SJSU SAN JOSÉ STATE UNIVERSITY

MTI MINETA TRANSPORTATION INSTITUTE

Solar-Powered Automated Transportation: Feasibility and Visualization

Project 1948
December 2021

Burford Furman, PhD
Laxmi Ramasubramanian, PhD, AICP
Shannon McDonald, AIA
Ron Swenson
Jack Fogelquist
Yu Chiao
Alex Pape
Mario Cruz

Solar powered automated transportation network guideway and station.

Humanity faces a climate emergency, greatly affected by carbon emissions from human activity, the largest component of which comes from transportation. While there are many ways to reduce emissions, all are not equal for mitigating the emergency. Cities and states around the world must act with urgency to implement viable, even audacious, solutions that will have the greatest impact on reducing carbon emissions. Widespread solar powered automated transit networks (ATNs) are proposed to take emissions beyond zero and provide other dramatic improvements over conventional modes of transportation.

This study answered two key research questions:

1. Can solar energy be sufficient to power a transportation system?
2. How can stakeholders be educated / motivated / persuaded and committed to act on a revolutionary advanced vision for truly sustainable urban transportation?

Silicon Valley has a deserved reputation for bold innovations, so a commitment to develop solar ATN at SJSU will spur further innovation to propagate this disruptive technology around the world.

Study Methods

ArcGIS and on-the-ground reconnaissance were used to plan the most feasible route for a prototype ATN that would connect the North and South campuses of SJSU. The microtraffic simulator SUMO with the SUMOPy extension was used to model the annual vehicle energy consumption for the ATN. The energy data was used with custom MATLAB software in conjunction with NREL data to size the solar photovoltaic canopies and determine the costs and real-time energy flows for grid-tie and energy storage components.

To convey the vision, the study team of architects, urban planners, industrial designers, and illustrators employed rigorous discipline to develop a compelling visual design for a functional solar ATN.

A comprehensive video was created to convey the compelling rationale and benefits of solar ATN, and the travelogue of a typical rider's experience. Attention was

given to route planning, the design of three convenient, functional and inviting stations, bicycle and disability accessibility, rider safety and comfort, and integration with the urban landscape.

Findings

The study found that it is feasible to power the North-South campus ATN by grid-tied solar energy and deliver surplus generation to the grid. A solar photovoltaic canopy about 7 m wide located above the guideway and at the three stations that were part of the prototype network will supply 6.2 MW of power, enough such that when combined with 9.8 MWh of battery storage, with grid connection, can allow the North-South campus network to run 24/7 and meet up to 115% of estimated passenger demand. The total cost for the energy system is estimated to be $11.4 million US dollars.

Solar powered transit can make a significant impact on reducing carbon emissions to mitigate climate change and improve the quality of urban life.

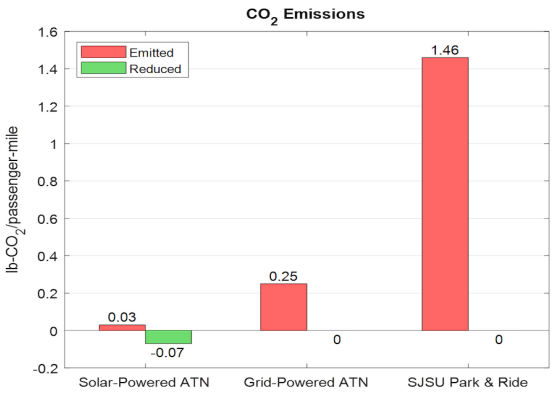
The study illustrated that a solar ATN can be woven into the urban setting between the North and South SJSU campuses. The conformity and visual impact of the ATN vehicles, stations, and guideways were shown to be appealing to the public. The user journey was shown to be convenient, bicycle friendly, private (or optionally semi-private), comfortable, and prompt.

Policy/Practice Recommendations

The authors recommend that solar ATN development be taken to the next level and implemented in San José. Actions to be taken include:

1. Recruiting multiple academic departments within SJSU and across CSU to collaborate and speed the development of solar ATN
2. Facilitating IRB approval to conduct stakeholder surveys to get feedback on the conceptual design of the system linking the North and South campuses
3. Obtaining funds from external sources and strategic industry support to further academic research and implementation of solar ATN for intercampus transportation
4. Publicizing the innovation in solar ATN that has been going on for the last nine years at SJSU (Spartan Superway)

CO2 emissions per passenger-mile for the solar-powered ATN, grid-powered ATN, and SJSU Park & Ride



About the Authors

Burford Furman is a professor of Mechanical Engineering at San José State University.

Laxmi Ramasubramanian is an architect and a certified urban planner, is Chair of the Department of Urban and Regional Planning at SJSU

Shannon McDonald is an Associate Professor at the School of Architecture at Southern Illinois University, Carbondale.

Ron Swenson is President of the International Institute of Sustainable Transportation.

Jack Fogelquist received his Masters in Mechanical Engineering from San José State University in 2019, and is now pursuing his PhD in mechanical engineering at the University of California, Davis.

Yu Chiao is a graduate student at San José State University.

Alex Pape is a graduate student at Southern Illinois University.

Mario Cruz is a product designer with a Master's degree in industrial design from the University of Cincinnati.

To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/1948**

MINETA TRANSPORTATION INSTITUTE

MTI is a University Transportation Center sponsored by the U.S. Department of Transportation's Office of the Assistant Secretary for Research and Technology and by Caltrans. The Institute is located within San José State University's Lucas Graduate School of Business.