

***Creating Futures***

University of Colorado *Denver*

*Small Footprints,  
Big Impacts*

*Center for Sustainable Infrastructure Systems*





## Infrastructure: Where Sustainability Meets Reality

To some, hybrid cars, solar panels and pristine open spaces are symbols of sustainability. While these popular signifiers play a crucial role, we must also focus on the foundations of our built environments—the infrastructure that underlies our cities and towns, at the crossroads between economic viability, individual well-being and nature.

By improving how we manufacture goods and services, manage our water, build utility grids and design transportation networks—thus reducing our footprint on the planet—we ensure a more sustainable future for the billions living in our cities and towns and all that lies beyond.

Built environments involve complex systems and linkages. Enhancing their sustainability entails logistic, coordination and political challenges. But no one group can solve these problems singlehandedly. To solve these problems, we need collaboration from many stakeholders including:

- **Engineers** to understand complex systems and design innovative technologies that conserve resources and protect the environment
- **Environmental scientists** to ensure positive consequences on human and environmental health
- **Policy experts** to navigate varied approaches and reconcile diverse motives and constituencies
- **Regulators** to establish consistent, measurable, achievable standards
- **Industry** to pursue production models that are both environmentally and economically sustainable; and
- **Nonprofits and advocacy groups** to engage our citizens in our quest toward a better future, and facilitate rapid diffusion of innovation



*A “blueprint-to-photo” rendering of a water-treatment project undertaken by Broomfield-based engineering firm MWH.*

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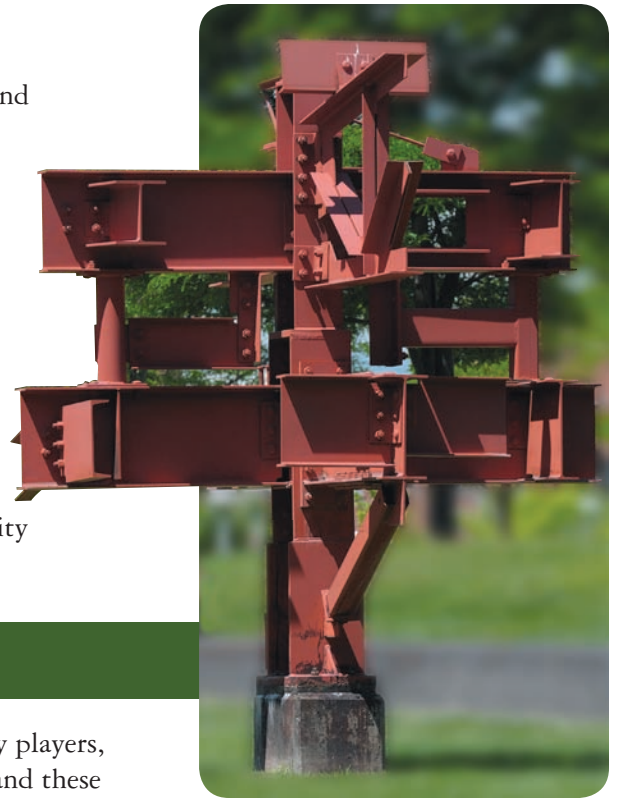
## We must address these challenges soon.

With increasing global population growth, fossil fuel, water, mineral and land resources are in short supply. These resource constraints challenge our infrastructure's ability to deliver essential services to people. Communities worldwide face an imposing challenge—how to secure environmentally and economically viable infrastructure for all people, now and into the future.

Fortunately, with federal stimulus funding shining a new light on old infrastructure, we now have a once-in-a-generation opportunity to effect great paradigm changes. We need a center to pioneer new models for sustainable infrastructure. It must reside beyond the marketplace, beyond government and beyond populism. And it must systematically harness the power of all stakeholders, at a major university such as the University of Colorado.

## UC Denver is the Place

At the Center for Sustainable Infrastructure Systems at UC Denver, key players, concepts and critical models can converge across multiple disciplines, and these challenges can finally be addressed. Expanding upon the resources, breadth and connections of a dynamic research university, this Center for Sustainable Infrastructure Systems—opening Spring 2010—will be a catalyst for solutions. With your help, we'll find these solutions sooner, to benefit all who live within and beyond our cities and towns.



*This sculpture on UC Denver's Auraria campus doubles as a teaching tool, used by the civil engineering department to show variations in girder construction.*

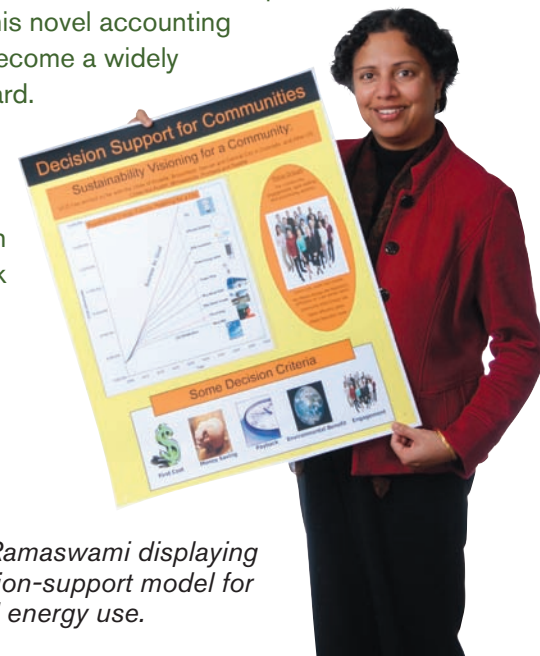
## Benchmarking Greenhouse Gas Production

The average American is responsible for 25 metric tons of greenhouse-gas emissions each year. Behind this thumbnail number lies a complex backstory—the story of the various infrastructures we need to sustain life in our cities. As carbon taxes and other energy incentives are legislated, communities, businesses and governments are using their carbon footprints to measure, strategize, prioritize and implement innovative infrastructure programs for sustainability.

**Anu Ramaswami**, UC Denver professor of environmental engineering and director of the Center for Sustainable Infrastructure Systems, has led the development of a holistic carbon-accounting method for cities that encompasses all human activity (or infrastructure) sectors. Pioneered in Denver, the method has since been applied to eight Colorado cities and eight cities nationally.

As a direct result of this method, Denver became the first city government to institute a green concrete

policy—incorporating recycled aggregates and fly ash into public-works concrete projects. For this, Denver and UC Denver jointly received the Environmental Protection Agency's Pollution Prevention Partnership award in 2008. This novel accounting approach could become a widely recognized standard. Interest has been expressed by international organizations such as the World Bank in applying this to cities worldwide.



*Dr. Anu Ramaswami displaying her decision-support model for municipal energy use.*

# The Center for Sustainable Infrastructure Systems will:

- **Develop innovative systems design approaches** that simultaneously address technological and environmental performance, economic viability and societal needs
- **Promote rapid diffusion of these innovations** by integrating science and technology with social actors
- **Develop a database of innovations**, pilot tests, field implementation and outcomes assessments
- **Facilitate and provide an objective forum** for dialogue among stakeholders
- **Establish a clearinghouse for information** on history, technology, trends, policies and breakthrough developments in related areas
- **Develop new technologies and management strategies** for water, energy, transportation and communication systems, with applications in diverse municipal and industry circumstances
- **Be a knowledge hub** for industry, regulators, public officials, academics, nonprofits and citizens
- **Overcome challenges and reveal opportunities** in implementation of new technologies and processes
- **Educate the next generation of professionals** with the multidisciplinary skills essential for progressing toward sustainability
- **Be a pioneer** that will generate greater emphasis on issues of sustainable infrastructure



# Building Upon UC Denver's Existing Assets



## The Center will benefit from:

- **UC Denver faculty expertise**, striking a fruitful balance between teaching and research
- **Interdisciplinary links** between UC Denver's College of Engineering and Applied Science, the School of Public Affairs and researchers throughout UC Denver and beyond
- The **Integrative Graduate Education and Research Traineeship (IGERT)**, a National Science Foundation-funded UC Denver program that attracts and educates doctoral students to become tomorrow's leaders on sustainable infrastructure systems
- The designation of **sustainability as a core priority** by both UC Denver and the State of Colorado
- **Established partnerships** with the Colorado Municipal League, Governor's Energy Office, National Civic League, Colorado cities and regional commercial firms and nonprofits
- **Regional resources focused on sustainability** and cities including federal labs such as the National Renewable Energy Laboratory, urban forums such as the National League of Cities and thriving industries in both green and traditional energy
- **A forward-thinking community mindset**, with cities and towns—our “working laboratories”—excited to work with us, an engaged populace and a pristine setting that exemplifies the values of a sustainable approach

With these key elements already in place, all we need is your support for the Center for Sustainable Infrastructure Systems to thrive at UC Denver.

## UC Denver Researchers Use Waste to Generate Energy



Staffers at the Denver Zoo are teaming up with researchers at UC Denver to turn poop into power. Waste from the zoo is sent to assistant professor of civil engineering and bioenergy researcher **Jason Ren**, who takes the liquefied waste and pours it into a handful of small gas reactors called microbial fuel cells (MFCs). MFCs are a novel technology that can harvest electricity directly from organic materials by using common bacteria from a wastewater treatment plant, without the need for gas treatment or linkage to a biogas engine. Ren thinks the application eventually could turn America's existing water treatment plants into power plants—producing electricity from the water they are already cleaning.

We plan to develop a decision-support tool to help wastewater plant operators weigh costs and benefits to various waste-recycling approaches for large-scale applications. We also plan to establish a demonstration MFC pilot suitable for industrial wastewater.





From left to right: civil engineering professor Kevin Rens, recent doctoral graduate Angela Hager and assistant professor Stephan Durham, during installation of green concrete on UC Denver's Auraria Campus.

## You Can Invest In Our Future

UC Denver has expressed great confidence in the mission of the Center for Sustainable Infrastructure Systems by supporting the Center's launch. Private partners ranging from the AT&T Foundation to the Walmart Foundation have made gifts to support our research. This early momentum helps our work have a "multiplier" effect, attracting federal and other external grants that bolster our academic enterprise and our on-the-ground impact in the region. But additional private support is needed to enable the Center to build interdisciplinary faculty teams that work on sustainable infrastructure projects, and to operate at full strength going forward.

### Our fundraising goals for this phase include:

- **Naming the Center** to ensure a perpetual operational basis for the center and establish an unprecedented legacy in favor of sustainable built environments. *\$5 million, endowed*
- **An endowed faculty chair** to give Center leadership the resources needed to effect transformative research and positive change. *\$2 million, endowed*
- **Fellowships** that enable students and faculty to pursue research in key areas of concern. *\$250,000 each for students (4); \$750,000 for faculty, endowed*
- **Laboratory space** to enable graduate students to obtain practical experience working side-by-side with renowned faculty, bringing together great minds from varied disciplines. *\$500,000, one-time current*
- **Outreach** including student internships, municipal partnerships, and funds for speakers to bring cutting-edge ideas and developments to UC Denver, enhancing exposure and community connections for the Center and university at large. *\$110,000, annual*
- **Technology transfer** to communities, governments and businesses, including the organization of a regional conference. *\$50,000, annual*



IGERT doctoral student Karen Kronoveter conducting research on waste-to-energy conversion.

## Rapid population expansion in global cities, often exceeding 5 percent of annual growth, is changing regional patterns of water use.

As cities expand, they take over rural lands and waters; agricultural activity shifts downstream from cities, using urban wastewater generated by urban residents that may provide a more continuous but poorer-quality water source.

What is the optimum configuration of wastewater treatment that can be designed in such areas to conserve water, enhance water quality, reduce health risks to humans and minimize energy use and greenhouse gas emissions?

A UC Denver-initiated energy- and water-efficiency assessment of recently constructed wastewater treatment plants in India, combined with field measurements of pathogens in irrigation water and in food, will be used to answer this question.



# Make a Difference Today



To learn about the many ways you can make a gift:

## Contact Ginny Davis

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The challenge of sustainability is that there is no single silver bullet. Rather, a portfolio of infrastructure interventions is needed to bring together the marketplace, government and citizens. Unless society as a whole implements a broad range of actions together, we will continue on a risky path toward an unsustainable future. But if we take corrective action, future generations will reap the benefits.

This future depends on people like you who care enough to make a difference. By making a gift toward the Center for Sustainable Infrastructure Systems, we will work together to build a sustainable world that maximizes our human potential. Please join us in this vital endeavor.



*"When we deal with the costs of doing business sustainably, we need to be able to demonstrate that doing right for the planet also does right by the bottom line. The Center for Sustainable Infrastructure Systems can provide new ways to 'metric' these advantages, and produce well-rounded students who understand not only engineering, but also business, ecology and other fields required of tomorrow's design/build industry leaders."*

**Bob Uhler, Chairman and CEO**  
MWH, a Broomfield-based global engineering firm

## University of Colorado Denver

*All gifts should be payable to the University of Colorado Foundation, specifying the appropriate fund.*

March 2010