

UCD-IGERT:UCD-IGERT: Sustainable Urban Infrastructure

Dr. Anu Ramaswami

Professor and Director, IGERT Program on Sustainable Urban Infrastructure
Center for Sustainable Infrastructure Systems
University of Colorado Denver



IGERT Students



UCD-IGERT Program on Sustainable Urban Infrastructure

Principal Investigators

- Anu Ramaswami, Engineering and Applied Science
- John Brett, Liberal Arts & Sciences
- Debbi Main, Family Medicine
- Brian Muller, Architecture & Planning
- Paul Teske, Public Affairs

Participating Faculty

- Kevin Krizek, Fred Andreas, Bruce Goldstein, Jeremy Nemeth (CAP)
- Chris Weible, Tanya Heikkela, Peter deLeon (SPA)
- Jason Ren, Arun Karunanithi, Bruce Janson, Kevin Rens, Wes Marshall, Stephan Durham (ENGR)
- Steve Koester, (HBS)

Center for Sustainable Infrastructure Systems

Administrative Team

- Dr. Anu Ramaswami (Professor and Director)
- Felix Flechas (Managing Director)
- Dr. Chris Weible, Dr. Tanya Heikilla (Professor and Asst. Director)
- Luann Rudolph (Asst. Director of Operations)
- Alison Culpen (Sustainability Outreach Project Coordinator)

Why Urban Sustainability? Emphasis?

- Challenge:
 - Population, human development, resources, vulnerability
- No single discipline has the solution



Our Program



What is IGERT?

Integrative
Graduate
Education
Research
Traineeship

- Highly competitive national award of \$3.2M from the National Science Foundation (NSF)
- Funds 26 PhD students in inter-disciplinary focus
- Integrates engineering, planning, policy, and behavior change strategies for sustainable infrastructure

IGERT Theme of Sustainable Urban Infrastructure at UCD

Design, analysis and rapid diffusion of sustainable urban infrastructures of the future by integrating technologies with social actors



Multi-Sector, Hard, Soft, Green
Multi-Sector, Hard, Soft, Green
Infrastructures



UCD Center for Sustainable Infrastructure Systems



New York Times Article

The New York Times

URBAN ENVIRONMENT

Sustainability Comes of Age

By HENRY FOUNTAIN

Published: December 29, 2009

WHEN Andrew Pattison was looking to pursue a graduate degree in sustainability, he drew on his post-college experience working as a conservation biologist in upstate New York. Butterflies were his thing, and he produced numerous recommendations about what should be done to protect them. "I found that quote-unquote important people who were decision makers would read the reports I filed and then not follow them," Mr. Pattison says.

[Enlarge This Image](#)



Those frustrations led him in a different direction. "I knew I wanted to study the way decisions were made on environmental policy," he says. He also knew where many of the important decisions were made: in cities. With energy and climate policy, he says, "the problem is global, but all politics are local."

Mr. Pattison, 32, is now a doctoral student in the [sustainable urban infrastructure program at the University of Colorado, Denver](#). It's one of a growing number of graduate programs in sustainability where the issues affecting cities are front and center.

SIGN IN TO RECOMMEND

TWITTER

SIGN IN TO E-MAIL

PRINT

SHARE



Four Unique Aspects of Our Program

- **Systems approach**
 - Integrates across infrastructures/sectors
 - Interconnections between water, energy, waste, transport
 - Applies environmental Life-cycle Assessment (LCA) Applies environmental Life-cycle Assessment (LCA)
- **Multi-objective: Multi-objective:** Infrastructure Performance + {People, Prosperity and Planet}
- **Outcomes and Metrics driven**
- **People + Processes**
 - Policy process, community engagement, institutions

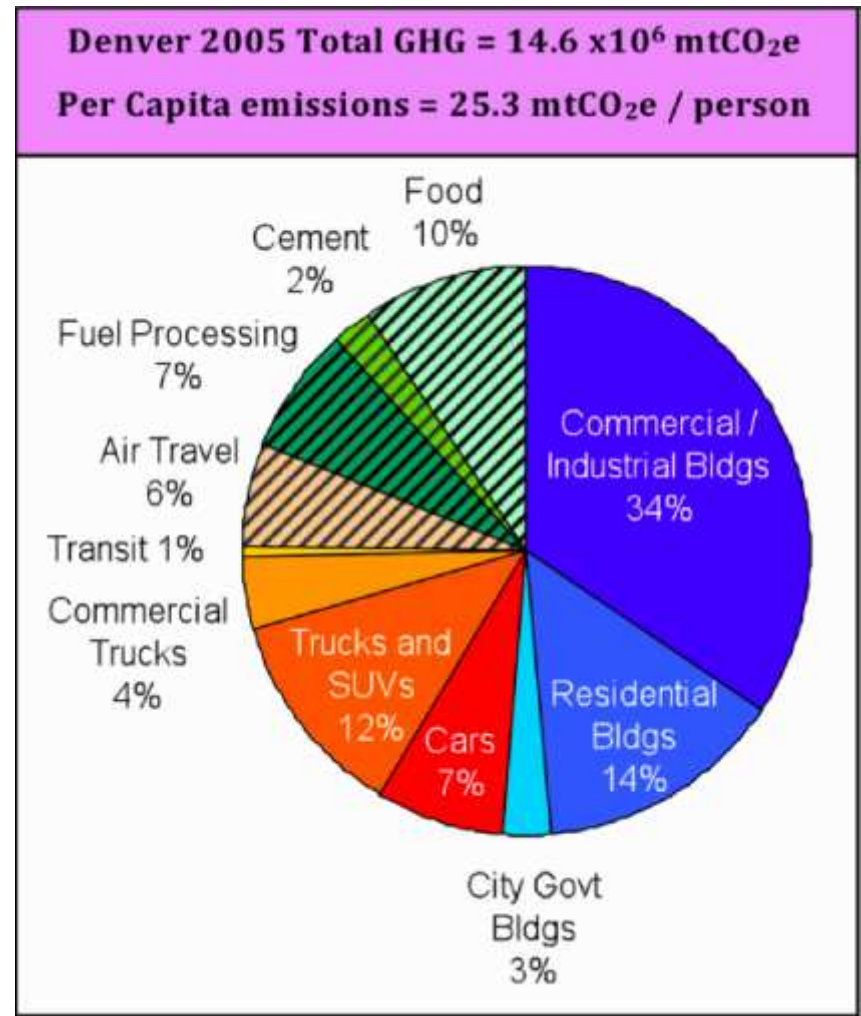
Example Projects



Systems Approach:

Life Cycle Based Carbon Accounting

- Using LCA and material flow analysis to quantify city-scale to quantify city-scale greenhouse gas (GHG) emissions
- Replicated method with:
 - 8 CO cities
 - 8 Cities nationally



Ramaswami et al., 2008.

Systems Approach:

Cross-Sector Solutions - Waste to Energy



Wastewater Treatment Plant



Use of Microbial Fuel Cells
to directly convert waste to
electricity

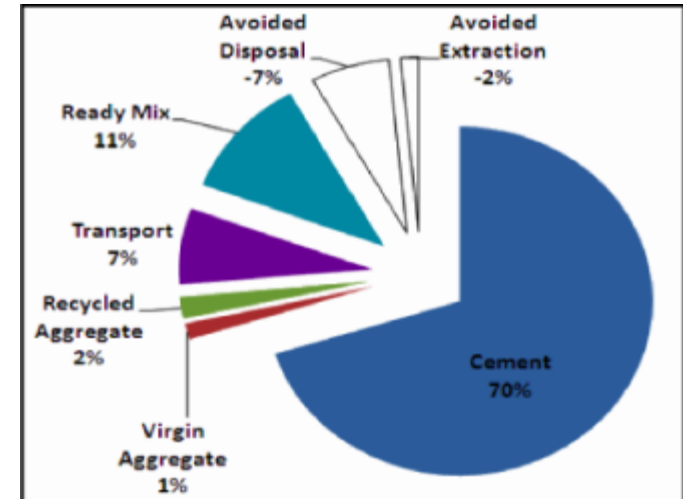


Electricity

Multi-objective: High Performance Green Concrete



High Strength and More Durable



GHG Mitigation = 0.17 mtCO₂e/ton



Lower Cost

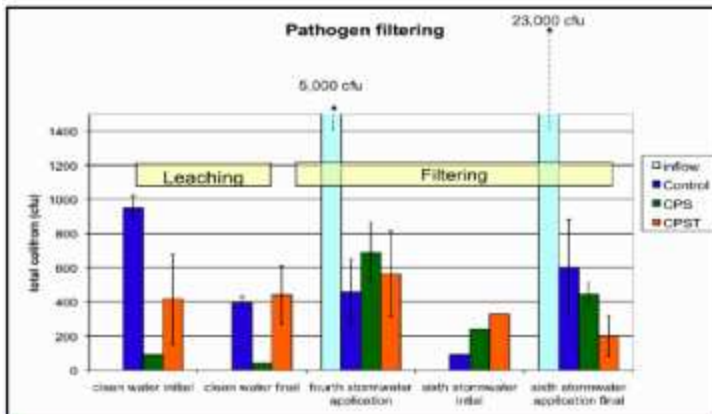
Reiner and Ramaswami, 2009;
Reiner, Rens, and Durham 2009

Multi-objective Engineering: Waste-Incorporated Stormwater Infrastructures

Waste Materials Reuse



Water Infiltration



Pathogen Removal

Guo et al., 2009, Ren and Mays, 2009



Lower Cost

Outcomes and Metrics Driven: Community-Scale Sustainability

Environmental Outcomes



Bike Share in Denver, CO

[Andrew Duvall]

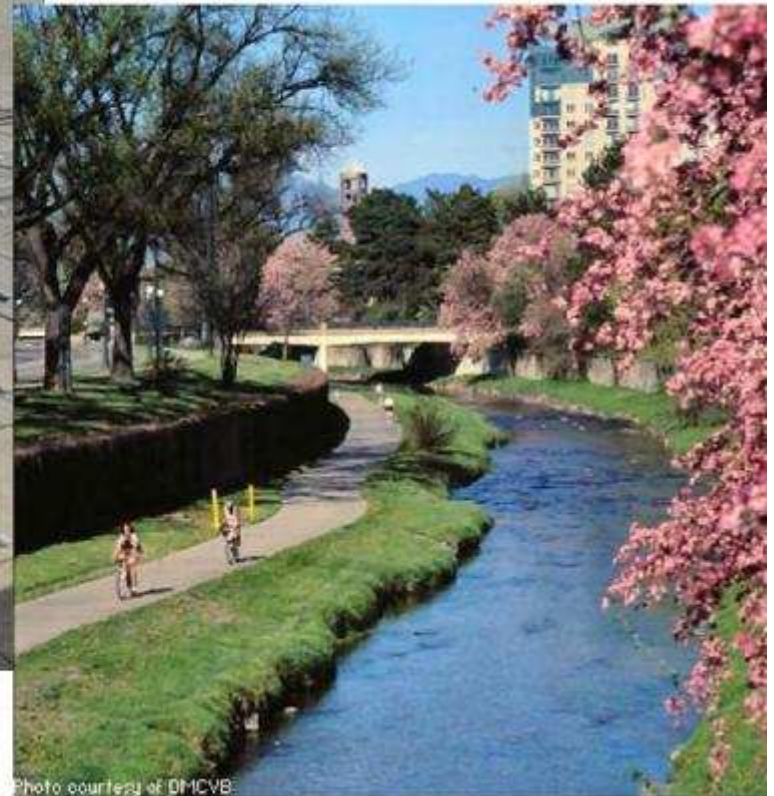
Health Outcomes



Urban Design & Health, Stapleton CO

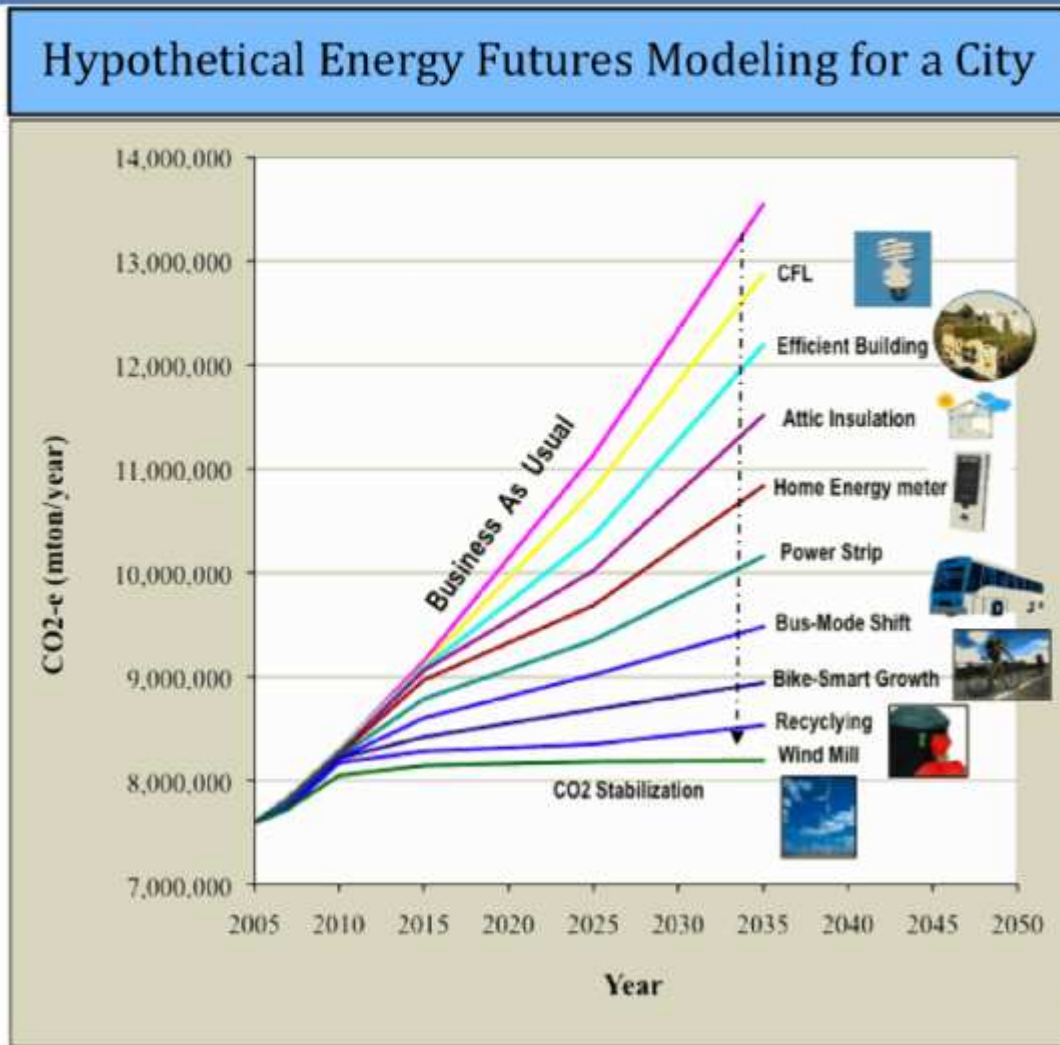
[Debbi Main]

Outcomes and Metrics Driven: Evaluating Non-Motorized Transport



[Dan Piatkowski, Andrew Duvall, Krista Nordback,
Eric Stonebraker, Kevin Krizek]

People and Processes: Community Engagement for Sustainability



Broomfield, CO:
Combining
Analysis with
Deliberation



[Andy Pattison, Laurie Madden, and Devin]

People and Processes: Voluntary Environmental Programs



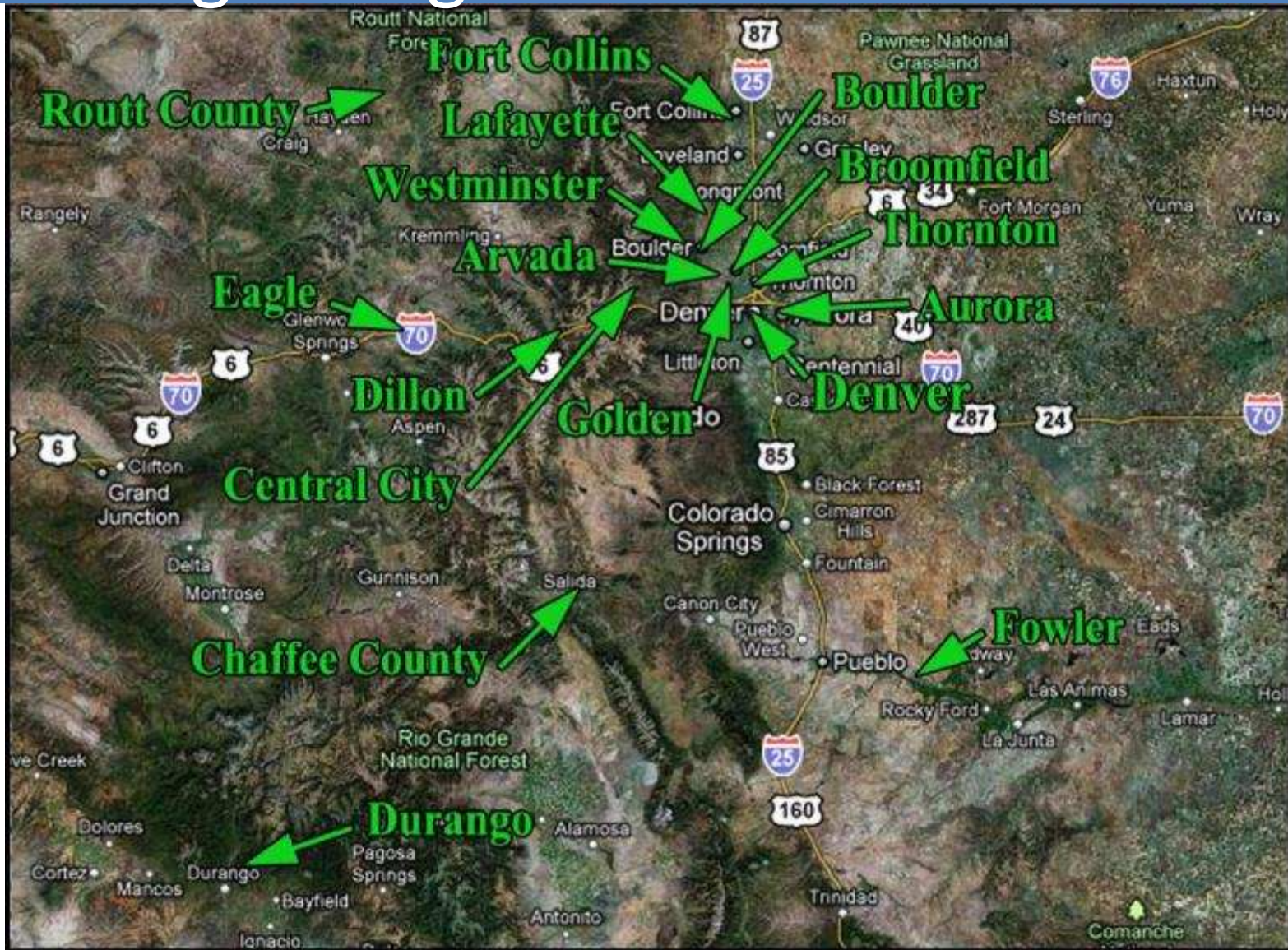
[Andy Pattison, Laurie Manderino]

Working with Cities

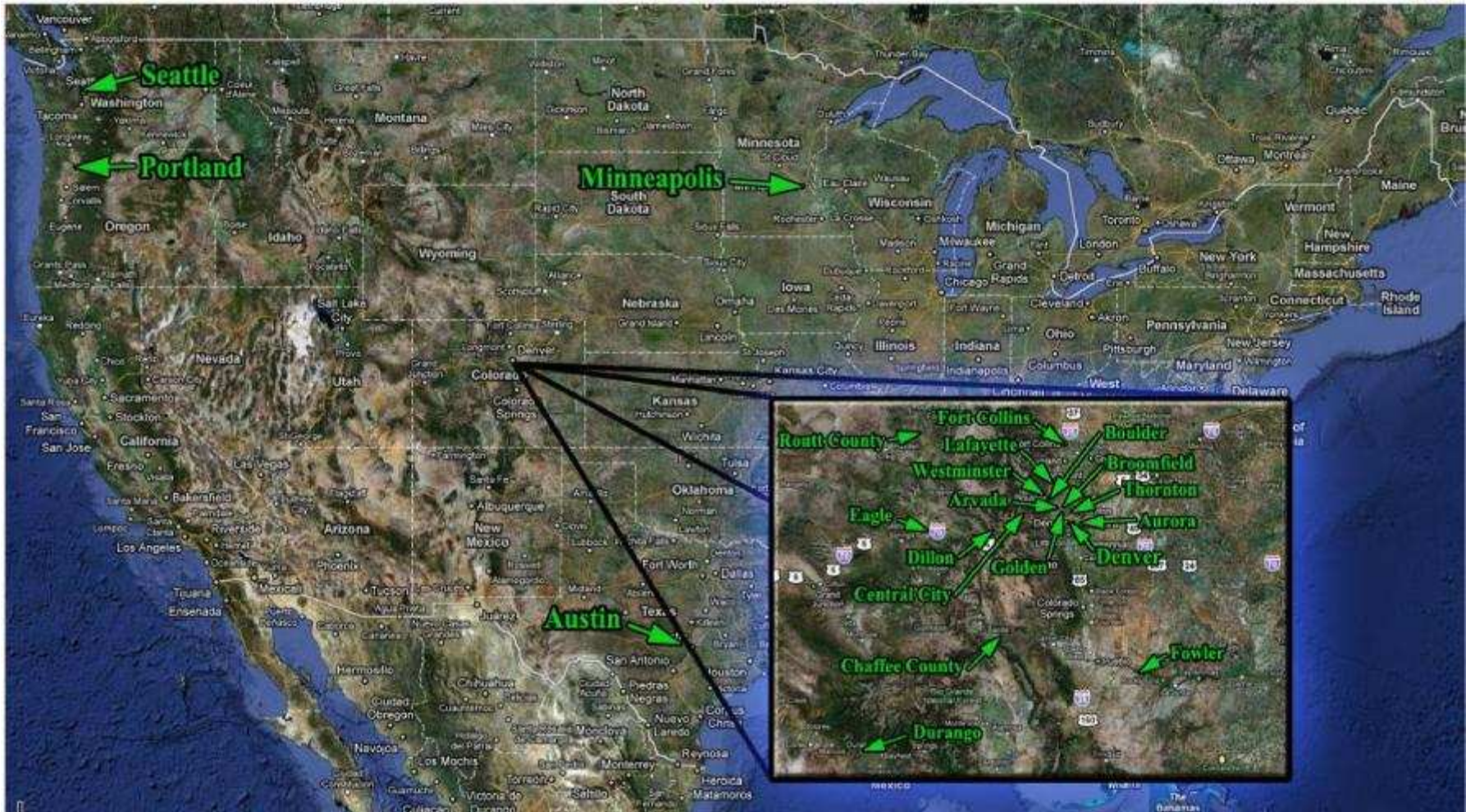


[Andy Pattison, Laurie Manderino]

Outreach to Colorado Cities: Originating with Denver in 2005



Our Work in U.S. Cities



*Hillman, T; Ramaswami, A. . ES&T 2010

Our Work in Global Cities

Our Global City Network*:

- Bangkok (city)
- Barcelona (city)
- Cape Town (city)
- Denver (city and county)
- Geneva (Canton)
- London (GLA)
- Los Angeles (county)
- New York City
- Prague (GPR)
- Toronto (GTA)

Cities in India:

Hyderabad, Rajkot and Coimbatore



*Kennedy, C et al. "Greenhouse Gas Emissions from Global Cities." Accepted to Environmental Science & Technology 2009, 43, 7297-7302, August 20, 2009.

Curriculum and Certificate Programs



Innovative Interdisciplinary Curriculum

- Introduction to Sustainable Infrastructure
- Defining and Measuring Sustainability
- Social Science Theories of Change for Sustainability
- Infrastructure and Public Health

Electives in Specialized Areas

· Transportation

· Energy and Buildings

· Water and Wastewater

· Food Systems

Hands-On Learning Exhibits at

Hands-On Learning Exhibits at UCD

Stormwater Test Bed

Renewable Energy Testing

Freeze-Thaw durability test
Freeze-Thaw
durability test

LCA and MARKAL Model

Interdisciplinary Graduate Programs

- Choice of Innovative Sustainable Infrastructure Programs
 - Certificate Program for retraining (4 courses only)
 - Open to all disciplines
 - Post-Graduate Degrees for Advancement
 - MS Environmental and Sustainability Engineering
 - MEng Sustainable Infrastructure
 - PhD
- In addition, UCD has MPA, MBA, MURP graduate programs with sustainability focus
- Focused on working professionals
 - Downtown location
 - Most courses 4:00 pm or later
- Excellent and diverse faculty: Track record for successful projects in multiple sectors

Connecting with the World: Our Students Making an Impact



Installing a Wind Generator
in a Tribal Village in India



EPA's National P3 Student
Design Award: 2005



Participatory Planning with
Cities

Blazing the Trail for Entrepreneurship in Sustainability
Engineering in CO

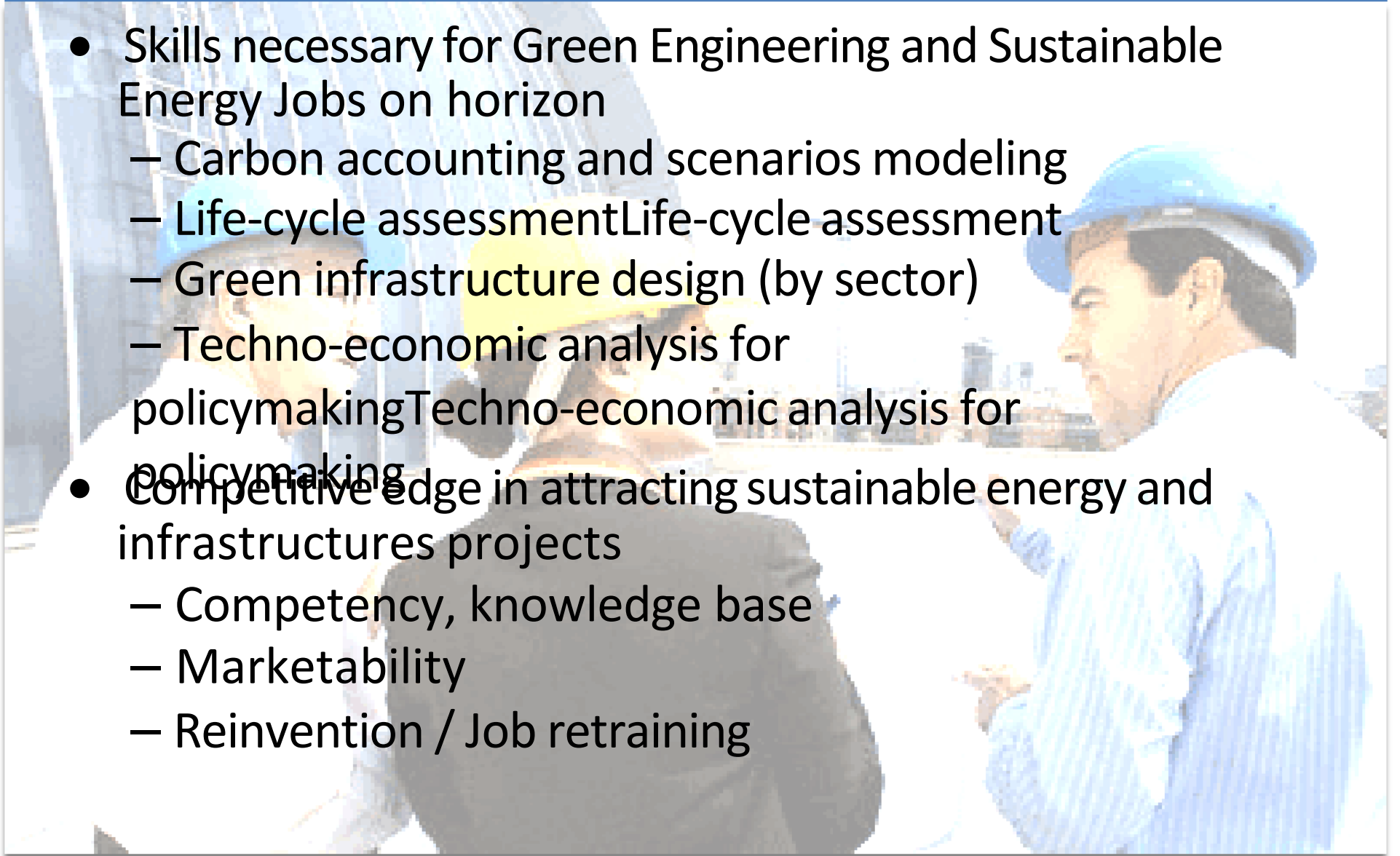


Professional Engineering
Activities in Colorado



Workforce Training

- Skills necessary for Green Engineering and Sustainable Energy Jobs on horizon
 - Carbon accounting and scenarios modeling
 - Life-cycle assessment
 - Green infrastructure design (by sector)
 - Techno-economic analysis for policymaking
- Competitive edge in attracting sustainable energy and infrastructures projects
 - Competency, knowledge base
 - Marketability
 - Reinvention / Job retraining



Sponsors and Partners



Other Program Sponsors and Partners: Public Sector

- Colorado Cities:
 - Denver, Arvada, Central City, Broomfield, Aurora, Durango, Lafayette, Thornton, Westminster, Chaffee County, Golden, Eagle, Dillon, Fowler, Routt County
- Governor's Energy Office
- Colorado Municipal League (CML)
- National Civic League
- Urban Drainage and Flood Control District
- Colorado Department of Public Health & Environment
- Office of Naval Research
- USEPA-P3 Program

Other Program Sponsors and Partners: Private Sector

- **AT&T Foundation:** Faculty Fellowship in Industrial Ecology
- **Wal-Mart Foundation:** Wal-Mart Foundation: Outreach to Colorado
Cities in partnership with CML
- **MWH:** Sponsored project with funded student
- **Clinton Global Initiative University Outstanding Commitment Award:** funding student outreach

Questions?

Thank you!

www.cudenver.edu/IGERT