

Turkey-Michigan Forum
“Trends in Research and Development with
Industry”
June 03-06, 2012

Trends in Water and Energy Security

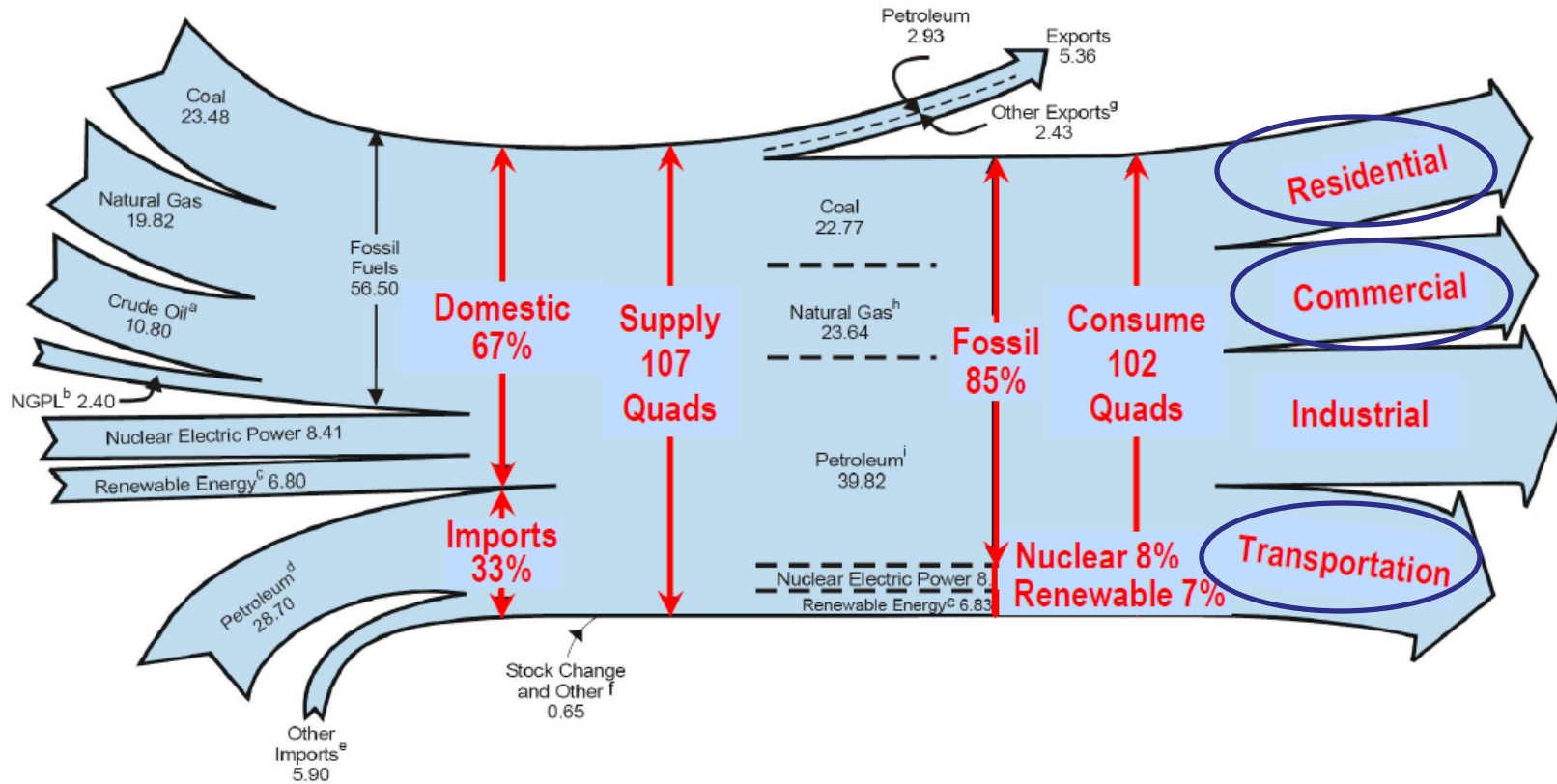
Dr. Haluk Aktan
Professor & Chair



WESTERN MICHIGAN UNIVERSITY

Civil and Construction Engineering

Background: U.S. Energy Flow, 2007 (Quads)

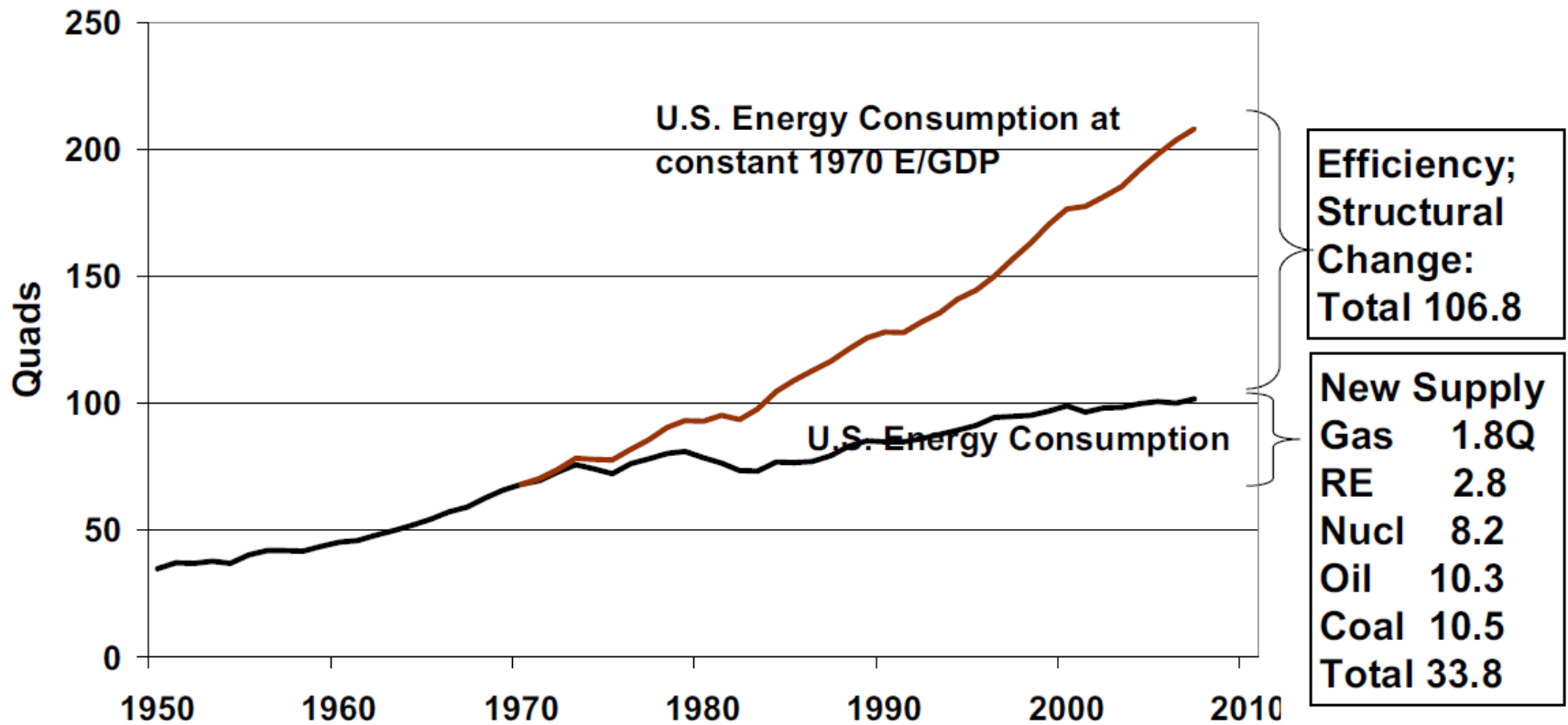


(Source: http://www.science.doe.gov/SC-2/Deputy_Director-speeches-presentations.htm)



Background: Energy Efficiency (1970-2007)

U.S. Energy Consumption

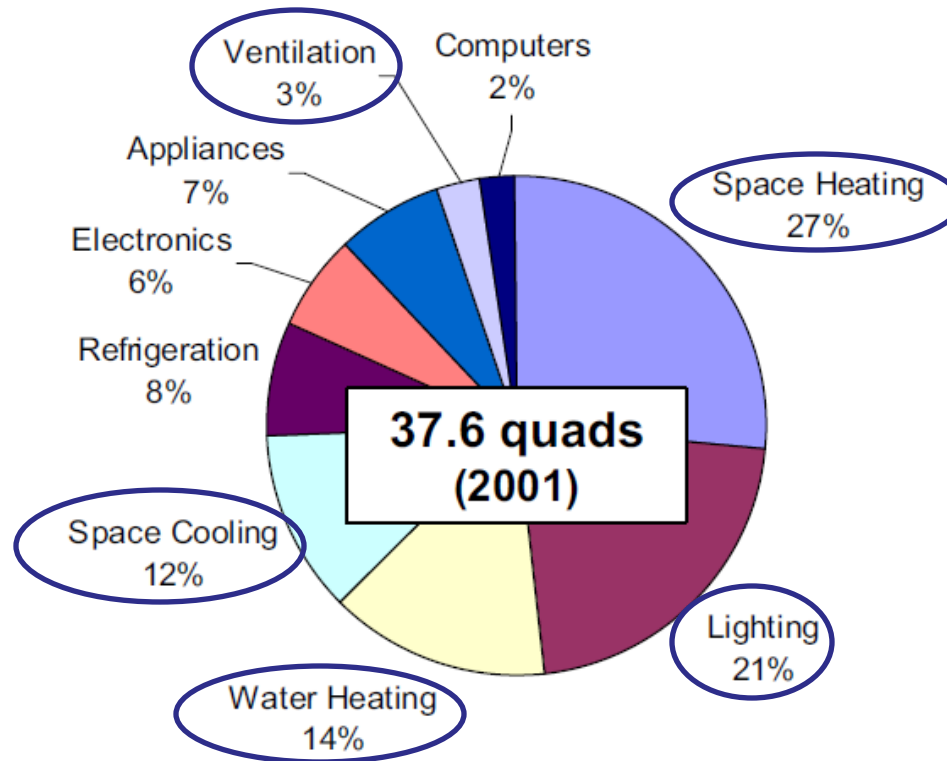


(Source: American Society for Engineering Education, 2009)



Background: Building (Residential, Commercial) Energy Use

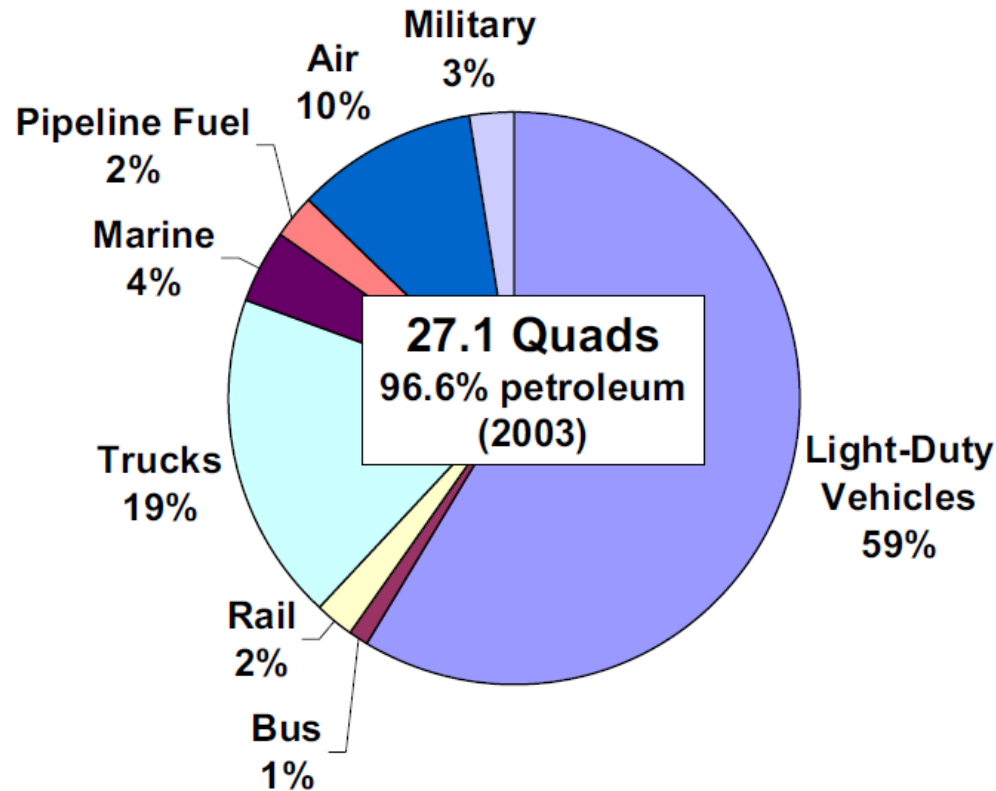
Total Primary Energy (all fuels)



Source: Building Technology Program Core Databook, August 2003. <http://buildingsdatabook.eren.doe.gov/frame.asp?p=tableview.asp&TableID=509&t=xls>



Background: Transportation Energy Use



(Source: American Society for Engineering Education, 2009)



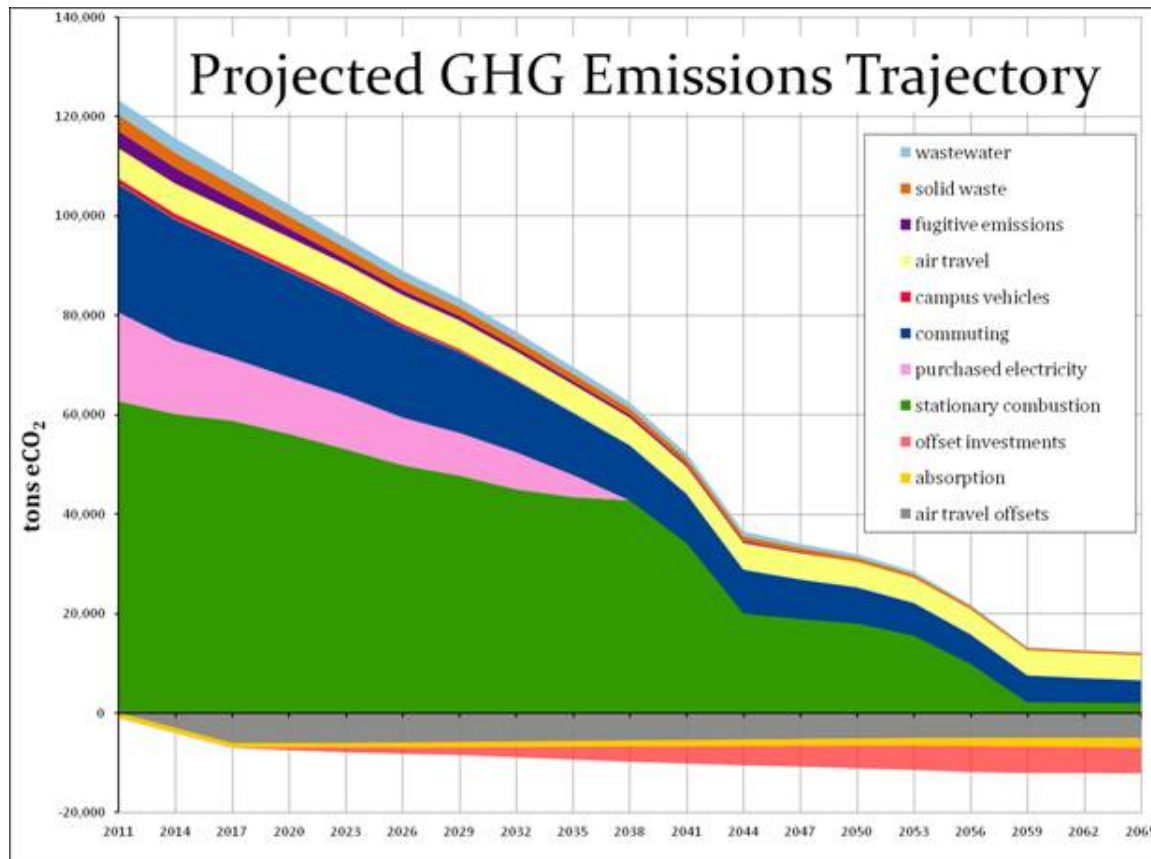
Background: Energy Future

- Generation, new/old technologies
- Management
- Security
- Climate change



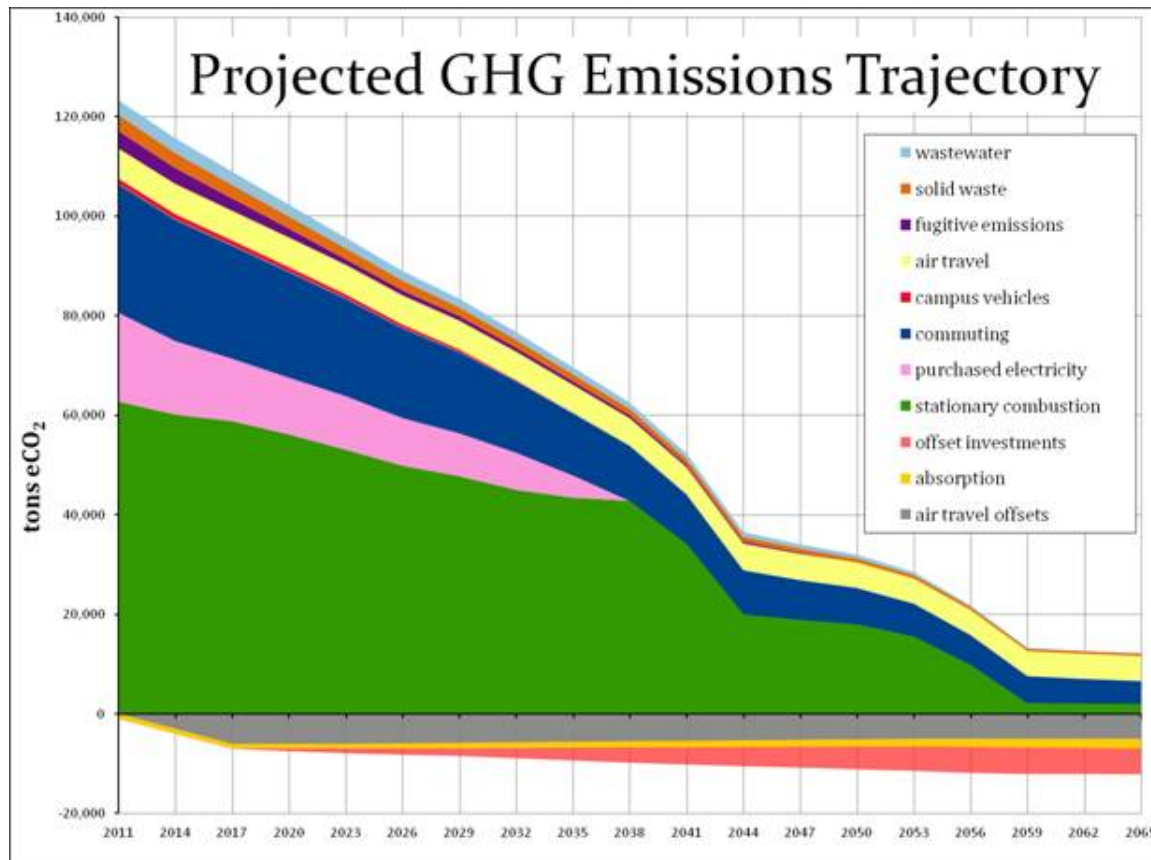
Climate Action Plan at Western Michigan University

- Future plans under consideration to advance sustainability, climate change, and climate neutrality learning opportunities include:
 - Integration of sustainability and climate neutrality education across the entire WMU curriculum
 - Redeveloping the Campus Sustainability website to share more information on WMU's efforts
 - Creating a html Office for Sustainability newsletter to help spread the word



Climate Action Plan at Western Michigan University (cont.)

- Future plans under consideration to advance sustainability, climate change, and climate neutrality learning opportunities include:
 - Creating a public lecture series to share innovative GHG reduction efforts (such as zero net buildings and the Living Building Challenge)
 - Building an asset map of who is doing what on campus—climate change and sustainability related—to facilitate communication, cooperation, and collaboration, ...



Sharpening CCE Department teaching,
research and service mission:
Technologies for Livable and Sustainable
Communities (LSC)

Adoption of existing technologies and
developing new technologies



LSC Attributes

- Buildings and Housing
- Public Mobility and public transportation
- Energy sustainability & management
- Information and communication
- Water management
- Waste water and solid waste management
- Education & job development
- Arts & Culture, Recreation



CCE Curriculum for LSC

- **General** - Sustainability design and analysis
- **Materials** - Carbon footprint and recyclability analysis, materials of extreme durability, renewable materials
- **Structural design** - Life cycle design, design to recycle, design with recycled structural materials, design for preservation, design for durable structures, design for optimal maintenance, integrated design construction and operation
- **Transportation** - Transportation modes and impact on liveability, mass transit, intermodal connectivity, non-motorized path, urban road design for pedestrian comfort, technologies for sensing-controlling-managing traffic



CCE Curriculum for LSC

- **General** - Sustainability design and analysis
- **Construction** – BIM, Green design concepts, lifecycle energy management, self sustaining buildings, renewable energy, deconstruction for recycling, healthy and comfortable building interior
- **Environmental** – waste reduction, waste water treatment sustainable options, surface water, runoff design



CCE Curriculum for LSC

CCE 3080 – Civil Engineering Materials

- Use of recycle and renewable materials –steel, concrete, wood
- Use of industry by-products – fly ash, silica fume, slag
- Performance based design of concrete mixtures and durability
- Practice of proper testing techniques to yield accurate results to minimize material waste
- ACI Concrete Field Testing Technician – Grade I

CCE 6480 – Finite Element Applications

- Use of a state-of-the-art simulation technology that is used in many disciplines ranging from civil, mechanical, automotive, and aeronautical engineering to material science, electrical and electronic engineering, and biomedical engineering to improve safety and optimum use of resources in product development.

CCE 6470 - Bridge Engineering

- State-of-the-art bridge construction technology to minimize disruption to travelling public while improving safety, durability, and aesthetics.
- Inspection procedures and techniques to assure safety of bridges and to collect quantitative data for making effective and efficient maintenance decisions that can extend the service life of bridges with minimum cost.



CCE Curriculum for LSC

CCE 6510 – Structural Systems and Assessment

- Use of structural system approach in design and evaluation to improve the designs and safety
- Structural condition assessment using state-of-the-art technologies to collect quantitative data to
 - i. assure safety
 - ii. make effective and efficient maintenance decisions that can extend the service life of structures with minimum cost
 - iii. evaluate the potential of recyclability of components or material

CCE 3330: Construction Codes, Contracts and Specifications

- Introduction of Building Information Modeling
 - This will help the students understand the norm in the industry for developing drawings and potential applications of BIM for lifecycle management of civil infrastructure systems.
- Introduction to Green Design concepts
 - This will help the students understand ‘Sustainable design and Renewable Energy’ at an early stage, thus providing opportunities for inclusion in future design projects.



CCE Curriculum for LSC

CCE 4450 Design of steel structures

- Teach students to design safe, efficient and durable civil structures

CCE 5520 Highway Design Principles

- Topics covered range from community involvement in the highway design process to construction and maintenance of highway facilities.
- Emphasis is put on making highway design decisions that facilitate intermodal connectivity, encourage people to use public transport, provide facilities that encourage walking or cycling and reduce the need/desire to travel.
- The impact of highways on the environment and social/community values are covered.
- Students are taught how to examine the environmental impact of design alternatives when preparing the Environmental Impact Statement (EIS).

CCE 4300 – Traffic Design

- Highway safety
- Traffic operations
- Quantification of emission and energy

CCE 5400 – Transportation Planning

- Environment impact and transportation planning
- Multimodal transportation planning
- Non-motorized transportation
- Travel demand management and transit system



Research Areas

- Waste and wastewater management
- Urban Water Infrastructure and reliability
- Pollution prevention and remediation
- Transit for livable communities
- No motorized transportation networks
- Buildings and Housing LEED process
- Buildings and housing hazard management



Ongoing CCE Research for LSC

➤ Structures and Materials

- Durable and sustainable bridges
- Extending life of existing infrastructure
- Seismic safety of wood frame structures
- Design and construct for public safety

➤ Transportation

- Intersection Safety –pedestrian detection tech.
- Safety of Non-motorized traffic
- Safety of elderly driving population
- High speed rail

➤ Construction

- Building lifecycle
- Modeling of deconstruction
- Energy management

➤ Student Activities

- Safe Routes to School



Ongoing CCE Research for LSC

- Accelerated bridge construction
 - minimized traffic disruption and congestion, improved work zone safety, and minimized environmental impact
- Noncontact technologies for structural condition assessment
 - state-of-the-art being developed
 - minimized disruption to facility users,
 - improved safety
- Condition assessment and health monitoring of structures
 - public safety
 - extend service-life of structures
 - help develop durable structures through an better understanding of behavior of existing structures
- Waste Powder Paint in Concrete
 - use of industry waste – preserve the environment and helps sustainability



Ongoing CCE Research for LSC

➤ Development of Versatile Hybrid Testing System for Seismic Evaluation

- reduce vulnerability to seismic hazards to be part of sustainable development
- improve performance of structures to enhance community resilience

➤ Research on Non-Motorized Modes of Transportation

- emphasis on safety of pedestrians and bicyclists
- potential for improving air quality by reducing emissions
- creating livable communities with walkable and bikeable paths
- improving community health through “active transportation”

➤ Research on Vehicle Communications

- improve traffic safety and environmental quality

➤ Research on Public Transportation

- modeling public transportation systems to improve transit connectivity and ridership
- measures of transit service quality and performances
- how to maximize the benefit from the Michigan’s accelerated (high-speed) rail



Ongoing CCE Research for LSC

➤ Cyber-Physical Systems Research

- sustainability requires the need to detect and react to events in the real world; this is the core concern of Cyber-Physical Systems
- the society depends on critical infrastructure (buildings, electric power, water, roadways, etc.). CPS can help manage and maintain such infrastructure by providing:
 - Zero net energy buildings;
 - disaster recovery;
 - structural health monitoring;
 - water distribution optimization; and
 - water safety monitoring



THANK YOU