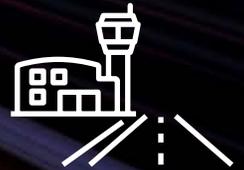


Inaugural Technologist in Communities Scanning Tour: Automated and Electrified On-Demand Mobility

Follow-On Summary Report
April 24–25, 2023

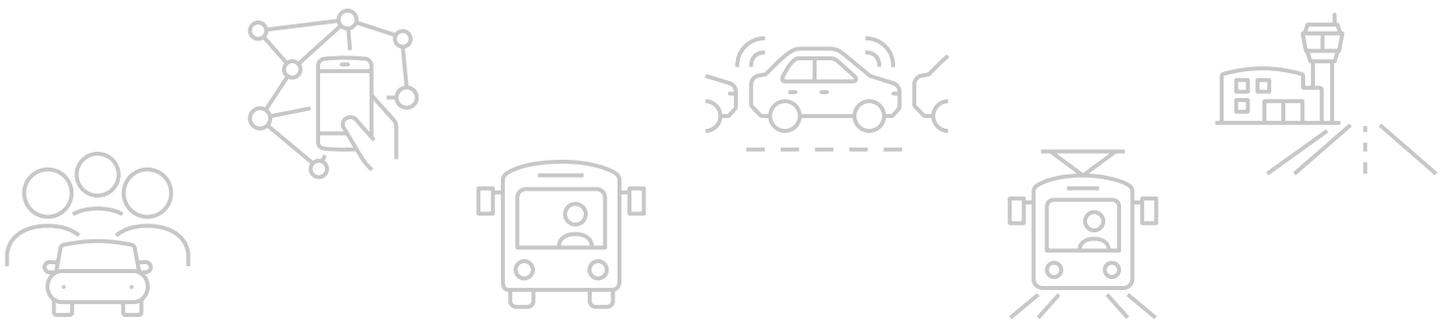


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List of Acronyms

DART	Dallas Area Rapid Transit
DOE	U.S. Department of Energy
EV	electric vehicle
MEP	Mobility Energy Productivity
NREL	National Renewable Energy Laboratory
PHX	Phoenix Sky Harbor International Airport
TIC	Technologist in Communities

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Background

In 2023, the Technologist in Communities (TIC) program hosted its inaugural scanning tour across the American Southwest, with a goal of investigating the region’s leading public mobility systems and their integration with on-demand public mobility services.

The scanning tour concept was inspired by and named after a U.S. Department of Transportation Federal Highway Administration practice of hosting “scanning tours,” both domestically and abroad, to explore innovative transportation practices throughout the 1990s and early 2000s. Guided by the idea that “seeing is believing,” scanning tours created opportunities for government and industry representatives to collectively experience new technologies and best practices firsthand.

In 2023, the National Renewable Energy Laboratory (NREL) followed suit by leading the inaugural TIC scanning tour. TIC, part of the Technology Integration program within the U.S. Department of Energy’s (DOE’s) Vehicle Technologies Office, supports positive energy and mobility outcomes in communities across rural to urban contexts. TIC enables technical experts to work directly with leaders and stakeholders in communities and assist them in implementing promising new technologies.

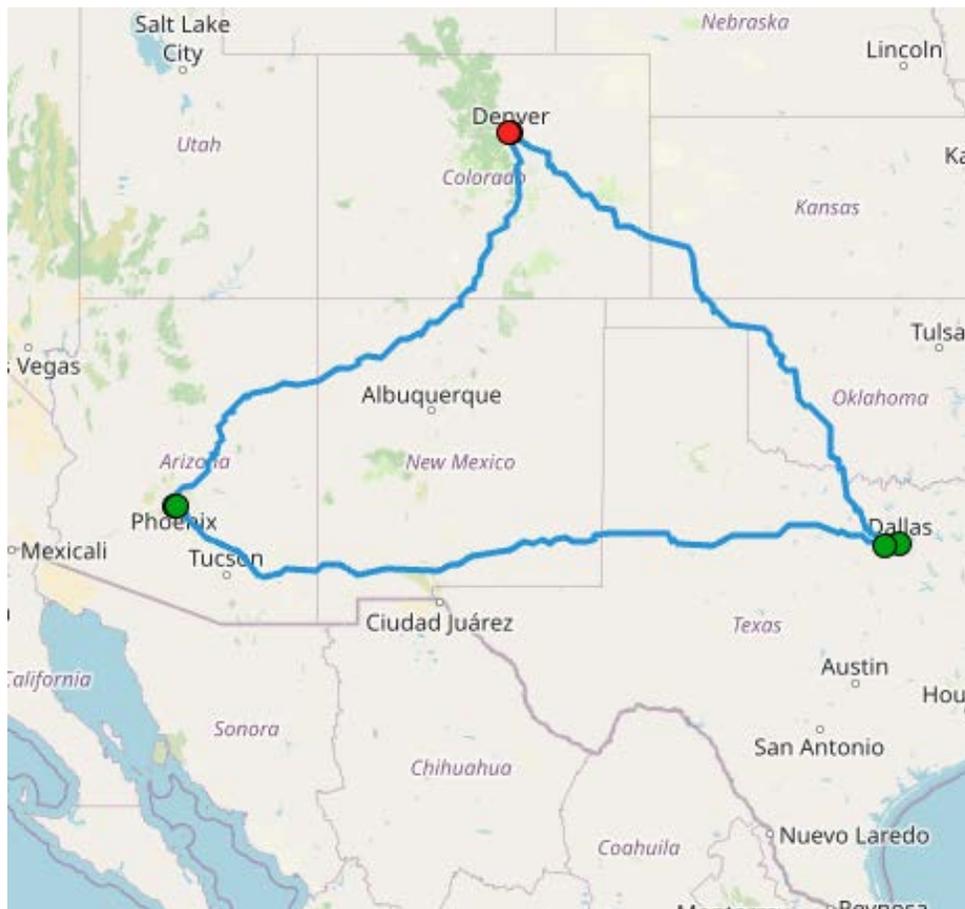
This first TIC scanning tour invited NREL, DOE, and industry experts to survey innovative public mobility practices and their integration into public transit systems across the Southwest. The tour’s goals included examining the state of innovation in public mobility in cities, communities, and airports; facilitating collaboration between entities; and sparking potential new partnerships.

The following report summarizes key findings from the scanning tour.

Tour Stops

The inaugural TIC scanning tour invited NREL researchers, DOE program managers, and leaders in the transportation technology space to survey emerging practices in on-demand mobility across Texas and Arizona. The tour stops included:

- Arlington, Texas: Arlington On-Demand ride-share and RAPID autonomous vehicle service.
- Dallas, Texas: Dallas Area Rapid Transit (DART) with GoLink and GoPass services.
- Phoenix, Arizona: Waymo One autonomous taxi service.
- Phoenix, Arizona: Phoenix Sky Harbor International Airport (PHX).



First Stop: Arlington, Texas

The city of Arlington’s Arlington On-Demand ride-share service illustrates the applications of on-demand mobility services in low-density suburbs without a preexisting public transit authority or traditional bus service.



Between 1980 and 2002, voters in Arlington, Texas, rejected three ballot initiatives to establish a traditional public transit system. As the city grew to nearly 400,000 residents over 100 square miles, it earned distinction as “the largest U.S. city without public transit.” In 2016, the city of Arlington convened a transportation advisory committee to study the community’s transportation needs and explore the possibility of emerging transportation modes, including on-demand ride-share and autonomous transit fleets.

In 2017, based on these recommendations, the city launched Arlington On-Demand, a ride-share service contracted through Via Transportation. After incremental expansion from 2017–2021, the service now connects all Arlington residents with on-demand, shared transportation through a smartphone application and a fleet of roughly 70 vehicles, primarily hybrid electric minivans.

The Arlington On-Demand system offers low-cost fares (\$3 to \$5 per ride) subsidized through Federal Highway Administration grant funding and the city’s general budget. The service covers the entirety of Arlington’s sprawling, low-density area and links to other regional transit options at its periphery with an on-demand ride-share service similar to Uber Pool. Passengers request rides primarily through a smartphone app—though call-in service is available—and a shared vehicle is dispatched to pick them up.

Similar to other commercial services, passengers can see their ride approaching using a map on their smartphone. Unlike other commercial services, ride-sharing is mandatory. With a “corner-to-corner” service model (as opposed to curb-to-curb), passengers may walk a block or two to their pickup spot or destination and will likely share their ride with others traveling in the same direction. Continued growth indicates that the service is providing a needed mobility option throughout Arlington.

In 2021, the city of Arlington added its RAPID program to Arlington On-Demand and now offers driver-assisted autonomous vehicle service in downtown Arlington and on the University of Texas at Arlington campus. Overall, both programs have been successful, seeing continued demand growth even during the last months of the COVID-19 pandemic, a time of notably diminished transit ridership.

Arlington On-Demand in Action

Participants in the scanning tour booked shared rides through Arlington On-Demand’s mobile app several times throughout the tour stop, beginning with a trip from their lodging to a meeting downtown with the City of Arlington Department of Transportation Planning. The group’s first Arlington On-Demand driver was an enthusiastic advocate for the city and offered several recommendations for shopping, dining, and entertainment, illustrating the value of having a live driver acting as an ambassador for the city. On another ride, three scanning tour participants requested a vehicle, which they shared with three other riders over the course of the trip, totaling six adults and a driver in the seven-passenger minivan.



Key Statistics

- 15,000+ rides per week as of early 2023
- 1.8+ million rides since launch in 2019
- 99 square miles of coverage
- \$3–\$5 fare per ride (\$1 for students)
- Hybrid electric minivans comprise majority of 70+ vehicle fleet
- Non-white, lower-income, non-car owners comprise majority of passengers
- No fixed schedules or routes
- Corner-to-corner service, rather than curb-to-curb.

Key Takeaways

- Arlington On-Demand is notable for its successful “greenfield implementation” in a city that has been resistant to public transit.
- Its low-cost, on-demand ride-share service provides a needed mobility option for lower-income, non-car-owning populations.
- The service’s flexibility and convenience have helped it outscore competitors, including Uber and Lyft, on NREL’s [Mobility Energy Productivity \(MEP\) tool](#), which measures accessibility with respect to travel time, cost, and energy, reflecting how efficiently, equitably, and sustainably people can move around an area.
- The program’s continued demand and growth indicates that on-demand transit has applications in low-density areas.

Key Questions

Is on-demand ride-share the new face of public transit for our sprawling suburbs? Can it be implemented in a cost-effective manner? What policies could help effectively replicate this service elsewhere?

Opportunities for the Future

- Creating new connections and service integration between Arlington and North Central Texas, including Dallas, Fort Worth, and Dallas-Fort Worth International Airport.
- Fully electrifying the Arlington On-Demand fleet and building out supporting electric vehicle (EV) charging infrastructure.
- Establishing criteria to determine if high-frequency, fixed-route services should be integrated into existing operations.
- Identifying new partnerships, including with major employers, to leverage the effectiveness of the system by enabling employer-provided mobility, such as rides to and from work.

Second Stop: Dallas, Texas

DART illustrates the potential for cities to retrofit legacy transit systems with integrated on-demand mobility services alongside traditional interregional transit.



In 2021, DART made a bold change to its operations: The transit agency eliminated 36 bus routes and 3,000 bus stops in order to focus its operations on major routes, reduce wait times, and integrate on-demand mobility options for the first and last mile of trips—in addition to serving as a local community circulator. The agency also replaced some fixed-route fleet vehicles with on-demand microtransit options provided through its GoLink service.

In response, ridership increased, wait times decreased, and the agency has seen significant cost savings. Now, DART is at the center of national conversations surrounding mobility as a service and integration of on-demand transit into established urban transit operations.

DART's operations throughout Dallas and 12 surrounding cities provide fully integrated public transit service through its GoPass smartphone application. The app allows customers to personalize their travel with fixed-route and on-demand options, including light rail, buses, microtransit, ride-share, and ride-hailing.

GoPass has allowed DART to integrate a single point of end-to-end trip planning, information, and payment for passengers, with a goal of making any of its transit modes as convenient as other options. Unlike popular routing apps such as Google Maps or Apple Maps, the GoLink app provides seamless itineraries across multiple modes of travel with a single point of payment. The

app demonstrates a successful shift toward mobility as a service, where transportation options—and information about how to access them—are accessible enough that consumers are able to shift away from ownership of, or travel despite lacking access to, a privately owned vehicle.

The agency’s success in retrofitting its legacy transit system with on-demand mobility services has drawn nationwide attention. As it continues to evolve GoPass and GoLink, other municipalities including Charlotte, North Carolina, and Tulsa, Oklahoma, are adopting similar systems supported by the DART GoPass technology platform. A particular draw appears to be the potential cost savings; synthesis of Uber to DART’s microtransit service has decreased the agency’s average trip subsidy from \$27 per ride to an industry low of \$16.

DART in Action

Scanning tour participants took the light rail from DART’s downtown headquarters across the city, then used the GoPass app to connect with the GoLink on-demand microtransit service. DART automatically matched participants to a GoLink fleet van for the second leg of the journey, where the members were able to view the DART vehicles and speak with a service provider driver. The experience was punctuated when, without prompting, a DART rider recognized the touring group and exclaimed “I love my DART!”



Key Statistics

- 700-square-mile service area
- 30 zones and 360 square miles of on-demand travel
- 13 cities within service area
- 96 fixed-route bus routes
- 7,000 bus stops
- 70% of on-demand trips booked through GoPass.

Key Takeaways

- DART offers one of the nation’s clearest examples of how a modernized, fully integrated public transit agency can lead a transition to mobility as a service.
- Fully integrating real-time routing data and third-party ride-share operations has enabled DART to improve timeliness, streamline multimodal trips, and simplify payment.
- Modernizing and improving DART’s operations required the agency to significantly restructure bus service, reducing bus stops and streamlining routes.
- The GoPass/GoLink system also provides a direct line of communication to patrons, not only for service offerings, but also with critical safety information and community resources.

Key Questions

How can transit agencies further integrate on-demand transit into legacy operations? How can lessons learned at DART be transferred to and replicated in other areas? How can neighboring cities like Dallas and Arlington integrate their offerings so that riders can seamlessly span jurisdictions? How has accessibility as measured by the MEP tool increased as a result of the advances made at DART?

Opportunities for the Future

- Adopting similar systems supported by GoPass’s technology platform in other municipalities.
- Fully electrifying the DART fleet and building out supporting EV charging infrastructure.
- Further optimizing GoPass and GoLink and building out their user base.
- Integrating with neighboring jurisdictions.
- Implementing measures of effectiveness, including using NREL’s MEP tool.

Third Stop: Phoenix, Arizona

Waymo One illustrates a leap forward for on-demand mobility thanks to its fully electric, autonomous, 24/7 operations.



After beginning operations in 2009 as part of the Google Self-Driving Car Project, Waymo is now the world’s first fully autonomous EV ride-hailing service. The company opened its operations to the public in the Phoenix metropolitan region—Chandler, Arizona—in 2021. In 2023, service expanded to the downtown region and continues to expand throughout the city. Waymo has also partnered with PHX to provide service to and from the 44th Street PHX Sky Train Station. Travelers in Phoenix can hail a ride in an automated Waymo vehicle through the Waymo One app.

Before beginning operations in a new city, Waymo creates detailed custom maps of the environment, including lane markers, stop signs, curbs, and crosswalks. Waymo’s automated driving software pairs these maps with real-time data from a powerful suite of sensors including lidar, radar, and long-range cameras, as well as “experience” it has gathered from 20 billion miles of simulations and 20 million miles on public roads. Waymo now bills the software as “the world’s most experienced driver.”

While Waymo One represents a potentially revolutionary path forward for convenient, energy-efficient, on-demand transportation, the company’s growth plan for deployment in new cities is contingent on stringent safety standards, and its near-term growth is projected to remain incremental. It is worth noting that Waymo also currently provides automated ride-hailing service in San Francisco, as does Cruise, which is a subsidiary of General Motors.



Discussions with Waymo’s head of sustainability and environment revealed a strong commitment to sustainable transport solutions for urban areas without relying on EV ownership. Rather, the company aims to create wider access to EVs on demand.

Waymo One in Action

Scanning tour participants downloaded the Waymo One app, added payment information, and then hailed rides after flying into PHX on the first day of the tour. They took Waymo from the 44th Street PHX Sky Train Station to their lodging, then rode back to PHX in the morning. There was no safety driver or attendant, and interaction with the vehicle was completely automated. Some participants were apprehensive or skeptical of the service, but by the end of the trip, all were impressed, and many took photos and videos and shared the experience on social media.

Key Statistics

- 20 billion simulated miles
- 20 million driver-assisted miles
- 2 million fully autonomous miles with 0 reported injuries to riders, cyclists, or pedestrians
- 2 million rides completed through Waymo One app
- 10,000 trips per week in the Phoenix area
- 3 cities with Waymo One operations: Phoenix, San Francisco, and Los Angeles (with safety operator).

Key Takeaways

- Waymo One is breaking new ground by offering convenient, energy-efficient, on-demand transportation.
- Applied at city scale, it could provide a viable alternative to private car ownership.

Key Questions

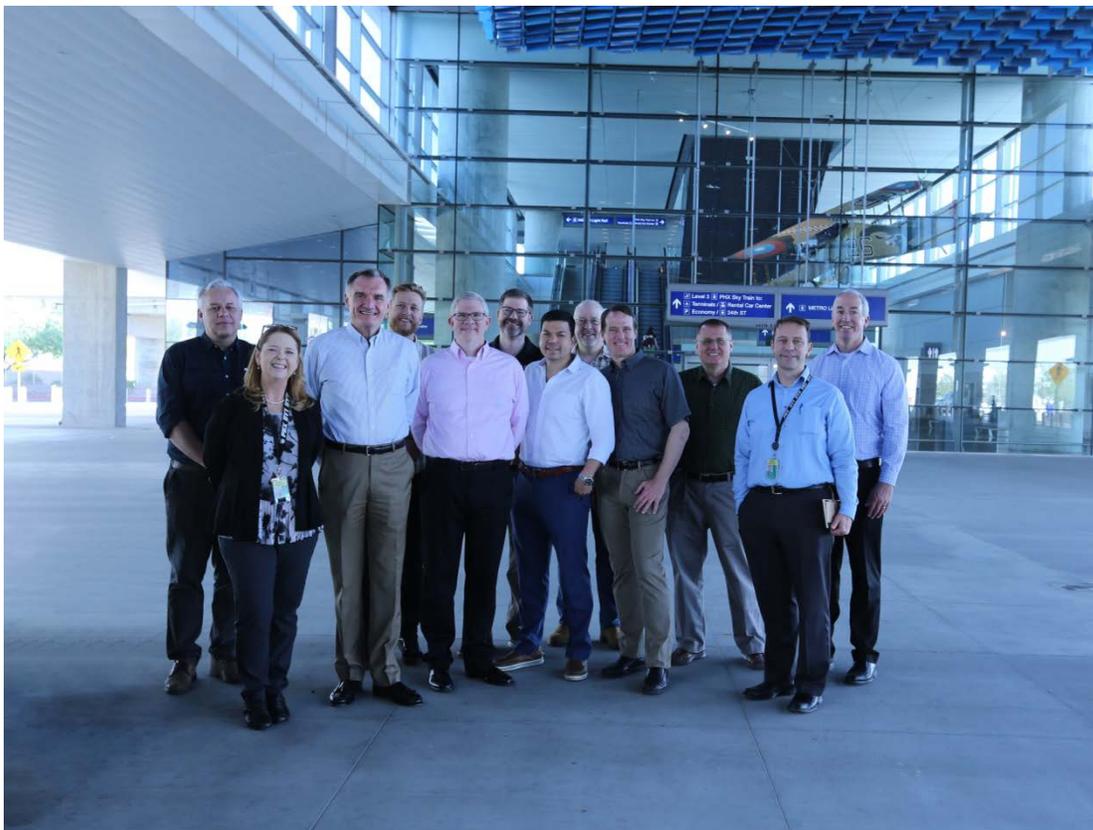
Can electric, autonomous, 24/7 ride-hailing services incentivize people to reconsider car ownership? Can these services become affordable enough to serve disadvantaged communities? Can automated driving software capabilities be integrated into municipal services?

Opportunities for the Future

- Sourcing the electricity for fleet charging from 100% renewable sources.
- Creating further efficiencies in operations, including reducing the power used by vehicle sensors and testing new curb management strategies to reduce congestion.
- Implementing curb management for automated services.
- Integrating automated driving with micromobility, active transportation, and existing public transit services.
- Integrating automated driving software into dedicated shuttles for efficient movement of people around cities.

Last Stop: Phoenix Sky Harbor International Airport

Researchers added Phoenix Sky Harbor International Airport (PHX) to the tour in light of its reputation as “America’s Friendliest Airport” and to identify potential areas for collaboration with a mid-size, rapidly growing urban airport.



Because airports are major employment and travel hubs for their communities and have seen a proliferation of ride-hailing services akin to on-demand transit, airports will be a key component of future on-demand transit planning. Building on NREL’s long-standing partnership with Dallas-Fort Worth International Airport—a large airport that serves as both a major hub and a regional destination, and which has significant sustainability goals—researchers added PHX to the scanning tour.

PHX’s *Roadmap to Net Zero Carbon* aims to achieve net-zero carbon emissions by 2040 with no more than 10% of emissions eliminated through carbon removal technologies. The airport’s sustainability strategies are focused on energy conservation measures, producing carbon-free electricity, and eliminating a small quantity of residual emissions through carbon removal technologies. It specifically aims to apply these strategies to its landside operations, vertical transportation, terminal operations, Sky Train automated people mover, and ground transportation.

The airport recently achieved a significant step toward its sustainability goals when it completed the final phase of its Sky Train, a fully electrified airport people mover. Five miles of track now

connect travelers to PHX’s consolidated rental car facility, convenient parking reserves, pickup and drop-off curbs at the 24th Street Station, and interconnection with the Phoenix light rail at the 44th Street Station. The extension also anticipates future expansion by reserving space for an additional station to service a future terminal.

Electrification and grid management strategies present pressing near-term challenges. For instance, PHX is working to provide on-demand taxi service from an EV fleet and shift its ride-hailing services to fully electric fleets by 2030. To meet these needs, the airport will require significant EV charging infrastructure. In order to reduce emissions despite this increased electricity demand, the airport is considering implementing utility-scale rooftop solar.

The airport also requires enhanced services for passengers with reduced mobility. Service demand from these passengers is growing at twice the rate of air traffic, which is itself growing at twice the rate of roadway traffic. Traffic management, particularly at curbside, also continues to be a challenge, as the airport road offers a convenient cut-through for Phoenix-area traffic. All these areas are ripe opportunities for collaboration.

Key Statistics

- 44 million passengers in 2022
- 120,000 passengers served daily
- 57,000 employees
- 3,400-acre footprint
- 21,000 parking spaces.

Key Takeaways

- PHX, like all airports with ambitious sustainability goals, must work toward both greater energy efficiency and improved mobility services.
- Efforts to increase energy efficiency, decrease energy demand, or implement emerging technologies must be paired with improvements to the customer experience and employee equity through more flexible, convenient commuting options, each of which is closely aligned with mobility efficiency.
- Improvements in mobility efficiency require stronger information-sharing and wayfinding systems, particularly to support growing communities of passengers with reduced mobility, as well as cross-modal integration.
- Automation with respect to fleet operations, fleet charging, passenger movement, and airport access will continue to be both leading disruptors and leading levers toward greater sustainability.

Key Question

As airports balance growth and decarbonization, which clean energy and mobility solutions should be prioritized?

Opportunities for the Future

- Increasing infrastructure support for passenger, commercial, and ride-share vehicle electrification.
- Investigating new traffic management solutions.
- Exploring curbside management solutions.
- Meeting the needs of a growing population of people with reduced mobility.
- Creating stronger information-sharing systems to improve communication with customers, especially to support customer adoption of emerging technologies.

Call to Action

If you represent a community interested in clean energy and mobility solutions, DOE's Office of Energy Efficiency & Renewable Energy has numerous initiatives offering support. Learn more about the:

- [Technologist in Communities program](#)
- [Clean Energy to Communities program](#)
- [Clean Cities Coalition Network](#)
- [Communities LEAP \(Local Energy Action Program\) Pilot](#).

If you represent a business or organization interested in clean energy solutions, NREL's experts may be able to help. Learn [how to work with us](#) and access NREL's:

- Sustainable [transportation research](#)
- World-class [facilities](#)
- Integrated [data and tools](#).