NYSERDA Clean Transportation Research & Development Evaluation Case Study:

KLD Engineering – Adaptive Traffic Lights

Final

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NYSERDA

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Acronyms and Abbreviations List

ACDSS	Adaptive Control Decision Support System; a traffic control system, based on IMPOST and developed by KLD
CO_2e	Carbon dioxide equivalent, a metric used to measure the radiative forcing impact (i.e., climate impact) of greenhouse gases relative to carbon dioxide (e.g., a gas with a CO_2e of 25 is 25 times more potent than CO_2)
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
FHA	Federal Highway Administration
IMPOST	Internal Metering Policy to Optimize Signal Timing; a traffic control algorithm developed in 1999 by KLD with NYSERDA support
KLD	KLD Engineering; a company that developed an adaptive control system with NYSERDA support
NYSERDA	New York State Energy Research and Development Authority

1 Introduction

The Adaptive Control Decision Support System (ACDSS) is an evolution of Internal Metering Policy to Optimize Signal Timing (IMPOST), a traffic control algorithm developed by KLD with NYSERDA support in 1999. ACDSS was originally installed in New York City and, eventually, expanded internationally, with distribution assistance from TransCore, a transportation logistics software and service company. This document serves as an outline and written supplement for the KLD Engineering Adaptive Traffic Lights case study that described the benefits of the technology as installed in New York City. The case study comprises findings from in-depth interviews, previous reporting on the technology, and general literature on adaptive traffic controls.

ACDSS optimizes and adjusts traffic signal timing across multiple intersections based on real-time detection of traffic flow, including that of motor vehicles, bicycles, and pedestrians. It can interface with a range of hardware systems and can be controlled by a centralized traffic control operator or autonomously, with the option of operator override. ACDSS is designed to improve traffic safety and reduce congestion, travel times, fuel consumption, and carbon emissions.

In this case study, background research, program documentation and data, and general literature on adaptive control systems informed the development of research areas and the associated metrics by which impacts could be estimated. Interviews with stakeholders elicited information on outcomes related to the economic, energy, environmental, non-energy, and replication benefits of the ACDSS technology. In addition, interviewees were asked about the extent to which NYSERDA's support influenced these positive outcomes. Table 1 shows a complete list of research areas and metrics.

Table 1: Research Areas and Metrics

Research Areas and Metrics	Potential Sources/Methods
Economic Benefits	
Number of jobs created at subject companies, follow-on funding, internal/external investments, sales information, cost savings, deferred capital expenses where applicable	Interviews, previous reports
Reduced travel time	Interviews, previous reports, literature review
Reduced operations and maintenance costs	Interviews

Energy Benefits	
Fuel savings	Interviews, previous reports
Environmental Benefits	
CO_2e reduction	Interviews, previous reports, literature review
Reductions of other automotive pollutants	Interviews, previous reports, literature review
Non-Energy Benefits	
Traffic safety: reduced car crashes, improved bicycle/pedestrian safety	Interviews, previous reports, literature review
Improved bus transit flow, reduced transportation time / congestion	Interviews, previous reports
Replication Benefits	
Similar initiatives undertaken by others	Interviews, literature review
Patents, publications, or communication and marketing activities used to encourage additional third-party investment and market development	Interviews
External investments, internal investments, in-market pilots, commercial-scale product launches	Interviews

NYSERDA provided four potential interviewees with the expectation that these respondents would yield additional interviewees through a snowball sampling approach. Outreach resulted in two completed interviews. Table 2 shows interviewee roles and their respective organizations.

Table 2: Disposition of Interview Respondents

Organization	Role
NYSERDA	Project Manager
KLD Engineering	Organization executive (title withheld for anonymity)

2 Findings

2.1 Economic Benefits

KLD derived economic and financial benefits from NYSERDA's investment, while other economic benefits were realized by the stakeholders associated with the development and implementation of its product. KLD reported that they created up to eight new full-time equivalent jobs as a result of the ACDSS technology. They expected that an additional two positions could be created in 2020. This respondent also estimated that up to 30 new full-time equivalent jobs were created at TransCore, which opened a new office overseas to monitor a recent deployment in the Middle East. They further explained that KLD now relied on its own internal research and development for funding product development, rather than relying on NYSERDA seed funding. The study corroborated previous reports that the IMPOST algorithm was designed to reduced stop-and-go driving, which can yield better fuel economy and in turn reduce fuel costs to drivers. According to the U.S. Energy Information Administration (US EIA),[1] the average New Yorker spends $708 on gas annually. This figure was applied to the 6% reduction in fuel consumption[2] (as observed in a previous study on ACDSS) and equates to $42 per year less in gas expenditure per person.

Findings Adjusted for or Excluded from the Final Case Study. Information on KLD's sales and off-peak travel time reduction estimates were not available for the case study. Additionally, information about NYSERDA's investment in eco-driving, where adaptive control systems communicate signal timing data to approaching vehicles, was excluded because this was out of scope of the KLD case study.

[1] EIA. https://www.eia.gov/todayinenergy/detail.php?id=40893

[2] KLD Associates, Inc. "Integrated Adaptive Traffic Signal Control with Real-Time Decision Support", November 2009.

2.2 Energy Benefits

Energy benefits include electricity or fuel savings associated with the use of the ACDSS technology. The previous reports, literature on adaptive control systems, and new data from stakeholder interviews indicated the potential for substantial fuel savings associated with the product in the initial demonstration. According to the EIA, motor vehicle traffic accounted for 28% of energy consumption across the nation in 2018,[3] indicating the substantial potential need for fuel-saving technologies such as effective traffic control systems. Preliminary simulations indicated that the four Staten Island intersections where ACDSS was installed showed a 6% reduction in fuel consumption.[4]

Previous reporting on ACDSS, literature on adaptive control systems, and the new stakeholder interviews concur that the estimated savings associated with this technology is highly dependent on baseline site conditions, including fleet composition, volume of vehicles passing through the intersection, average vehicle speed, time of day, and the type of controls that were upgraded to the adaptive system. Actual fuel consumption reduction is also hard to measure because it requires highly granular data collection efforts that are often not feasible. Site-specific analyses based on actual traffic records could be used for detailed estimates, but without this information, detailed real-world measurements are impossible; modeling efforts seem more feasible for estimating savings. To accurately and fully account for the specific impacts at a given intersection (or series of intersections), data collection would need to include vehicle volumes, types, and speeds by time of day, along with information on the current control system being replaced (e.g., timed, on-demand, sensor-based). Accordingly, the Staten Island simulation estimates represent the best available data for that immediate area, but those fuel consumption reductions are unlikely to be the same as those realized in other areas. In fact, other areas may see substantially higher savings if the adaptive control systems are installed in intersections without any type of modern control system.

Findings Adjusted for or Excluded from the Final Case Study. Excluded from the case study are estimates of high fuel savings reported in the literature due to adaptive control systems that are not applicable to the New York City environment. Fuel savings estimates vary based on many factors, particularly the type of traffic control system being replaced with ACDSS. Intersections

[3] EIA. https://www.eia.gov/energyexplained/use-of-energy/transportation.php

[4] KLD Associates, Inc. "Integrated Adaptive Traffic Signal Control with Real-Time Decision Support", November 2009.

that have not received upgrades or investments over the years may achieve higher levels of savings given their low baseline performance. Because the literature shows a large range of potential reduction (10% to 40%), and the actual estimate for a particular intersection is highly dependent on baseline conditions, this range of estimates was deemed too wide to be applicable to New York City as a whole.

2.3 Environmental Benefits

Environmental benefits primarily include CO_2e reductions due to reduced idling and wait times at red lights.[5] As context, motor vehicle traffic in New York produces 71 million tons of CO_2e emissions.[6] A previous report found that preliminary tests with simulation indicated the Staten Island ACDSS installations achieved a 3% reduction of emission levels.[7] This reduction is due to a 6% reduction in vehicle stops and a 7% average decrease in vehicle delay.

2.4 Non-Energy Benefits (NEBs)

Non-energy benefits are positive impacts, beyond direct energy savings, associated with improved energy efficiency. Respondents were asked about NEBs that might be associated with KLD's ACDSS product, such as potential improvements to traffic safety (including bicycles, pedestrians, and cars), improvement to bus transit flow, and reduced transportation time and congestion. Interviewees noted that by reducing travel time and delays, traveler quality of life is likely to be improved.

Stakeholder interviews corroborated previous findings in ACDSS reports showing an 8% reduction in travel time in New York City across affected intersections.[8] Adaptive control system literature explains that travel time reductions vary by jurisdiction and could be as high as 40%, depending on initial intersection conditions. One interviewee noted that because ACDSS generally prioritizes passenger vehicle throughput, it is unlikely that the technology improves bus flow.

[5] Estimates based on the U.S. EPA's emissions estimate tool. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[6] NYSERDA. "New York State Greenhouse Gas Inventory: 1990-2016", Final Report. July 2019.

[7] KLD Associates, Inc. "Integrated Adaptive Traffic Signal Control with Real-Time Decision Support", November 2009.

[8] Ibid.

To provide context around the need for traffic safety improvement, the case study includes a timeline to show the number of injuries and fatalities between 2010 and 2020, including noting the implementation of Vision Zero, a program created to eliminate all traffic deaths and serious injuries in New York City as a means of addressing that problem.[9] According to one respondent, ACDSS creates platoons of vehicles that clear the intersection at uniform speeds, which improves predictability of traffic flow and thereby safety for all users. In addition, the interviewee corroborated findings from a previous report by noting that when traffic lights react in real time, emergency vehicles can move through intersections more quickly than in systems without that ability. Interviewees noted that there has been limited research that quantifies safety impacts because they are difficult to measure accurately. Transportation time and congestion are sources of commuter stress and wasted time, and interviewees noted that by improving these conditions, rider quality of life is improved, though that is a difficult outcome to measure.

Findings Adjusted for or Excluded from the Final Case Study. During the interview, KLD referenced a recent field study out of St. Louis finding that ACDSS reduced travel time by 11% during off-peak hours. This is excluded from the case study because this report could not be obtained to verify the estimate.

2.5 Replication Benefits

Replication benefits include positive impacts related to similar initiatives undertaken by others as a result of the KLD ACDSS project. This may include patents, publications, and communication and marketing activities to encourage additional third-party investment and market development.

KLD demonstrated proof of concept of ACDSS during its initial deployment in New York City and subsequent installations across hundreds of intersections in the U.S. (New York, California, Missouri, and Kansas) and the Middle East. KLD markets and promotes ACDSS via industry conferences and trade journals and partners with TransCore for distribution needs. TransCore has a large international user base that facilitates ACDSS deployment outside of New York City.

[9] http://www.nycvzv.info/

2.6 NYSERDA's Influence

NYSERDA provided financial backing that may have helped with the development, production, and commercialization of the KLD product, thereby helping to achieve the aforementioned benefits.

KLD described that NYSERDA helped it develop ACDSS, which TransCore helped distribute, and that it was then promoted by local/state transportation agencies and the FHA, yielding a product that could be replicated across the country. KLD reported that NYSERDA's influence was critical to the development, deployment, and commercialization of ACDSS. With NYSERDA's support, KLD was able to develop the IMPOST algorithm, apply it in real intersections, and deploy ACDSS into the high-profile New York City environment. ACDSS was developed for New York City's extreme levels of traffic congestion. One respondent indicated that competitors may integrate KLD's New York City-specific algorithms into their traffic control systems.

Findings Adjusted for or Excluded from the Final Case Study. One respondent noted that the FHA promotes adaptive signal control technology at the higher level to encourage local and state agencies to promote the technology. This is excluded from the case study because it was deemed not to be a critical finding.