athena

Wisdom to guide mobility transformations at U.S. ports

Airport Infrastructure Expansion Under Uncertainty

Multistage stochastic optimization can help transportation hubs like airports and seaports plan for future infrastructure expansion while considering risks from emerging technologies and changes in demand.

The Challenge

U.S. airports have seen tremendous growth in both passenger and freight demand in the last 20 years, and this growth has required creative solutions for adapting and expanding existing infrastructure to meet the challenge. Meanwhile, emerging technologies such as shared mobility, electric vehicles, and autonomous vehicles have created new uncertainties for how infrastructure can be best designed for the future.

Our Approach

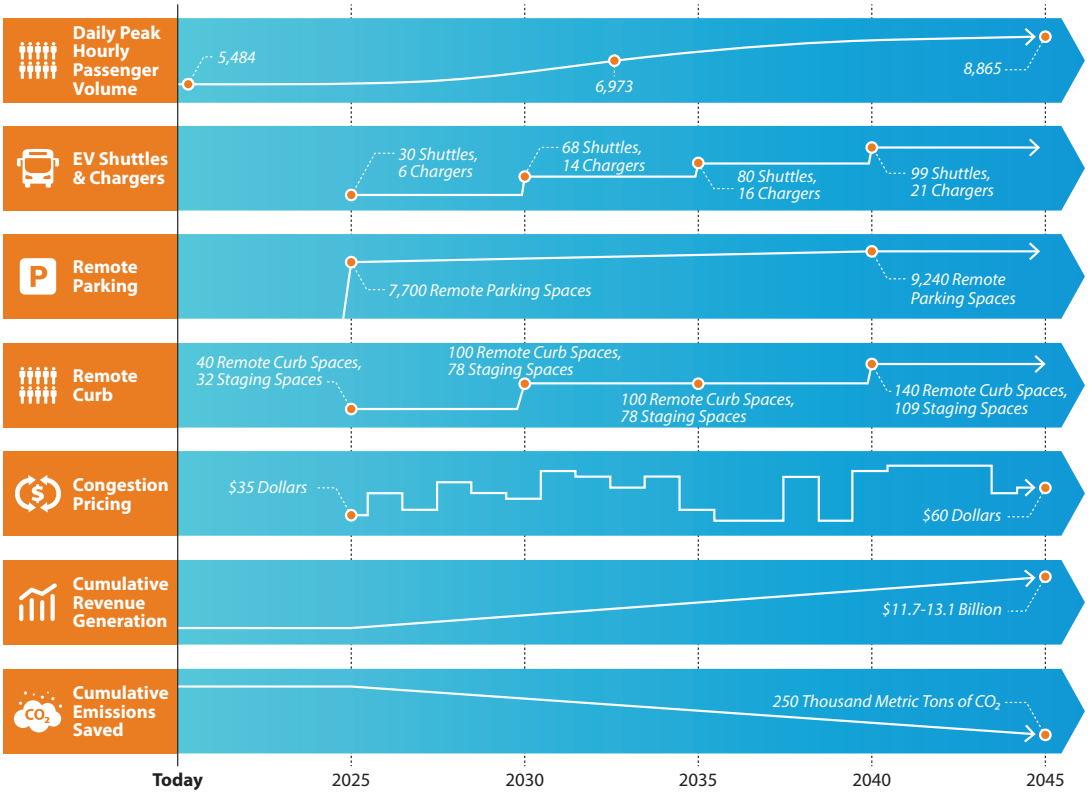
We have developed a novel multistage, multiperiod stochastic optimization model that considers an airport's decisions from 2025 to 2045 under different possible future macro trajectories and day-to-day variations in operational conditions captured as "annual representation of operations" scenarios with respective probabilities. We designed the model to leverage the outputs of various efforts under the Athena project to create a combined decision framework for infrastructure decisions. Our computational experiments of the modeled system at scale have resulted in a working version of our infrastructure model that enables the explicit representation and consideration of various sources of uncertainty in the decision process to enable robust, flexible decision-making.

Results

Our model has been effectively run on NREL's high-performance computing system, Eagle, with large numbers of stochastic scenarios, and it shows promise as a scalable tool for robust consideration of uncertainties in airport planning. We tested the model using 30,240 operational circumstances, which resulted in a problem with more than 200 million variables. The model was solved in several different configurations, and a workflow to simulate the performance of the infrastructure model results was developed and deployed. Though this modeling approach was developed in close partnership with Dallas/Fort Worth International Airport, the approach may could be generalized to other airports.

Impact

In general, our results indicate that a combination of remote parking, remote curb infrastructure, and dynamic pricing can generate revenue, reduce emissions, accommodate emerging technologies such as autonomous vehicles and electric vehicles, and manage airport passenger growth over time. We have seen that autonomous vehicle adoption by transportation network companies might necessitate larger amounts of remote curb. The results of this work inform strategies for airport infrastructure decision making, as well as demonstrate the value of an adaptable model, but they also indicate avenues where further research would be of value remain.



Detailed simulations and scenario optimization at Dallas Fort Worth International Airport show an opportunity to increase revenue and reduce emissions while improving customer experience. This can be accomplished through careful investment in infrastructure over the next 20 years.. Figure by Chris Schwing, NREL

Learn More

For more information, please see our comprehensive technical report at **https://www.nrel.gov/docs/fy21osti/80637.pdf**. You can also visit **athena-mobility.org** or contact **athena.mobility@nrel.gov**.

Photos by Dennis Schroeder, NREL.

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