

Positive Environmental Impacts of Traffic Smoothing

Leveraging Intelligent Transportation System (ITS) Technologies

The last several decades, the total amount of driving (as measured in vehicle miles traveled or VMT) has grown significantly, contributing to severe roadway congestion in many urban areas. As a result, in many cases, vehicle emissions have become the dominant source of air pollutants, according to the Transportation Research Board (TRB). The trend for higher vehicle emissions across the nation continues to rise as confirmed in a study by the U.S. Department of Energy (DOE): *Effects of Travel Reduction and Efficient Driving on Transportation: Energy Use and Greenhouse Gas (GHG) Emissions*. The report found that transportation currently accounts for 71% of total U.S. petroleum use and 33% of the nation's total carbon emissions. The effects are having a profound impact on the environment and communities.

The effects of transportation on the environment are not just isolated to the U.S., *Air Pollution and Mortality Benefits of the London Congestion Charge* (Tonne et al.) predicted that the congestion reduction in London, would gain 183 years-of-life per 100,000 population and a total of 1,888 years-of-life in the greater London area. *The Stockholm Congestion* (Eliasson et al.) estimated that a similar zone in Stockholm would avoid 20–25 deaths annually due to traffic-related air pollution in the inner city, and 25–30 deaths annually in the metropolitan area, which contains 1.4 million inhabitants. How can we reduce traffic congestion while not negatively impacting commerce?

Key Benefits of Leveraging ITS Technologies:



Reduce GHG Emissions
Up to 21%



Reduce Travel Time
Up to 30%



Reduce Fuel Consumption
Up to 10%



Ease Traffic Congestion,
Reduce Stops Up to 75%



Safer Mobility: Reduce
Pollution-Related Deaths



Improve Quality of Life with
Increased Life Expectancy

Reducing Traffic Congestion: Turning to Technology

The *Co-operative Systems for Sustainable Mobility and Energy Efficiency* or COSMO project adopted a system-wide approach to assess innovative traffic management systems on fuel consumption and vehicle emissions, as well as the energy used to operate road-side equipment.

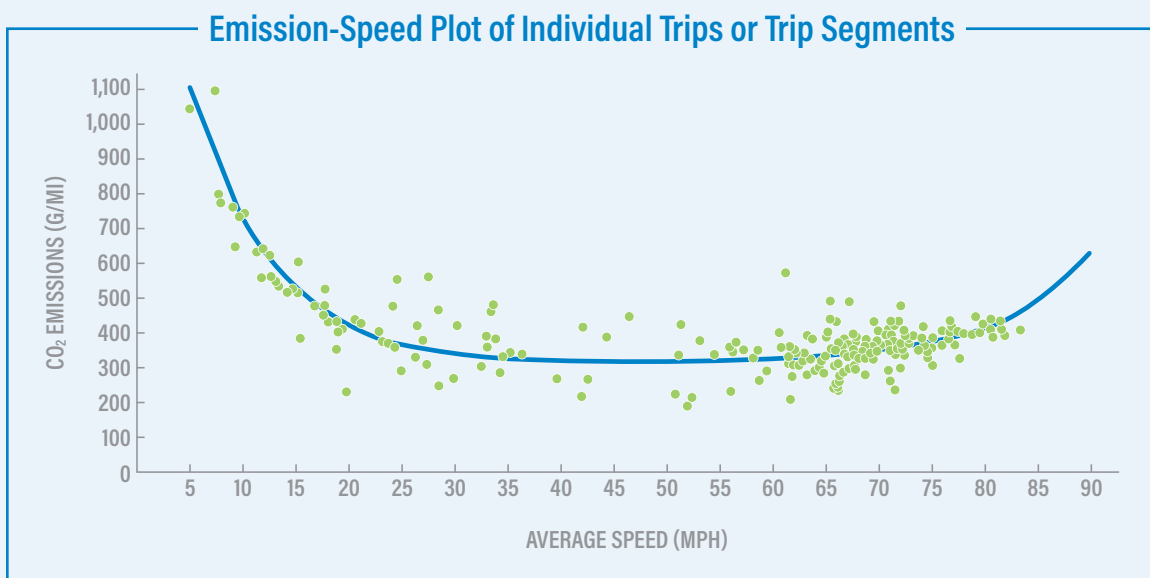
- Test sites in Salerno, Vienna, and Gothenburg using ITS that ran from 2010 to 2013 demonstrated CO₂ emission reductions on the order of 5–15%.

Carnegie Mellon launched the Scalable Urban Traffic Control (SURTRAC) project in 2012 as part of its Traffic21 research initiative. Over a nine-month period, nine traffic signals in Pittsburgh were outfitted with adaptive signal control technology that adapted to actual traffic conditions.

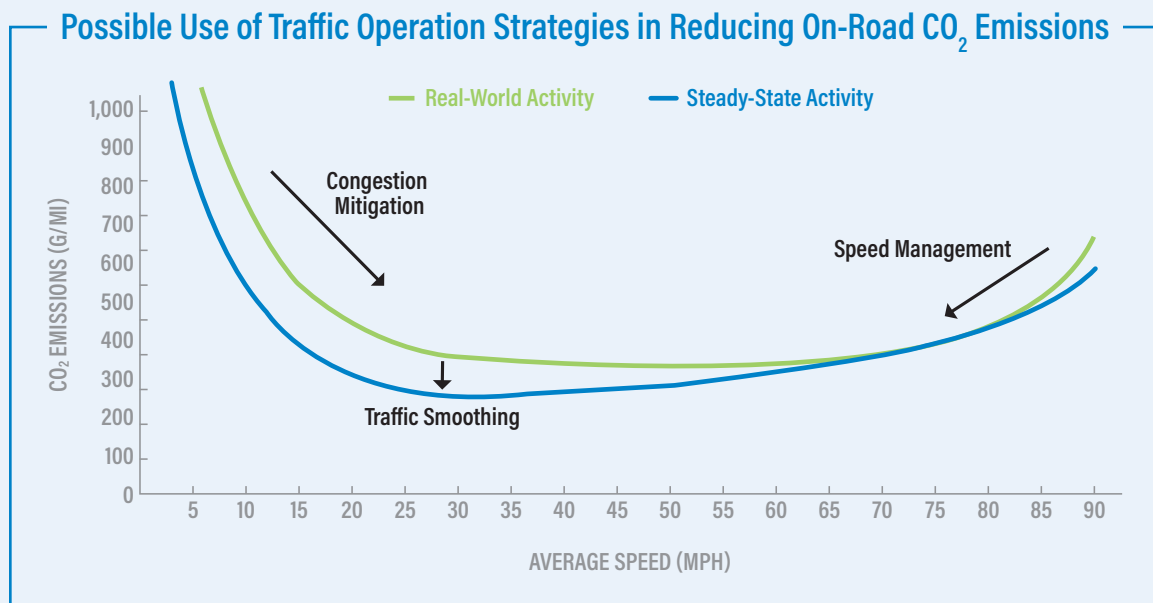
- The results were remarkable: a 40% reduction in vehicle wait time and a 26% reduction in travel time. The project found that the technology reduced vehicle emissions by about 21%.

A University California of Riverside research study found that vehicle emissions production was directly affected by driving patterns (more congestion resulted in more vehicle emissions).

- When average vehicle speed is reduced below 45 mph (for freeways), CO₂ emissions increase. Vehicles spend more time on the road, which results in higher CO₂ emissions. Therefore, congestion mitigation programs will reduce CO₂ emissions.
- Smoothing stop-and-go patterns of traffic will reduce CO₂ emissions.



Source: UC Riverside: Real-World CO₂ Impacts of Traffic Congestion



- In the 2015 study, *Emission Minimizing Adaptive Signal Control: A Multimodal Optimization Approach* (M. Haberl, M. Cik, M. Fellendorf, T. Otto, R. Luz, and P. Roth), researchers found that in a well-planned fixed traffic control system, the integration of an adaptive signal-control smooths traffic, and therefore helps to reduce number of stops (~8%), increases the mean travel speed (~13%), and helps to reduce emissions and fuel consumption (~10%). Public transport vehicles need ~5% less fuel.

Real-World Results of Traffic Smoothing Using Traffic Signal Optimization and Technologies

Miami-Dade County, FL

300 Traffic Signal System Modernization and Adaptive Signal Control

In 2017, under the direction of the Miami-Dade County Department of Transportation and Public Works (DTPW), Econolite completed the deployment of a small-scale adaptive signal control system on a very congested segment of NW 36th St./NW 41st St. between 71st and 84th Avenues.

- The initial traffic smoothing results of the adaptive signal control system on the NW 36th St. corridor demonstrated a 10% average reduction in travel time.



The County considered this mobility improvement significant enough to expand the adaptive system on the NW 36th/NW 41st corridor, and upgrade 300 additional intersections along 10 additional congestion management corridors. The initial independent studies by Regional Integrated Traffic Information System (RITIS) – an automated data sharing and dissemination system that helps agencies measure performance (University of Maryland) – of the other updated corridors completed in 2019 show that:

- **NW 36th St./NW 41st St.:** with the adaptive signal control expansion, up to a 14.5% travel time improvement.
- **SW 27th Ave.:** up to a 23.6% travel time improvement from Bayshore Drive to Tamiami Trail.
- **Miami Gardens Dr. (NW 186th St.):** up to a 10.7% improvement in peak weekday travel times between NW 87th and NW 67th Avenues.
- **Flagler St.:** up to a 10% weekday travel time improvement between LeJeune Rd. and Milam Dairy Rd.
- **NE 163rd St./SR 826:** up to a 10.4% travel time improvement.
- **LeJeune Rd. (SW 42nd Ave.):** up to a 12% travel time improvement between Anastasia Ave. and SW 16th St. Also, a 10% weekday travel time improvement between Tamiami Trail and Bird Rd.
- **Indian Creek/SR A1A:** up to a 15.2% travel time improvement for southbound weekday morning commutes between 63rd and 88th streets. For northbound traffic, up to a 33.3% travel time improvement.
- **US 1:** up to a 19% weekday travel time improvement between SW 98th St. to 17th Ave. This is a nearly eight-mile segment with 52 signalized intersections.
- **Biscayne Blvd.:** up to a 17.4% travel time improvement between NE 82nd St. and I-395.

Mission Viejo, CA

Alicia Parkway Traffic Smoothing Traffic Light Synchronization Program (11-mile corridor with 41 signalized intersections)

- A before-and-after study showed that the number of stops reduced by up to 75% during the morning and evening hours. Average speed increased by as much as 31%. In addition, GHG emissions were reduced by 7%.



Madison, WI

Freeway Construction Project

To proactively address the expected increase in traffic volume of diverted freeway traffic onto a bypass road, the City of Madison, WI and WisDOT turned to Intelligent Transportation System (ITS) technology, particularly adaptive signal control. First, the City re-timed the 13 signals along the 4-mile bypass corridor to increase the efficiency as much as possible until the adaptive signal control system was deployed.

- Before-and-after travel time reports indicated up to a 22% reduction in travel times and a 65% reduction in stops. Strand Associates conducted the before-and-after travel time validation study.



The Connected Vehicle Technology Potential

The USDOT has a long-term research program in connected vehicles. One of the foundational elements of the connected vehicle research effort in the environment area is the *Applications for the Environment: Real-time Information Synthesis (AERIS) program*. Using vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and infrastructure-to-vehicle (I2V) communications, the goal of the AERIS program is to design ITS applications that aim to reduce energy consumption and emissions.

Traffic Management Systems

- **Eco-Speed Control Using V2I communications also carried out by Virginia Tech.** In this project, innovative eco-adaptive signal control algorithms were developed and tested. These systems were modeled using traffic simulation software and tested for different roadway configurations.
- **Eco-Friendly ITS (ECO-ITS) carried out by UC Riverside.** This project is built on previous ECO-ITS research in predicting second-by-second fuel consumption and tailpipe emissions for different environmental ITS applications and strategies, including advanced traffic signalization.

Each of the ITS environmentally beneficial applications mentioned typically have GHG reductions up to 15%. These applications are additive; therefore, greater benefits may be achieved when a multitude of environmentally-friendly ITS programs are put into place. It is clear that as more ITS programs are deployed, environmental impact assessments must be performed to validate the ongoing improvements that have resulted.