CENTER FOR ADVANCING RESEARCH IN
Transportation Emissions, Energy, and Health
A USDOT University Transportation Center

Federal Agency:	Office of the Assistant Secretary for Research and Technology US Department of Transportation
Federal Grant Number:	69A3551747128
Project Title:	Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH)
Center Director:	Josias Zietsman, Ph.D., P.E., j-zietsman@tti.tamu.edu (979) 317-2796
Submitting Official:	Haylee Yung Assistant Director, Administration h-yung@tti.tamu.edu (979) 317-2804
Submission Date:	October 31, 2022
DUNS & EIN Numbers:	93-848-5539; 74-2270624
Recipient Organization:	Texas A&M Transportation Institute 1111 RELLIS Parkway Bryan, TX 77807
Recipient Identifying Number:	608101; 608102; 165821; 165822; 165823
Grant Period:	November 30, 2016 – September 30, 2023
Reporting Period End Date:	September 30, 2022
Report Term:	Semi-Annual
Signature of Submitting Official:	

OVERVIEW

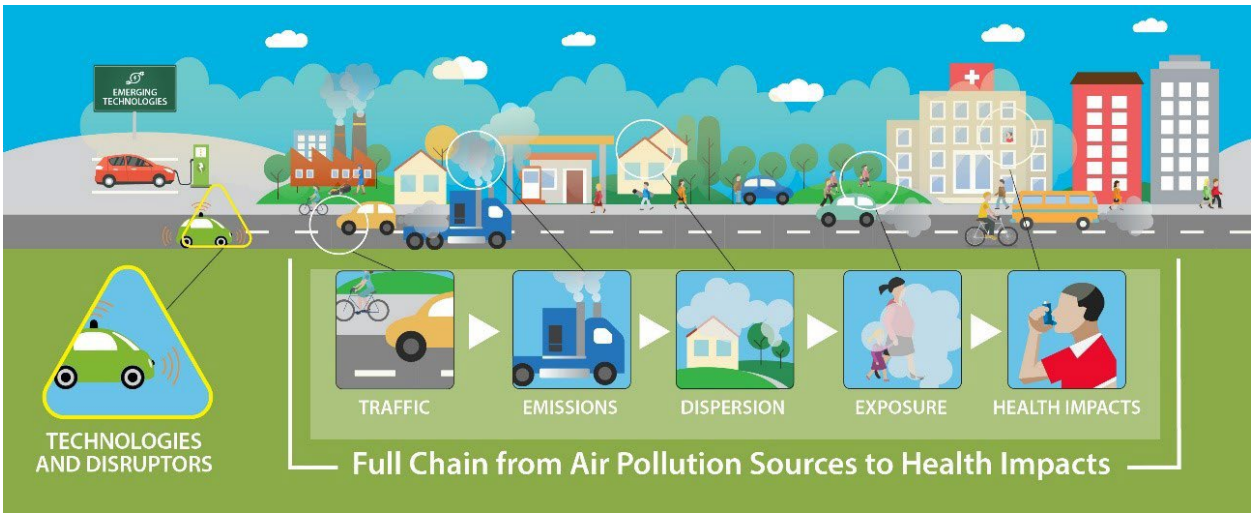
The Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) has been highly productive during this reporting period as we continue to build on our successes of the last five years. The year four projects are winding down; however, and our year five competitive research projects and strategic initiatives are progressing well. We have initiated several technology transfer activities, which have received extremely positive feedback. At the end of this reporting period, we continue to be proud of our achievements and excited about upcoming activities in all our goal areas.

ACCOMPLISHMENTS

Major Goals of the Program

CARTEEH brings together experts from transportation and public health, two disciplines that have not traditionally worked together. CARTEEH's focus is to advance research on transportation emissions in a comprehensive manner, mapping the holistic tailpipe-to-lungs spectrum, as shown in Figure 1.

Figure 1: Tailpipe to Lungs Spectrum



CARTEEH's research focus areas were defined to cover this spectrum and are as follows:

- Transportation System
- Emissions and Energy Estimation
- Exposure and Health Impacts
- Data Integration
- Policy and Decision-Making

Progress in each CARTEEH goal area is detailed in the following sections:

CARTEEH Goal #1: Research Program

CARTEEH's research program includes collaborative research projects conducted jointly among consortium members, competitive program awards, and other initiatives that support our strategic research, education, and technology transfer goals. A comprehensive list of these projects are available on CARTEEH's website Projects (carteeh.org), and are no longer included in this report due to space constraints. This section and following sections of the report discuss some of these projects and results in further detail.

In this reporting period, work continued on our remaining projects, which include current projects awarded during the last RFP cycle as well as collaborative projects led by our consortium members. These projects are all aligned with CARTEEH's "SMART Infrastructure Initiative" that attempts to link health and health equity considerations into decision-making. These projects have progressed well over the past quarter, and many are on track for completion in the coming months.

Since we are in the last year of our grant, our focus is to enhance and build upon current or concluded project to further our goals as a center. During this reporting period, we have started initiatives to revamp our PATHS web-portal, continue investigating electric vehicle impacts on air quality, and complete all collaborative projects related to SMART. Five projects have submitted their final reports, and we will be adding them to our web site along with submittal to USDOT in the next reporting period.

CARTEEH also initiated selected quick-turnaround projects for the final year of the grant, on timely and impactful topics. For example, TTI recently awarded an initiative to Mr. Madhu Venugopal entitled *Modeling Electric Vehicle Impacts on Air Quality*. The goal of this study is to evaluate the impact of future Plug-in electric vehicles (PEVs) scenarios on the regional ozone levels for the metropolitan areas in Texas. The study focuses on characterizing the complex interactions between PEVs' population, vehicle activities, charging behavior, electricity generation mix, energy consumption and emissions, and their impact on ozone levels at a regional scale. This information can help the state and regional decision-makers identify and develop the best policies and strategies to maximize the benefits of PEVs operating in Texas' non-attainment areas (shown in Figure 2).

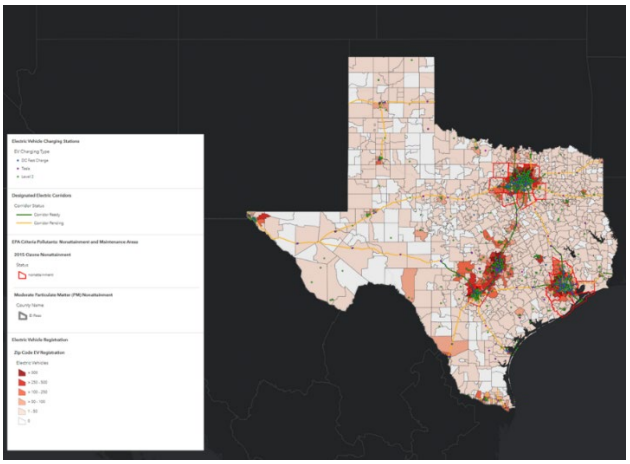


Figure 2 Current State of Electric Vehicles in Texas which shows the EV registrations by Zip codes, EV charging stations, Ozone and PM Non-attainment areas, and Designated EV corridors

During the reporting period, The University of California – Riverside has completed work in *Quantifying the Environmental and Health Impacts of Curbside Management for Emerging Multi-Modal Mobility Services.* This study proposes an integrated analysis, modeling, and simulation (AMS) platform for estimating traffic-related health impacts in a microscopic manner. Besides the traffic model and emission models, we introduce a grid-based concentration model and a human exposure model as the key components of this platform. A case study on the evaluation of different curbside management strategies has shown the effectiveness of the developed tool. It turns out that the centralized pickup strategy has much significant negative effect on subject health in terms of exposure to NOx and PM2.5, compared to distributed pickup strategy. The difference in accumulative inhale mass (AIM) per person on average can be as high as 70% and 82% for NOx and PM2.5, respectively. The reasons may include: a) relatively higher concentration due to the bottleneck created by the for-service vehicles; and b) longer waiting time for the pedestrian in the centralized pickup scenario. In the future, we will apply this tool to investigate the health impacts of different roadway design and Transportation Systems Management and Operations (TSMO) strategies. In addition, we will conduct more sophisticated field experiment to collect data for dispersion model calibration and keep improving the model fidelity by considering more realistic aerodynamic effects (e.g., turbulence) in the field of transportation.

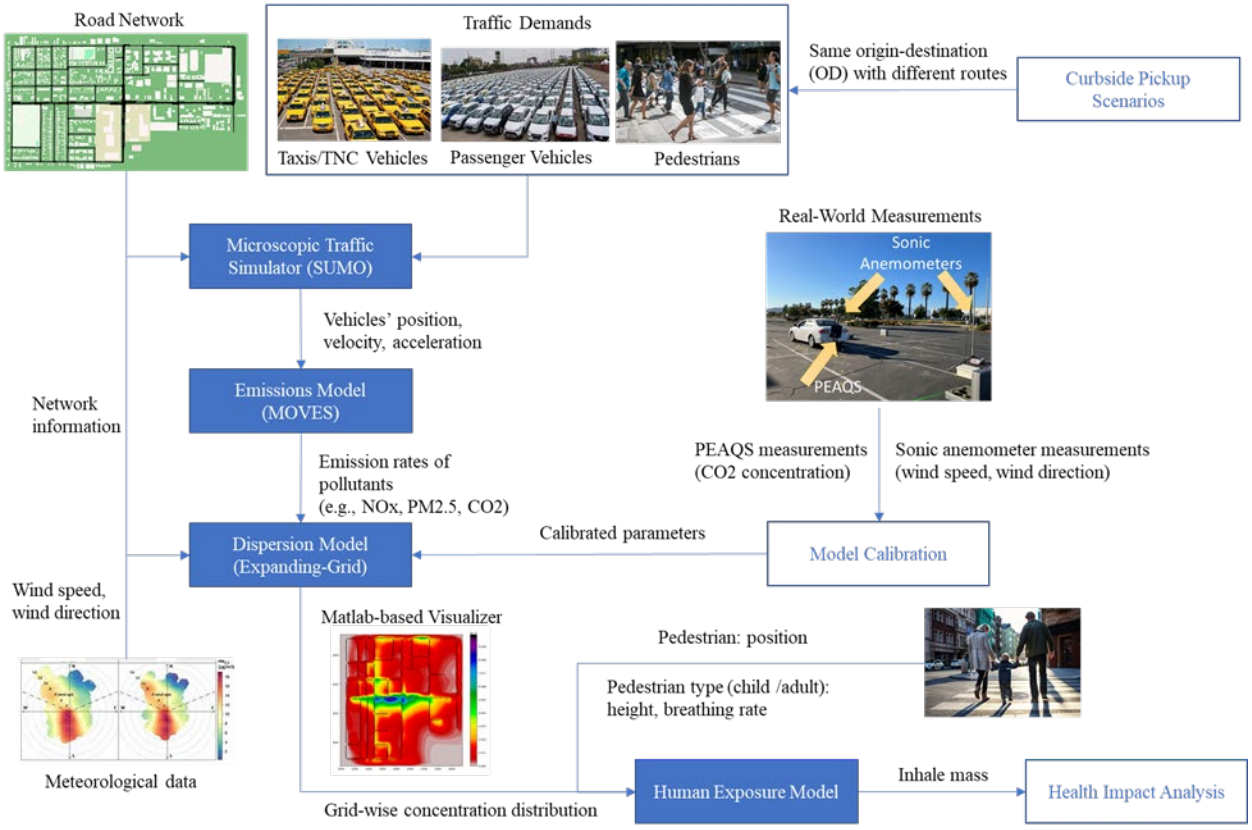
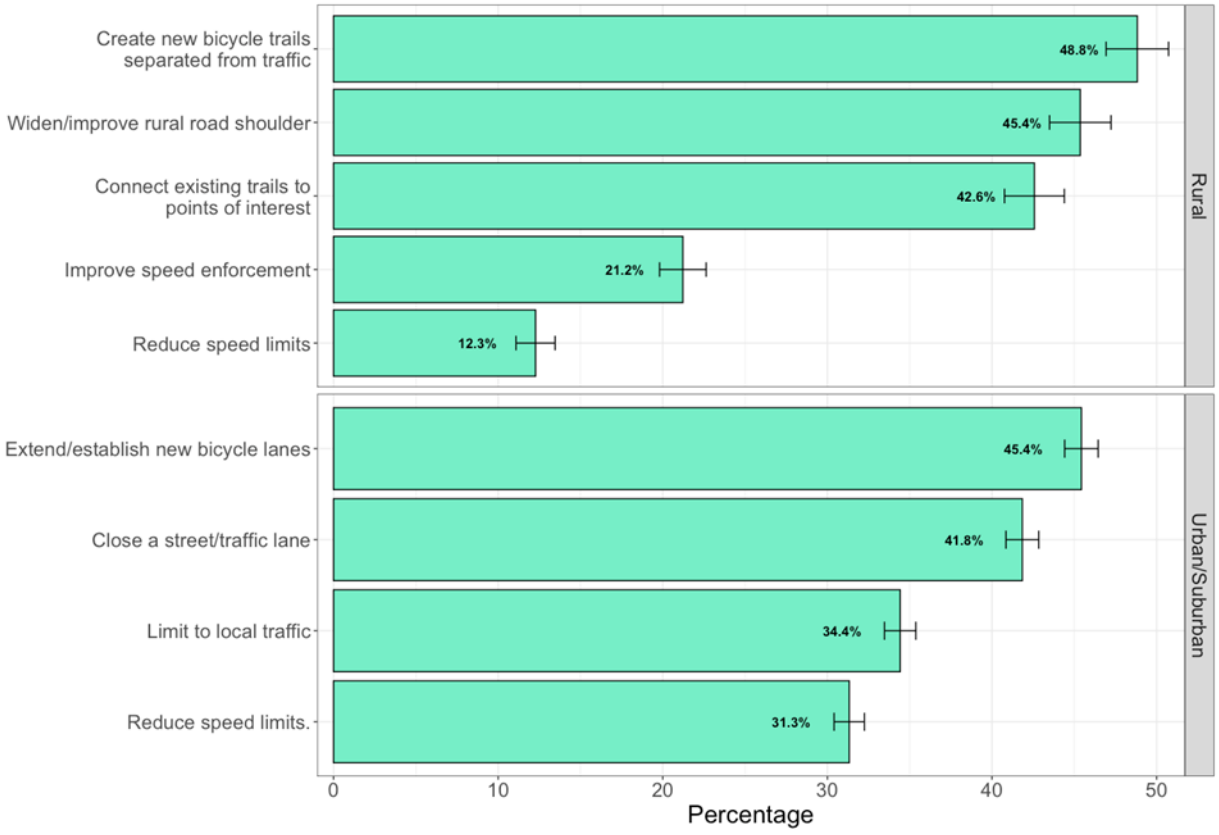


Figure 3. The workflow to run the integrated modeling platform.

Johns Hopkins University is currently completing an initiative that is studying cycling and policy change. Bicycling is a form of transportation with significant public health benefits, but also carries with it risks. Literature reviews completed at JHU show each year in the U.S., nearly 1,000 cyclists are killed, with more than 130,000 injured in crashes. Cyclists, by design, are close to road traffic and are without the protection that motor vehicles provide; this leaves cyclists more susceptible to injuries following collisions and more exposed to noise, air pollution, and other natural hazards. And yet, studies repeatedly demonstrate the benefits of cycling outweigh the risks. Cycling is a form of physical activity that can reduce chronic disease risk. At a community level, shifts towards cycling can reduce carbon emissions —thereby improving air quality –and increase social capital by providing opportunities for chance interactions according to some studies. Despite known relationships between cycling and health, little is known about how individuals conceptualize the safety of bicycling and how transportation policies and perceptions of cycling interact to impact behavior. The research undertaken as part of this project fielded a national, generalizable survey of U.S. adults to provide insight into the relationships between policy, perceptions, and behavior. The survey was fielded in May and June of 2022 and yielded a sample of 6,735 adults. Data analysis is underway and indicates a significant potential for policy to influence behavior. As depicted in the figure below, a significant portion of respondents in urban, suburban, and rural communities indicate a willingness to bicycle more in response to policy changes.



Research Results Disseminated

CARTEEH researchers continue to disseminate their research results through various venues, including presentations at conferences, paper submittals to journals, and meetings and outreach to stakeholders. Key research findings and final reports are also disseminated through the CARTEEH website. CARTEEH continues to host webinars that feature completed work funded by the grant.

Plans for Next Reporting Period to Accomplish Research Goal

In the next reporting period, CARTEEH leadership will continue working with the principal investigators of the ongoing projects to ensure the success of their projects and the development of impactful results. We plan to continue to build upon our SMART Infrastructure initiative. We expect to leverage our research results for further education and technology transfer activities, with an emphasis on stakeholder engagement and in line with our technology transfer plan.

CARTEEH Goal #2: Education and Workforce Development

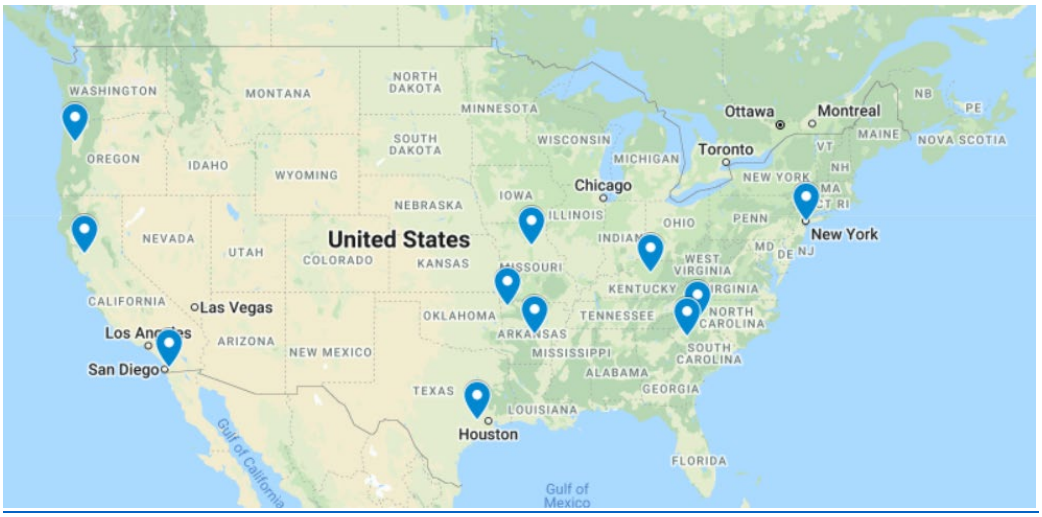
CARTEEH research projects are catalysts for CARTEEH student involvement, with the number of students involved with CARTEEH increasing each semester.

Texas A&M University College of Education Collaboration

The CARTEEH STEM outreach kit is a hands-on experience that includes an air pollution demonstration, presentation by a CARTEEH researcher, a swine lung activity showing the impacts on health, and the creation of a mural with possible solutions to reduce air pollution. Following a successful pilot at Greens Prairie Elementary in College Station, Texas (featured in the previous semiannual report), the kit was used at two STEM Family Nights at other locations:

- March 29, 2022: Kingsoborough Middle STEM Night in San Antonio, Texas (175 participants)
- April 25, 2022: Forest Ridge Elementary STEAM Night in College Station, Texas (350 participants)

CARTEEH K-12 classroom lessons were developed to implement in 5th – 8th grade classrooms as a week-long scientific inquiry unit with the objective of measuring particulate matter and identifying sources of air pollution. A link to the lesson materials including teacher's guide, student handouts, and overview video were distributed to 537 elementary and middle school teachers. From these schools, eleven elementary and middle schools, primarily Title I sites, were selected to receive a supply grant for air quality monitors. Teachers were also requested to complete survey on air pollution knowledge and beliefs, related environmental behaviors, and teaching practices. This data will inform our curriculum development efforts.



On April 22nd, a group of undergraduate engineering students who plan to become high school teachers visited CARTEEH and the TTI Environmental and Emissions Research Facility. They received a presentation and tour. This experience was followed by a workshop on how to translate this research into a K-12 classroom lesson.

We are working closely with 11 elementary and middle schools to pilot the "What's in the air?" lessons to make updates for effective classroom implementation. The classroom teachers are also testing out various air quality monitors to find an optimal balance between cost effectiveness, accuracy, and classroom use. Based on feedback from teachers and piloting with students, we are finalizing an article detailing the lesson sequence on air pollution. We plan to submit to Science Scope, a journal for middle school teachers published by the National Science Teaching Association.

Curriculum Course Development

CARTEEH' completed the development of a cross-disciplinary course titled *"Traffic-Related Air Pollution, Human Exposures, and Health*." The course materials, which include a course outline and lectures which can be adapted for various teaching purposes can be found posted on the CARTEEH website.

The course is intended to form the basis for a three-credit-hour graduate-level course offered by consortium member institutions and targeted at students and practitioners in the areas of urban planning, transportation planning, transportation policy, transportation engineering, geography, environmental sciences, environmental epidemiology, environmental policy, and public health. In its entirety, the course is designed to equip participants with cutting-edge knowledge and the skill sets required to understand, assess, and quantify road traffic, vehicle emissions, traffic-related air pollution (TRAP), human exposures, biological mechanisms, associated health effects, and population-based impacts and their societal costs. Further, the course will specifically explore the role of current knowledge in environmental regulation and real-world policy making and practice. The course can be offered in three high-level separate tracks, reflecting CARTEEH's vision and tailored to the participants' existing knowledge and potential application. Each lecture within the course will be marked as HT, TT, PPT, or a combination of the three. Health track (HT) is mainly targeted at urban planners, transportation planners, and engineers with limited knowledge of public health-related concepts. Transportation track (TT) is mainly targeted at environmental epidemiologists and public

health professionals with limited knowledge of transportation-related concepts. Planning and policy track (PPT) is mainly targeted at planners, civil servants, and policy and decision makers with particular interest in the science-policy link.

CARTEEH Summer Internship Program

In conjunction with two other University Transportation Centers (UTCs), CARTEEH held its annual summer internship program from May to July of this year. During this reporting period CARTEEH selected five summer interns, who worked remotely and on site with mentors on research projects and deliver a final research paper and presentation. Students participated in weekly virtual events over the course of the internship, which ran from May 24 to July 31, 2022. The interns worked on a plethora of topics, including sociodemographic factors related to health and transportation, air quality trends and socio-economic parameters, electric vehicle charging infrastructure, and literature reviews related to our SMART infrastructure initiatives. For a further in-depth look at their work this summer please click here.

CARTEEH Webinar Series

The Center for Advancing Research in Transportation Emissions, Energy and Health (CARTEEH) hosted a webinar on **June 8, 2022** on Planning, Policy, and Economic Impacts of Expanding EV Infrastructure in the United States. CARTEEH researchers from the Texas A&M Transportation Institute discussed the planning, policy, and economic implications of expanding charging infrastructure for electric vehicles (EVs) in the United States. An increased emphasis—including a significant influx of funding — is being placed on the expansion of EV charging infrastructure both through the recent Investment and Infrastructure Jobs Act (IIJA) as well as from the transportation industry. This increased momentum makes it imperative that local and state governments have access to guidance related to the economic and health impacts associated with the expansion of EV charging infrastructure; as well as how to effectively plan for equitable access and outcomes. Presenters discussed how recent research conducted by CARTEEH can inform decision makers of potential economic benefits and provide an overview of how stakeholder engagement and collaboration are critical to the effective expansion of EV infrastructure in the United States.

Materials and recordings from the webinars can be accessed and viewed at the CARTEEH website.

Plans for Next Reporting Period to Accomplish Education Goal

During the next reporting period, the current education initiatives will continue, and CARTEEH will look for additional opportunities for education and workforce development growth. CARTEEH is scheduled to continue participation in STEM related activities as part of the collaboration with the College of Education.

CARTEEH Goal #3: Technology Transfer

CARTEEH views technology transfer as a vital part of the research process, and one that must be integrated with our activities at all stages and in a cross-cutting manner. We value stakeholder engagement, as well as emphasizing information dissemination and the creation of open-access tools and methods that enable practical application of cutting- edge research findings. Several technology transfer activities are underway and progressing. The CARTEEH technology transfer activities aim to make research results and knowledge available to the research community and beyond.

Clean Transportation Collaborative

On April 13th, CARTEEH's newly formed Clean Transportation Collaborative (CTC) held a virtual kick-off meeting for members. The purpose of the CTC is to bring together interdisciplinary and intersectoral stakeholders to facilitate thought leadership and guide research in the transition to a low-emissions transportation system. The event included a welcome and overview of the CTC from CARTEEH director, Joe Zietsman, and Texas A&M Transportation Institute Director, Greg Winfree, as well as two keynote speeches. The keynote speakers, Deputy Assistant Secretary for Sustainable Transportation at the US Department of Energy, Michael Berube, and Interim Deputy Director for Joint Office of Energy and Transportation, Dr. Rachael Nealer, discussed current federal priorities for advancing clean transportation options with a focus on the recently passed Infrastructure Invest and Jobs Act. The event also included a thirty-minute question and answer session for members to interact with the speakers. Eighty people registered for the event from public, private, and academic organizations in the transportation, energy, and public health spheres, with only a few organizations sending multiple attendees. CARTEEH has received positive feedback from many attendees and is planning future virtual and in-person events to facilitate peer exchange and inform center research.

On July 13th, 2022, the CTC hosted a virtual event for members. The goals of the meeting we to connect CTC member to each other through meaningful conversation on emerging issues related to topics of interest; and develop, record, and disseminate experiences, ideas, and insights from expert practitioners that can influence research areas and policy recommendations. Members discussed recent electric vehicle and air quality federal policies and Notices of Proposed Rulemaking. Electric vehicle charging standards were also a topic of discussion related to installation, operations, management, infrastructure interoperability, sign, signals, markings, data, network connectivity, public information, and workforce development. For more information please click CTC Slides.

Transportation Emissions and Health Dashboards and Data Hubs

Work has continued on one of the competitive research projects selected in year five has created an online geospatial dashboard for exploring and visualizing children's exposure to vehicular pollution in Texas school districts. A draft version of this GIS-enabled dashboard is available at: https://tinyurl.com/CCVPTXSD. This dashboard allows users to browse and examine interactive maps and datasets related to traffic pollution exposure and socio-demographics of children at the school district level (information compiled in Phase 1 of this project). This resource will yield societal benefits by providing school administrators, school board members, families of school children, residents, transportation planning agencies, and various other stakeholders with convenient access to selected project-related outputs.

We continue to expend and improve our CARTEEH DataHub with new data from competitive projects and other data repositories. Work commenced in April of 2022 to update and create a more accessible web portal for our current DataHub.

Currently CARTEEH is in the final development of the SMART Toolkit. The web-based tool will navigate the SMART Framework and available resources. The tool will target research projects addressing aspects of transportation infrastructure and health equity. *Healthy People Through Smart Infrastructure* is a framework to help navigate these challenging issues in a consistent and comprehensive manner. This framework was developed to guide practitioners and policy makers through the complex intersections between transportation and health to make the most healthful decisions for people and for the planet. Researchers are in the final development stages of creating a Transportation–Health Enhancement Toolkit, which will include a range of strategies, methods, models, and practitioner guidance that can be used by transportation decision makers to determine how to enhance the health benefits of transportation infrastructure projects. The range of strategies, methods, models, and practitioner guidance will connect to one or more of the transportations–health pathways.

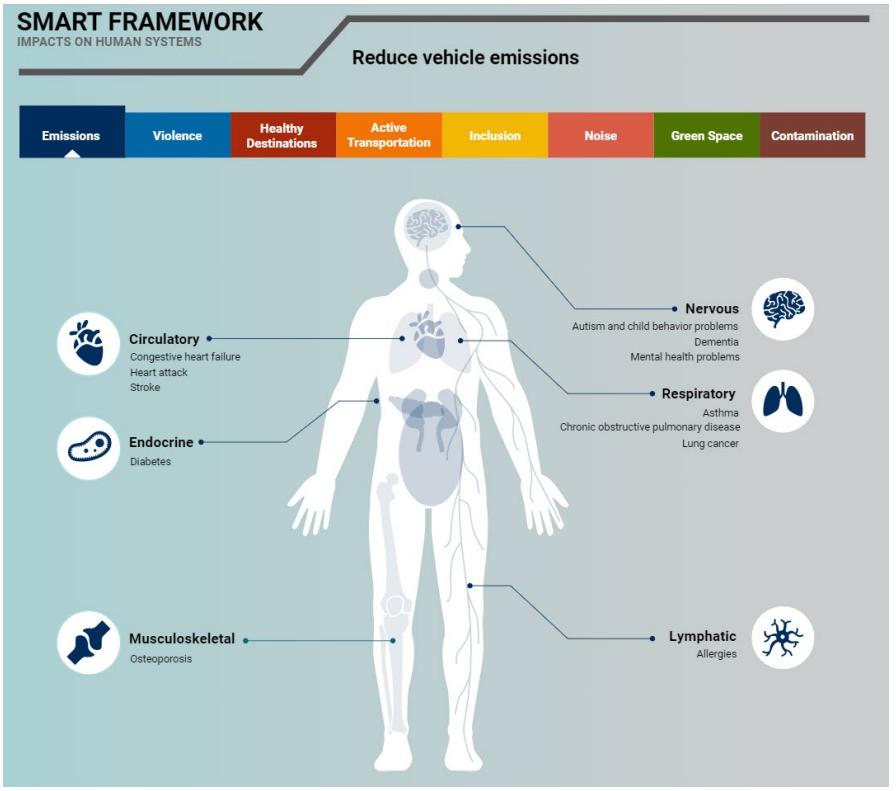


Figure. 4 Example Interactive Visual from Transportation-Health Enhancement Toolkit

During this reporting period, TTI is leading an effort to re-imagine the Platform to Assess Transportation, Health, and Sustainability (PATHS) portal. PATHS is a cloud-based modeling platform for integrating and automating the deployment of transportation, energy, and emissions models. The pipeline accelerates analysis and provides sound evidence for optimized infrastructure decision-making to regulators and policymakers. The models integrated into PATHS range from land-use and travel patterns to emissions, air quality, and public health.

CARTEEH Literature Library

The CARTEEH literature library continues to be maintained on the CARTEEH website. This tool is intended as a resource for students, researchers and practitioners interested in the area of transportation and health, especially the impact of transportation emissions and air pollution on human health. It currently contains a reference list of over 1,000 scientific studies addressing the full-chain of events between transportation pollution sources and health impacts, in addition to technologies and disruptors. The literature library tabulates several attributes for each study, including the citation details, the publication type, topic area(s), and type(s) of study. This reference list will be periodically updated to include new studies as they become available.

Technology Transfer Results Disseminated

All Center activities are posted to the CARTEEH website, with several updates made to the site following this reporting period. While earlier research projects are just coming to completion, a significant number of abstracts have been submitted, as well as presentations made.

Plans for Next Reporting Period to Accomplish Technology Transfer Goal

We plan to continue the implementation of the Technology Transfer Plan, engaging with stakeholders, and developing tools and project outputs that can directly aid practitioners in their work.

PARTICIPANTS AND COLLABORATING ORGANIZATIONS

CARTEEH is made up of a consortium of five institutions: TTI is a member of the Texas A&M University System and home to the Center. Faculty and students from other colleges, such as the Texas A&M Health Science Center, are also involved. Johns Hopkins University, Georgia Tech, University of Texas-El Paso, and the University of California, Riverside, complete the partnership.

Partner Organizations and Other Significant Collaborators

CARTEEH's focus areas cross multiple disciplines, bringing opportunities for a unique collaborative effort with institutions and individuals. These partners are essential to the success of the Center. Organizations and individuals in the following tables have directly supported or collaborated on Center activities.

Table 1: CARTEEH Partner Organizations

Organization Name	Location	Contribution
Air Alliance Houston	Houston, Texas	Collaboration
American Thoracic Society	New York	Collaboration
Atlanta Bicycle Council	Atlanta, Georgia	Collaboration, In-kind support
Atlanta Bike Coalition	Atlanta, Georgia	In-kind support
Atlanta Regional Commission	Atlanta, Georgia	Data, Collaboration
Breathe Easy Dallas	Dallas, Texas	Collaboration

Broadway Services	Baltimore, Maryland	Access to facilities and data
California Air Resources Board	Sacramento, California	In-kind support
California Energy Commission	Sacramento, California	In-kind support
Cherry Hill Neighborhood	South Baltimore, Maryland	Collaboration
Chesapeake Climate Action Network	Takoma Park, Maryland	Collaboration
City of Austin Department of Transportation	Austin, Texas	Collaboration
City of Carson	Carson, California	Personnel
City of Dallas	Dallas, Texas	Collaboration
City of Los Angeles	Los Angeles, California	Data
Clean Water Action	Washington, D.C.	Collaboration
Dallas Independent School District	Dallas, Texas	Access to facilities
El Paso Independent School District	El Paso, Texas	Facility and student access
El Paso Health Department	El Paso, Texas	Data sharing
El Paso Metropolitan Planning Organizatoin	El Paso, Texas	Data sharing
Emory University	Atlanta, Georgia	Personnel, Collaboration
Environmental Defense Fund	Austin, Texas	Collaboration
George Mason University	Fairfax, Virginia	Collaboration, data
Georgia Department of Transportation	Atlanta, Georgia	Data
Georgia Ports Authority	Savannah, Georgia	Data, access to facilities, in-kind support
Georgia Tech Research Institute	Atlanta, Georgia	Data, personnel, access to facilities
Health Effects Institute	Boston, Massachusetts	Collaboration
Houston-Galveston Area Council	Houston, Texas	Collaboration
Institute for Healthy Living at the University of Texas at El Paso	El Paso, Texas	Collaboration, facility and student access
Kelly Burt Dozer	College Station, Texas	In-kind support
Larry Young Paving	College Station, Texas	In-kind support
Los Angeles County Metropolitan Transportation Authority	Los Angeles, California	In-kind support
Maryland Institute College of Art	Baltimore, Maryland	In-kind support
Metropolitan Atlanta Rapid Transit Authority	Atlanta, Georgia	Collaboration, in-kind support
Mississippi State University	Starkville, Mississippi	Collaboration
Mount Winans Community Association	Baltimore, Maryland	Collaboration, facility access
Nashville Metropolitan Transit Authority	Nashville, Tennessee	Collaboration, in-kind support
National Weather Service	Santa Teresa, New Mexico	Information/data sharing, collaboration
New Mexico Department of Environment	Santa Fe, New Mexico	Data, collaboration
New Mexico Department of Health	Santa Fe, New Mexico	Data, collaboration

New Mexico Department of Transportation	Santa Fe, New Mexico	Data, collaboration, access to facilities (field site)
North Central Texas Council of Governments	Arlington, Texas	Collaboration
Oak Ridge National Laboratory	Oak Ridge, Tennessee	Computer models
Port of Galveston	Galveston, Texas	Facilities
Port of Houston	Houston, Texas	Facilities
Port of Long Beach	Long Beach, California	Facilities
Port of Los Angeles	Los Angeles, California	Personnel
South Baltimore Go! Pilot Project	South Baltimore, Maryland	Collaboration
South Coast Air Quality Mgmt. District	Diamond Bar, California	Data, equipment, and facilities
Tampere University of Technology	Tampere, Finland	Collaboration, personnel exchange, in-kind support
TAMU Department of Construction Science	College Station, Texas	Facilities
Texas Department of Transportation	Austin, Texas	In-kind support, collaboration
The City of Dallas	Dallas, Texas	Collaboration
The Nature Conservancy	Austin, Texas	Collaboration
U.S. Department of Agriculture	Big Spring, TX and Fort Collins, CO	Collaboration, in-kind support, data, equipment, student access
U.S. Geological Survey	Reston, Virginia	Data, in-kind support, access to equipment
University of Delaware	Newark, Delaware	Collaboration
University of Miami	Miami, Florida	Collaborative research
University of Southern California	Los Angeles, California	Collaboration
University of Texas, El Paso Department of Public Health	El Paso, Texas	Data sharing
University of Texas Houston School of Public Health	Houston, Texas	Collaboration and student access
University of Washington	Seattle, Washington	Collaboration
USDA Agricultural Research Service	Big Spring, Texas	In-kind support, equipment, collaboration
USDA Agricultural Research Service	Fort Collins, Colorado	In-kind support, equipment, collaboration
USDA Agricultural Research Service	Las Cruces, New Mexico	Equipment, collaboration
WeGo Public Transit	Nashville, Tennessee	In-kind support, access to facilities
Sun Metro	El Paso, Texas	Project Stakeholder
El Paso County Transit	El Paso, Texas	Project Stakeholder
City of El Paso	El Paso, Texas	Project Stakeholder
Camino Real Regional Mobility	El Paso, Texas	Project Stakeholder
Center for Disease Control and Prevention	Atlanta, Georgia	Next Generation Sequencing
Children's Hospital Los Angeles	California	Collaboration

El Paso Electric Company	El Paso, Texas	Provided sample survey questions
Texas Commission on Environmental Quality	Houston, Texas	Sampling and logistics
LINK Houston	Houston, Texas	Collaboration
City of Riverside	California	In-kind support
Norfolk Southern Railway	Atlanta	Personnel, Collaboration
Ray C. Anderson Foundation	Atlanta	Data, Personnel

Table 2: CARTEEH Collaborators

Name	Affiliation	Contribution	Country
Dr. Ananya Roy	Environmental Defense Fund	Collaboration	USA
Dr. Andrea Polidori	University of California - Riverside	In-kind contributions	USA
Dr. Bakeyah Nelson	Air Alliance Houston	Collaboration	USA
Dr. Cassandra Gaston	University of Miami, Miami, FL	Contact/Collaboration/data sharing/leveraging	USA
Dr. Chanam Lee	Texas A&M University	Collaboration	USA
Dr. Daniel Tong	NOAA, Washington DC	Contact/leveraging	USA
Dr. David Cocker	UCR, Department of Chemical and Environmental Engineering	Experimental Design and Data Analysis	USA
Dr. David Dubois	Office of the State Climatologist, Las Cruces, NM	Collaboration	USA
Dr. Dongjoo Park	University of Seoul	Collaboration	Korea
Dr. Ellen MacKenzie	Dean, JHU Bloomberg School of Public Health	Collaboration	USA
Dr. Eun Sug Park	TTI – Mobility Analysis Program	Collaboration	USA
Dr. Gabriel Ibarra-Mejia	The University of Texas at El Paso, Department of Public Health	Collaboration, Data, Faculty	USA
Dr. George Delclos	University of Texas Health Science Center at Houston	Collaboration	USA
Dr. George Thrushton	New York University School of Medicine	Collaboration	USA
Dr. Jennifer Horney	University of Delaware	In-kind support	USA
Dr. Jenny Mindell	University College London	Collaboration	The U.K.
Dr. Jeremy Sarnat	Emory University	Collaboration, Faculty	USA
Dr. Joan Reibman	New York University School of Medicine	Collaboration	USA
Dr. Joao Ferreira-Pinto	The University of Texas at El Paso, Department of Public Health	Collaboration, Data, Equipment, In-kind, Faculty	USA
Dr. John Tatarko	USDA Agricultural Research Service, Fort Collins, CO	Collaboration	USA
Dr. John Wright	Bradford Institute for Health Research	Collaboration	The U.K.
Dr. Jorma Keskinen	Tampere University of Technology	In-kind contributions	Finland
Dr. Julian Marshall	University of Washington	Collaboration	USA

Dr. Kai Zhang	University of Texas Health Science Center	Collaboration	USA
Dr. Karen Lucas	University of Leeds	Collaboration	The U.K.
Dr. Kees de Hoogh	Swiss Tropical and Public Health Institute	Collaboration	Switzerland
Dr. Kent Johnson	University of California, Riverside	Data	USA
Dr. Kyuok Kim	Korea Transport Institute	Collaboration	Korea
Dr. Leah Whigham	University of Texas Houston Health Center	Collaboration, Data, Equipment, In-kind, Faculty	USA
Dr. Lixin Jin	The University of Texas at El Paso	Collaboration, Data, Equipment, In-kind, Faculty	USA
Dr. Liz York	Centers for Disease Control and Prevention	Collaboration	USA
Dr. Mark Benden	TAMU Health Science Center	Collaboration	USA
Dr. Mark Burris	TAMU – Civil Engineering	Collaboration	USA
Dr. Michael de Miranda	TAMU - College of Education	Collaboration	USA
Dr. Mark Nieuwenhuijsen	Barcelona Institute for Global Health	Collaboration	Spain
Dr. Martina Klose	Barcelona Supercomputing Center, Barcelona, Spain	Contact/ data sharing	Spain
Dr. Michael Jerett	University of California, Los Angeles	Collaboration	USA
Dr. Nicholas Webb	USDA Agricultural Research Service, Las Cruces, NM	Collaboration	USA
Dr. Nick Duffield	Texas A&M Institute of Data Science	Collaboration	USA
Dr. Qi Ying	TAMU – Civil Engineering	Collaboration	USA
Dr. R. Scott Van Pelt	USDA Agricultural Research Service, El Paso, TX	Collaboration	USA
Dr. Rashid Shaikh	Health Effects Institute	Collaboration	USA
Dr. Rob Scott McConnell	The University of Southern California, Keck School of Medicine	Collaboration	USA
Dr. Robin Autenreith	TAMU – Civil Engineering	Collaboration	USA
Dr. Roya Bahreini	UCR, Environmental Sciences	In-kind contributions	USA
Dr. Shams Tanvir	University of California, Riverside	Personnel	USA
Dr. Susan Anenberg	Environmental and Occupational Health, George Washington University	Collaboration	USA
Dr. Susan Chrysler	TTI – SAFE-D UTC Assistant Director	Collaboration	USA
Dr. Tom Durbin	University of California, Riverside	Data	USA
Dr. Wei Li	TAMU – Landscape Architecture and Urban Planning	Collaboration	USA
Dr. Yunlong Zhang	TAMU – Civil Engineering	Collaboration	USA
Mr. Brandon Feenstra	South Coast Air Quality Management District	Data, In-kind support	USA
Mr. David Ederer	Centers for Disease Control and Prevention	Collaboration	USA
Mr. Douglass Mann	Maryland Institute College of Art	Data collection access	USA
Mr. Hugh Pocock	Maryland Institute College of Art	Data collection access	USA
Mr. Iyasu Eibedingil	The University of Texas at El Paso	Collaboration, Data, Equipment, Student	USA

Mr. John Smart	Advanced Vehicles - Idaho National Lab	Collaboration	USA
Mr. Juan Aguilera	Institute for Healthy Living at the University of Texas at El Paso	Collaboration, Data, Equipment, Student	USA
Mr. Marcos Mendez	The University of Texas at El Paso	Collaboration, Data, Equipment, Student	USA
Mr. Mathew Bechle	University of Washington	Data	USA
Mr. Michael Garber	Emory University	Collaboration	USA
Mr. Zhiming Gao	Oak Ridge National Laboratory	In-kind support	USA
Ms. Niina Kuittinen	Tampere University of Technology	Collaboration	Finland
Ms. Victoria DeGuzman	University of Southern California/ METRANS UTC	Collaboration	USA
Mr. Trent Botkin	New Mexico Department of Transportation	Collaboration	USA
Mr. William Hutchinson	New Mexico Department of Transportation	Collaboration	USA
Mr. Michael Baca	New Mexico Environment Department	Collaboration	USA
Dr. Sarah Hayes	U.S. Geological Survey	Facilities, Equipment, Data	USA
Dr. Robert Wunderlich	Center for Transportation Safety, TTI	Data	USA
Dr. Jothikumar Narayanan	Centers for Disease Control and Prevention	Next Generation Sequencing	USA
Stephen Paciotti	Texas Commission on Environmental Quality	Collaboration	USA
Dr. Shankar Chellam	TAMU	Collaborator	USA
Jennifer Dien Bard	Children's Hospital Los Angeles	Collaboration	USA
Kevin Hall	TTI	Data	USA
Jacob Aun	Socio-Environmental and Geospatial Analysis Lab, UTEP	Data collection access	USA
Ernesto Ortiz	El Paso Independent School District	Access	USA
Jacob Burns	Institute for Medical Information Processing, Biometry and Epidemiology	Collaboration	Germany
Anthony D. May	Institute for Transport Studies	Collaboration	The U.K.
Shams Tanvir	California State Polytechnique, San Luis Obispo	Collaboration	USA
Tom Durbin	University of California at Riverside	Data	USA
Cesunica Ivey	University of California at Riverside	Equipment	USA
Akura Ventakram	University of California at Riverside	Equipment	USA
Nanpeng Yu	University of California at Riverside	Data	USA
Ran Wei	University of California at Riverside	Data	USA
Amy Moore	Oak Ridge National Laboratory	Data, In-Kind Support	USA
Mary Katherine Watson	The Citadel	Collaboration	USA
Andrew Danneberg	University of Washington	In-Kind Support, Collaboration	USA
April Willis Rodgers	Samford University	Collaboration, In-Kind Support	USA
Daniel Rochberg	Emory University	In-Kind Support, Collaboration	USA
Dr. Teresa Penbrooke	GP RED and GreenPlay, LLC	Collaboration	USA

OUTPUTS

We have successfully met several of our outcome performance measures, such as the number of attendees at seminar and outreach events, and the number of visitors to the website, literature library, and Data Hub. For this six-month reporting period, we had over 300- attendees to our webinar and outreach events and 2,500 visits to our website and are on track to meet our yearly goals for these metrics.

Presentations

Name: Grossman, Alice; Kuzio, Jaqueline
Event: CARTEEH Webinar Series, June 8th, 2022
Title: Planning, Policy, and Economic Impacts of Expanding EV Infrastructure in the United States

Name: Li, X.J.
Event: Seminar at The University of North Dakota, Grand Forks, ND, USA; February 25, 2022 (not previously reported)
Title: Innovations in microfluidic platforms for bioanalysis

Name: Li, X.J.
Event: 13th International Bordetella Symposium; Vancouver, BC, Canada; June 26th-30th, 2022
Title: Rapid and Accurate Diagnosis of Pertussis on a Point-of-Care Biochip

Name: Li, X.J.
Event: TAMEST 2022 (Texas Academy of Medicine, Engineering, Science & Technology); San Antonio, TX; June 20th-22nd, 2022
Title: Nanoparticle-Mediated Quantitative Photothermal Biosensing Using a Common Thermometer based on TMB Photothermal effects

Name: Santacruz, Kenji
Event: ASPIRE Student Presentation; El Paso, TX; April 8th, 2022
Title: Tracking the Source of Marginal Electricity Generation and Emissions on a Spatial-Temporal Basis in an Electricity Market

Name: Dadashova, Bahar
Event: 2022 CUTC Summer Meeting
Title: Impacts of COVID-19 Induced Active Transportation Demand on the Built Environment and Public Health

Name: Ramani, Tara
Event: TWG Quarterly Meeting, September 1st, 2022
Title: Database and Interactive Visualization Tool for Transportation Emission Reduction Strategies

Name: Jaikumar, Rohit
Event: Air & Waste Management Association 115th Annual Conference, June 27th-30th, 2022
Title: Air Pollution Exposure Assessment of E-Scooters: A Case Study in the City of Austin

Conference Papers, Conference Papers, and Journal Articles

Zhang, X.; Wang, L.; Li, X. C.;* **Li, X.,*** AuNP aggregation-induced quantitative colorimetric aptasensing of sulfadimethoxine with a smartphone. *Chin Chem Lett* 2021, In Press. DOI: 10.1016/j.cclet.2021.09.061. (IF 6.8)

Zhang, J.;+ Tavakoli, H.;+ Ma, L.; Li, X. C.; Han, L.; **Li, X**.* Immunotherapy discovery on tumor organoid-on-a-chip platforms that recapitulate the tumor microenvironment, ***Adv Drug Deliv Rev*** 2022, 187, 114365. DOI: 10.1016/j.addr.2022.114365. (**2021 IF 17.9**)

Santacruz, Kenji, Sang, Yuanrui, Environmentally Aware Allocation of Electric Vehicle Charging Stations by Analyzing Locational Marginal Emissions, 54th North American Power Symposium, Salt Lake City, UT; October 9th-11th, 2022.

Y. Ding, et al. "Estimating Exposure to Vehicle Exhaust during Idling and Starting", Transportation Research Part D (under review).

Fu, G.;* Hou, R.; Mou, X.; **Li, X.*** Integration of 3,3',5,5'-tetramethylbenzidine (TMB)-probed ELISA-like systems in a photothermal bar-chart microfluidic chip for multiplexed immunoassay, *Anal Chem* 2021, 93, 15105-15114. DOI: 10.1021/acs.analchem.1c03387. (IF 7.0)

Zhou, W.;+ Dou, M.;+ Sanjay, S. T.;+ Xu, F.;* **Li, X.*** Recent innovations in cost-effective polymer and paper hybrid microfluidic devices, ***Lab Chip*** 2021, 21, 2658-2683. DOI: 10.1039/D1LC00414J. (Invited. IF 6.8).

Chakraborty J. 2022. Children's Exposure to Vehicular Pollution: Environmental Injustice in Texas, USA. **Environmental Research** (ISI impact factor = 6.498). Volume 204, Part A, 112008. Available at: https://doi.org/10.1016/j.envres.2021.112008. Federal support was acknowledged.

Chakraborty J, Schwanke L, and Salas K. 2021. Characteristics of Children and Vehicular Pollution in Texas School Districts Dashboard. Available at: https://tinyurl.com/CCVPTXSD.

Sourav Das, Brent V. Miller, Joseph Prospero, and Shankararaman Chellam (2022). Sr-Nd-Hf Isotopic Analysis of Reference Materials and Natural and Anthropogenic Particulate Matter Sources: Implications for Accurately Tracing North African Dust in Complex Urban Atmospheres. *Talanta,* **241**(15): 123236.

Fox, Mary & Penbrooke, Teresa & Farzaneh, Reza & Rahman, Mariya & Ramani, Tara & Zietsman, Josias. (2022). Pilot study and cumulative risk framework to advance long-haul driver health. Journal of Healthy Eating and Active Living. 2. 88-96. 10.51250/jheal.v2i2.43.

Media References

None

Website

The CARTEEH website continues to be the face of our Center and is regularly updated with the latest center activities. It also provides access to the Transportation Emissions and Health Data Hub, as well as the literature library and videos from CARTEEH seminars. From April 1, 2022, through September 30, 2022, the CARTEEH website had a total of 6,148 page views and a total of 2,900 unique visitors.

Technologies

Dr. Ann Xu of CARTEEH co-founded ElectroTempo, Inc., a Delaware corporation, to commercialize the charging demand simulator technology that was developed as part of CARTEEH-funded research in the area of transportation electrification and energy. ElectroTempo, Inc. is a software-as-a-service (SaaS) company with a mission to accelerate transportation electrification. ElectroTempo, Inc. is licensing the technology from the Texas A&M University System and productizing the technology to serve market needs. Recently, TTI has initiated a master agreement with ElectroTempo to streamline our joint work by leveraging ElectroTempo's Light-Duty Vehicle Charging Demand Simulation tools. CARTEEH and ElectroTempo are working together to use these simulation tools in conjunction with CARTEEH research on emissions to better understand EV impacts on emissions and health.

Inventions

None to report for this period

Other Products

None to report for this period

OUTCOMES

We have successfully met several of our outcome performance measures, such as the number of attendees at seminar and outreach events, and the number of visitors to the website, literature library, and Data Hub. Our target measure for the number of attendees to the seminar, webinar, and outreach events is 150 per year; we are meeting that goal. A second performance measure is the number of visitors to the CARTEEH website, literature library, and Data Hub. Our target number is 700 per year. We are continuing to exceed this goal each year.

IMPACT

We are continuing to see the impacts of our work, ranging from the successes of our students and interns to the dissemination of our research results and technology transfer activities, including the establishment of a successful spin-off venture that builds on CARTEEH research. We continue to engage several transportation agencies and work with them collaboratively on solutions that can maintain and enhance the functioning of the transportation system while also promoting health. Our outputs continue to impact the body of existing scientific knowledge, with publications and conference presentations reaching a scientific audience, as well as the local media. We hope to continue outreach to stakeholders with a view of increasing our impact in the coming reporting period.

CHANGES/PROBLEMS

None

SPECIAL REPORTING REQUIREMENTS

No special reporting requirements.