Researchers say action needed now to meet greenhouse gas emissions goals

A team of University of Minnesota researchers has found that the transportation sector can meet its share of the state’s goals for reducing greenhouse gas (GHG) emissions in 2015 and can possibly exceed them in 2025—but action must start now.

The findings are the result of a study commissioned by the Minnesota Legislature and led by CTS; the interdisciplinary research team was led by mechanical engineering professor David Kittleson, civil engineering assistant professor Julian Marshall, and assistant professor Elizabeth Wilson of the Hubert H. Humphrey Institute of Public Affairs.

The researchers say that the majority of the changes don’t require any costly or new technologies and are applicable in other states, too, not just in Minnesota.

In 2007 the legislature established GHG reduction goals for all sectors of the economy of 15 percent by 2015, 30 percent by 2025, and 80 percent by 2050 (compared with 2005). The legislature also funded the CTS study to evaluate GHG emissions from transportation sources.

The final research report—Reducing Greenhouse Gas Emissions From Transportation Sources in Minnesota (CTS 08-10)—says that meeting the goals will require a combination of strategies targeted to reduce fuel consumption, vehicle-miles traveled, and fuel carbon content.

"The emission reduction goals are achievable if action starts today," says Robert Johns, director of CTS. "By changing the amount of traveling we do, purchasing vehicles with higher fuel efficiency, and adopting low-carbon fuel standards, we can exceed the goals that the Minnesota legislature has put before us and be a leader in the nation for reducing greenhouse gas emissions."

"There is a misconception that it is not possible to make these changes because they aren't affordable," says Marshall. "In fact, these methods can save people a lot of money and fuel. Energy efficiency can help consumers and also benefits the economy, especially with high gas prices."

"The technology to make this happen exists, it is just a matter of using it," says Kittelson. "The engines we use in our cars are no worse or better than the engines they have in passenger cars in Japan or Germany—the difference is, we put our engines in enormous cars."
The research team also looked at ways the state can lay a foundation for meeting the 2050 goal.

CTS associate director Laurie McGinnis provided interdisciplinary leadership, with assistance from CTS program coordinator Jan Lucke.

"Our interdisciplinary approach was invaluable in producing knowledge and strategies to address this complex challenge," says McGinnis, "and the involvement of our students helps prepare them as future leaders."

Non-faculty researchers contributing to the study included mechanical engineering research associate Winthrop Watts and graduate student Adam Boies; civil engineering graduate students Tyler Patterson and Steve Hankey and undergraduate Chris Weyandt; and Humphrey Institute graduate student Peter Nussbaum.

Complete information about the study, including a press release, a video about the study, a summary report, and the technical report, can be found on the study’s Web page.

---

**Policy & Planning**

**Access to Destinations Study reports examine non-auto travel, metro-wide simulation**

The publication of a pair of new research reports brings the Access to Destinations Study closer to its goal of capturing a complete picture of the trends affecting transportation accessibility in the Twin Cities region. The study is sponsored by the Minnesota Department of Transportation and Hennepin County.

As part of their effort to develop more accurate and detailed models of travel and land use in the Twin Cities region, researchers Kevin Krizek, Ahmed El-Geneidy, and Michael Iacono analyzed how distance to different destinations and services affects travel by non-automotive modes including public transit, bicycling, and walking. At the same time, the need to improve planning and analysis over large metropolitan areas motivated John Hourdos and Panos Michalopoulos to evaluate the feasibility of building a simulation system capable of modeling the entire Twin Cities region.

**Probing patterns of non-auto travel**

Many metropolitan planning agencies, including the Twin Cities Metropolitan Council, are increasingly seeking to promote development patterns that reduce local residents’ reliance on automobiles. However, this planning goal is difficult to achieve because empirical research into non-automobile travel behavior has been relatively uncommon compared to the large amount of research devoted to automobile travel patterns. As a result, planners have been forced to rely on vague assumptions about local travel, such as defining a local catchment area for pedestrian travel as roughly one-quarter mile around a particular destination.

Analyzing the data on non-automobile travel in the Twin Cities revealed significant differences in how far people are willing to travel for different purposes, such as required commuting to work versus discretionary travel for entertainment.

In their report, Krizek, El-Geneidy, and Iacono explain how they developed a set of distance-decay functions that yield a nuanced picture of non-auto travel, and use these functions to construct a more accurate model of complex travel behavior.

The project’s final report, *How Close is Close Enough? Estimating Accurate Distance-Decay Functions for Multiple Modes and Different Purposes*, is available from the Access to Destinations Study Web site.

**Examining the benefits of metro-wide simulation**

For transportation planners, "what if...?" questions—such as "What if we added another lane to a major arterial street?" or "What if the regulations governing mixed-use development were amended?"—are among the most difficult to answer. Simply implementing a new traffic management strategy in the real world in order to see how it performs is far too risky and disruptive; however, in many cases, small-scale simulation systems are inadequate to model the potential impacts of large-scale changes.

This situation has motivated several metropolitan and regional planning organizations around the world to undertake the development of metro-wide simulation systems. After evaluating the available data and the capabilities of various commercial simulation software packages, the researchers decided to recommend a "hybrid" simulation approach incorporating elements of so-called microscopic and mesoscopic simulation.

In microscopic simulation, the transportation system is modeled at the level of individual vehicles, while mesoscopic systems model groups of vehicles and are therefore slightly less demanding in terms of data and computational power. While a purely microscopic simulation would offer distinct advantages, Hourdos and Michalopoulos determined that available data would not be sufficient to support such a system.


---

**Journal of Transport and Land Use debuts**

The first issue of the *Journal of Transport and Land Use* (JTLU) was published in July. JTLU is an open-access, peer-reviewed online journal publishing original interdisciplinary papers on the interaction of transport and land use.

CTS is sponsoring the journal with editorial leadership provided by Associate Professor David Levinson, Braun/CTS Chair in Transportation Engineering, and former University of Minnesota assistant professor Kevin Krizek (now with the University of Colorado). CTS staff provide final editing and formatting assistance and manage the Journal Web site.

The goal for JTLU is to be the leading outlet for research at the interdisciplinary intersection of transport and land use, say the editors, including work from the domains of engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science, and complex systems.

Subscriptions and submissions are free. You can also register with JTLU to be notified when new issues are published. The journal is scheduled to be published quarterly.
The collapse of the I-35W bridge over the Mississippi River on August 1, 2007, sparked a number of new research studies, as structural engineers sought to understand the causes of the catastrophe. At the same time, transportation researchers realized that the tragic event had provided them with a rare opportunity to study how metropolitan travel patterns respond to the sudden loss of a major transportation link.

Analyzing the ways transportation networks change over time is a specialty of the University of Minnesota’s NEXUS research group, headed by David Levinson, who holds the Richard P. Braun-CTS Chair in Transportation Studies. NEXUS stands for “Networks, Economics and Urban Systems,” and the group is currently bringing a variety of research methods to bear on the aftermath of the bridge collapse, says Levinson.

In the weeks immediately following the collapse, Levinson worked with a group of transportation researchers including Henry Liu, Nikolas Geroliminis, and Kathleen Harder that received funding from the National Science Foundation’s Small Grants for Exploratory Research program and the University of Minnesota’s Department of Civil Engineering to gather traffic data, perform a preliminary analysis, and identify further research needs.

The initial study, The traffic and behavioral effects of the I-35W Mississippi River bridge collapse (PDF download) found that traffic adapted well to the bridge collapse, and though most travelers did not see a change in time, some saw an increase, and a smaller number saw a reduction in travel time. Interestingly, of the 140,000 vehicles crossing the bridge prior to the collapse, only 90,000 could be accounted for due to increased traffic on other bridge crossings, suggesting 50,000 trips a day avoided crossing the river, either not making the trip, or more likely changing destinations.

The results of the initial study led to additional funding from the NSF and Minnesota Department of Transportation (Mn/DOT) to carry out two additional studies of the effects of the collapse.

The first of these studies, "Traffic Flow and Road User Impacts of the Collapse of the I-35W Bridge over the Mississippi River," was funded by Mn/DOT with the goal of understanding the effect of the bridge closure on observed travel behavior, shifts in traffic flows, and resulting effects on alternate routes. Using data from travel surveys as well as GPS tracking of study participants whose travel activities are affected by the loss of the bridge, the researchers are developing a model of local travel behavior prior to and following the collapse. Using these models and observations of travel pattern changes, the researchers will attempt to estimate road-user costs associated with the collapse.

Complementing the Mn/DOT study, "BRIDGE: Behavioral Response to the I-35W Disruption: Gauging Equilibration," funded by the NSF with additional support from the University of Minnesota’s Metropolitan Consortium, aims to better understand how an extensive traffic system responds to a sudden, major network disruption. Equilibration refers to the process of establishing equilibrium—a stable condition that is assumed to characterize normal operation in many complicated transportation systems. Following a serious disruption, the researchers theorize, the Twin Cities surface transportation system is likely to settle into a new state of equilibrium as thousands of users adapt their behavior to the new demands of getting from place to place. On the other hand, the possibility that the system will remain chaotic for a long time cannot be ruled out without gathering detailed data.

Both projects are expected to be completed in 2010. NEXUS group members have already completed several academic papers on the effects of the bridge collapse, which are available on the group's Web site, along with more information about the research projects and related transportation issues.

Oberstar Forum proceedings available

The seventh James L. Oberstar Forum on Transportation Policy and Technology was held on April 7, 2008, in Minneapolis. The forum addressed potential directions of the next authorization of the federal transportation act, which will succeed SAFETEA-LU (Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users) at the end of its five-year period of 2005 through 2009. The forum used as one source of information the recent report Transportation for Tomorrow created by the National Surface Transportation Policy and Revenue Study Commission, which recommends dramatic institutional reform and revamping of federal transportation programs and policy.

This year's program began with a public portion featuring Congressman Oberstar's keynote speech, "Transformation of National Transportation Policy for the 21st Century." Panel discussions with state and national leaders followed. A proceedings of the 2008 forum is now available as a PDF document.
Ajay Joshi, a graduate student in the Artificial Intelligence, Robotics, and Vision Laboratory (AIRVL), described his group’s ongoing efforts to develop a robust machine-vision system to identify potentially dangerous actions in public spaces using video cameras. He showed how the current system is capable of identifying an object that has been abandoned in a public space, as well as tracking multiple individuals moving around a scene.

The system is not designed to cut human operators entirely out of the loop—in fact, humans’ ability to rapidly and accurately assess complex situations is a key part of the system design. Instead, the machine-vision algorithms monitor incoming video for situations that may require further attention, and the system then alerts a human operator for evaluation and possible response.

One important aspect of the system is its ability to use multiple cameras with different points of view to monitor complex scenes. The system is particularly adept at dealing with tightly spaced groups of several people—a common condition in crowded urban areas, Joshi said. Using prior knowledge of the scene in combination with accurate calibration of the cameras, the system is able to provide accurate counts of groups even when the individuals are moving around the scene.

Led by Nikolaos Papanikolopoulos, AIRVL carries out research on advanced computer and robotic systems. Papanikolopoulos also directs the Security in Transportation Technology Research and Applications (SECTTRA) Program, a joint effort of the Department of Computer Science and Engineering and CTS to support the development and application of advanced technologies to improve transportation security.

More information on this research, including a final report (Multi-Camera Monitoring of Human Activities at Critical Transportation Infrastructure Sites, CTS 08-08) is available on the CTS Web site.

Rajesh Rajamani of the University of Minnesota’s mechanical engineering department is no stranger to ITS research, having led or contributed to numerous projects in the area of intelligent vehicle control systems. For several years he has been interested in the problem of measuring friction between vehicle tires and the road surface—an important issue for winter road maintenance vehicles that apply deicing chemicals—and has been developing new ways to produce accurate measurements in real time.

Current friction measurement systems generally rely on a redundant wheel to measure friction with the road. Rajamani’s first attempt eliminated the redundant wheel and used high-accuracy GPS and onboard motion sensors to calculate the forces acting on the plow and derive a friction coefficient. The system worked, he said, but only if the vehicle was changing speed or direction—accelerating, slowing down, or steering.

Rajamani returned to the redundant-wheel concept for his second, more successful system: a 10-inch wheel mounted near a plow’s front tires, mounted at a slight angle to the direction of travel and subject to a constant vertical load via a pneumatic actuator, is connected to a force sensor. The system proved effective whether or not the vehicle is changing speed or direction, but introduced a new problem in the form of signal noise produced by wheel vibration. To overcome this problem, Rajamani and his research team developed several filtering algorithms to clean up the friction data, including a way to incorporate data from an onboard accelerometer into the filtering process.

The system is also designed to interface with an onboard Geographic Information System (GIS) that provides information about the road ahead and road segments that have been previously identified as problem areas.

More information on the project is available on the CTS Web site.

Peter Easterlund, an affiliate of the Institute’s HumanFIRST Program, gave an overview of “rapid prototype visualization”—an emerging approach to transportation project planning that relies heavily on recently developed simulation and visualization technologies—during a session devoted to design and analysis tools. Simulation, he explained, should be distinguished from techniques such as street-view and flyover animations; it is a user-controlled, dynamic, real-time, and immersive approach to looking at transportation projects.

Integrating information from plan drawings, terrain mapping, and traffic modeling presents unique advantages for planners and engineers during the design process, Easterlund said. GIS and data management techniques have reduced the costs of such applications considerably in recent years, making rapid prototype visualization an appealing option for today’s complicated projects. However, he noted, the unfamiliarity of the technology and the need to gather detailed visual and spatial data to build models remain obstacles to wider adoption.

More information on the simulation and modeling capabilities of the HumanFIRST Program and the Minnesota Traffic Observatory is available on the programs’ Web sites.

Safety & Security

Research seeks to save more lives by improving EMS response time

In rural areas, the average emergency response time is 52 minutes, compared to 34 minutes in urban areas. According to Tom Horan, research director of the University of Minnesota’s Center for Excellence in Rural Safety (CERS), this may partially explain why rural crashes are more likely to become fatal crashes, with 60 percent of all U.S. traffic fatalities occurring on rural roads though only about 20 percent of the population lives in rural areas. Survivability for trauma patients is significantly improved if arrival to a hospital is less than 30 minutes.

"Because of the longer response times, there is an important need to understand how emergency response can be improved," Horan said. "We need to understand the role information can play in improving the timeliness and the quality of emergency response in rural areas."

In 2007, Horan and CERS established a partnership with the Mayo Clinic in Rochester, Minnesota, to develop a best-practices model for responding to emergencies in rural areas. The clinic, in addition to having a state-of-the-art emergency care and emergency communications department, owns the local ambulance provider as well as helicopter and air medical transport services. Representatives of every phase of an emergency response participated in focus groups with Horan and research associate Ben Schooley to determine where gaps in information existed and how information technologies might address those gaps. The researchers also were given

(From left) Researchers Brian Hilton and Tom Horan meeting with William Bell of GM’s OnStar service
access to information about crashes and medical response for the year 2006.

At present, critical EMS data concerning a patient are not typically available to hospital personnel at the time of care. Critical information could include everything from the G-force of the crash, which in-car computer systems, such as OnStar, might collect, to whether the occupant was thrown from the vehicle, to any pre-existing medical conditions the victim might have, such as high blood pressure, or a list of medications the victim may be taking.

"In order to be effective, you have to cut across those silos and deliver information that can be used during emergency response," Horan said. "It’s really two cultures coming together and not coming together: the response culture and the hospital culture.”

The research, sponsored by the Federal Highway Administration, is being conducted through the State and Local Policy Program at the Humphrey Institute of Public Affairs in collaboration with CERS and the Intelligent Transportation Systems (ITS) Institute at CTS, with additional support provided by the National Science Foundation.

CERS and the University of Minnesota were recently selected to host the Rural Highway Safety Clearinghouse, a national clearinghouse for research and information related to rural road safety. U.S. Transportation Deputy Secretary Thomas J. Barrett made the announcement in Minneapolis on June 30. "The only way we will cut the number of deaths and injuries on the nation’s roads is by finding a way to get officials the right information at the right time,” Barrett said. “The University of Minnesota is going to do just that—and as a result, it is going to make our roads safer.”

More information on CERS and rural road safety is available on the CERS Web site.

---

**Transit, Bicycling, and Walking**

**TCRP research publications available online**

The federal Transit Cooperative Research Program (TCRP), administered by the Transportation Research Board, provides practical transit research to address technical and operational issues. TCRP emphasizes putting research results into the hands of organizations and individuals that can use them to solve problems.

Recent TCRP publications include:

- [Resources for Legal Issues Associated with Bus Maintenance](https://www.trb.org/publications/trbdocs/trbreports/TRB126626.pdf) (TCRP Legal Research Digest 26)

---

**Upcoming Events**

**October 1-2**

Fall Maintenance Expo, St. Cloud, Minnesota.

**October 7–8**

[Toward Zero Deaths Conference](https://www.cers.umn.edu/), Rochester, Minnesota.