Professor in Department of Chemical Engineering and Materials Science, Principal Investigator
- Masoud Rahman, Solar Research Engineer, UC Davis California Solar Energy Collaborative, Co-Principal Investigator
- Nesreene Ghaddar, Professor, Mechanical Engineering, American University of Beirut
- Kamel Ghali, Chair, Department of Mechanical Engineering, American University of Beirut
- Sara Outcault, UC Davis Western Cooling Efficiency Center. Social and Behavioral Scientist

- Steven Wiryadinata, UC Davis Department of Mechanical Engineering, Building HVAC Engineer
- Tobias Benjamin Barr, UC Davis Energy Institute and UC Davis Energy & Transportation Hub, Project Manager

Air conditioning is one of the major energy consumption items in Dubai and counties with the same environmental conditions. Employing renewable technologies for air conditioning energy will be a major step toward sustainable and green cities. In this proposal, different solar technologies scenarios for providing the air conditioning of one of the buildings in the Sustainable City will be evaluated. This study will include the determination of air conditioning demand of the building based on the environmental condition, behavioral aspects of the users of the building, air conditioning modeling, and the technologies available in the building. In the next step, various solar technology scenarios such as hybrid photovoltaic-thermal (PV/T) and hybrid solar thermal-absorber chillers will be evaluated. Finally, based on the technical, commercial, economic, social impact, and environmental benefit the best scenario will be recommended to the sponsor (Diamond Developers).