THE ECONOMIC IMPACT OF ESTABLISHING AND EXPANDING URBAN AIR MOBILITY OPERATIONS IN SOUTHERN CALIFORNIA

Prepared for
Long Beach Economic Partnership

Prepared by
California State University, Long Beach

OCTOBER 2023 | Long Beach Economic Partnership

The Economic Impact of Establishing and Expanding Urban Air Mobility Operations in Southern California

Release Date | October 17, 2023

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FORWARD FROM THE MAYOR OF LONG BEACH, CALIFORNIA

In the early twentieth century, hot air balloonists and early pilots of fabric covered biplanes first used the city of Long Beach's miles of sandy beaches as a landing strip, drawing interest from spectators, thrill seekers, adventurers, and ultimately early aviation entrepreneurs. Long Beach quickly emerged as a hub of early flight, inspiring the likes of Ameilia Earhart, Charles Lindbergh and in 1911, Cal Rodgers completed the first transcontinental U.S. flight departing from New York and landing safely on the shores of Long Beach, etching a permanent place for our city in aviation history.

In 1919, Earl Daughtery opened a twenty-acre flight training field and school in Long Beach. As the concept grew in popularity, the city saw an opportunity to establish the foundation of what would eventually become the oldest municipal airport in California by acquiring more than one hundred acres, and breaking ground in 1923.

This year, we are celebrating the 100th anniversary of the Long Beach Airport, and like those visionaries who came before, we continue to look skyward for the newest innovations in aviation technology that will continue to bring new visitors to our city, while further connecting our region to the country, and the world.

As we witness the emergence of the Urban Air Mobility Sector in Southern California, the city of Long Beach is proud of the efforts put forth by the Long Beach Economic Partnership, and California State University, Long Beach, to better understand the economic impacts of establishing and eventually expanding vertiports regionally.

Long Beach sits at the meeting point between Los Angeles and Orange County and is uniquely positioned where visitors arriving through the Long Beach Airport can be transported via vertiport to key destinations across the region — from cruise terminals along the waterfront, to theme parks and other regional tourist attractions. As millions come to Long Beach to see one of the many events that will be held within city limits during the 2028 Olympics and Paralympics, vertiports will serve as a key network to circumvent and alleviate the famed congestion of our state highways.

As the authors of the report highlight, the potential economic benefits of a sophisticated and interconnected vertiport system which include hundreds of new job opportunities, and anticipated expenditures in the tens of millions, will be a transformational boon to our region.

Thoughtful planning and community engagement to further explore the impacts and benefits of advanced air mobility will be essential in all vertiport design and placement decisions. We must understand and account for the totality of stakeholder experiences, from users and non-users alike, regarding this new mode of travel.

As we prepare for the onset of advanced air mobility, our industry leaders and educational institutions must work together to create the necessary training and licensing opportunities so that our residents are prepared to participate in and benefit from this emerging sector, especially residents from low-income and underserved communities.

Readying our city to embrace urban air mobility is an important step to help make Long Beach a safer, healthier, and more sustainable place to live, work and play, while continuing our legacy as a national leader in aerospace innovation.

EXECUTIVE SUMMARY

The Southern California region is one of the largest and most congested metropolitan regions in the United States. The Los Angeles-Long Beach-Anaheim region was ranked number 1 in the US in 2019, in terms of annual delay per commuter, with 119 hours, and in terms of congestion cost, with over 20.6 billion USD of lost productivity. There are large potential gains in terms of time and economic benefit if advances in transportation technology increase mobility for commuters, as well as other travelers.

Urban Air Mobility (UAM) has been proposed as an augmentation to the transportation network that can increase urban transportation choices while contributing to sustainability and economic development. Aerospace manufacturers are in various stages of developing piloted and autonomous electric vertical takeoff and landing aircraft (eVTOLs) for "air-taxi" services and are also planning for the eventual construction and operation of networks of vertiports in regions of the U.S. and elsewhere around the world.

This study estimates the economic impact of a much-anticipated Urban Air Mobility sector in the city of Long Beach, California, and the greater Los Angeles-Orange County metropolitan area, in the middle of which it is located. A six-vertiport system is initially considered across this region, ultimately expanding to a ten and finally a twenty-vertiport system.

The economic impact of UAM operations is divided into two distinct phases. The first phase includes construction activity and other capital expenditures associated with the initial creation of the infrastructure network and its subsequent expansion. The second phase includes the impact of the integrated UAM flight operations as the vertiport system rolls out and expands air taxi service over time.

The economic impact of these phases is measured in terms of jobs created, associated income generated, and economic output produced. The study also estimates the sector's tax revenues generated in each phase, and its broader fiscal impact.

CONSTRUCTION / CAPITAL EXPENDITURES PHASE

Beginning with a six-vertiport system, there will be a total of $82.0 million in outlays that include $37.8 million in construction spending, communications infrastructure expenditures at $16.1 million, and upgrading the electrical grid at $16.0 million. The economic impact of the initial construction phase of the six-vertiport system is as follows:

- *803 jobs, including 472 direct jobs and 331 indirect and induced jobs.*
- *$67.5 million in labor income, including $42.4 million in direct income and $25.1 million in indirect and induced income.*
- *$153.9 million in output, consisting of $82.0 in direct output and $71.9 million in indirect and induced output.*

Urban Mobility 2021 Report *(p.42)*

When the system is expanded to twenty vertiports there will be total cumulative outlays of $226 million in the region, resulting in 2,133 jobs, $174.0 million in labor income, and $423.6 million in economic output. Based on these estimated results:

- *The output multiplier for the construction phase is 1.9, meaning that every $1 million in direct expenditures results in $1.9 million in total output for the metro area economy.*
- *The jobs-to-expenditures multiplier is 9.4. That is, for every $1 million in direct expenditures, 9.4 jobs are created.*
- *The average wage per worker over the three construction phases is $79,800 per year.*

OPERATIONS PHASE

The economic impact of the operations phase captures the recurring annual impact of operating the vertiport system. This includes flight activity between the individual vertiports, the air traffic control required to track and guide their movements around the network and in relation to other aircraft, ground operations, services related to passengers, and customer service functions associated with ticket reservations, both online and on-site through customer service agents. Site costs are also included. These include leasing, utilities, and facilities maintenance for both the vertiports and network support buildings.

For the six-vertiport system, there will be $29.6 million in recurring annual expenditures. By virtue of the multiplier effect, these expenditures will support a total of $59.9 million in total output, 320 jobs, and $29.6 million in labor income. When the system is expanded to twenty vertiports, there will be $84.4 million in total outlays, generating the following recurring annual impacts:

- *$173.3 million in output, including the direct expenditure impact of $84.4 million and $88.9 million in indirect and induced impacts.*
- *$90.3 million in labor income.*
- *943 jobs.*

The results may be interpreted as follows:

- *The output multiplier for the twenty-vertiport system is estimated at 2.0, meaning that every $1 million of initial expenditure generates a total of $2 million in output.*
- *The jobs-to-expenditures multiplier is 11.2, meaning that 11.2 jobs are created for every $1 million of initial expenditures.*
- *The average wage is $95,800 per year.*

TAX IMPACTS

In addition to creating economic impacts in terms of jobs, labor income, and output, the vertiport systems will generate new tax revenues.

- *For the construction phase, cumulative tax revenues are estimated at $57.4 million, including $22.7 million in state and local taxes.*
- *For the operations phase, recurring annual tax revenues for the twenty vertiport system are estimated at $29.4 million, including $12.0 million in state and local taxes.*

The expectation is that as the network scales, piloted operations will be joined by supervised autonomous operations later in this decade. Autonomous operations will enable increased throughput, additional cost efficiencies, and most importantly the safe scaling of the network. Also, as operations scale with autonomy, there are anticipated benefits for the communities in terms of increased mobility and sustainability that can contribute to economic and workforce development as well as overall quality of life goals. This study is applicable to the UAM industry as a whole, inclusive of both piloted and unpiloted aircraft.

It is hoped that this information will enable elected officials and other stakeholders to better understand the potential opportunities presented by UAM for their communities, and encourage officials to consider inclusion of UAM in future transportation planning.

INTRODUCTION

The Southern California region is one of the largest and most congested metropolitan regions in the United States. The Los Angeles-Long Beach-Anaheim was ranked number 1 in the US in 2019, in terms of annual delay per commuter, with 119 hours, and in terms of congestion cost, with over $20.6 billion of lost productivity. There are large potential gains in terms of time and economic benefit if advances in transportation technology increase mobility for commuters, as well as other travelers.

Aerospace manufacturers are in various stages of developing electric vertical takeoff and landing aircraft (eVTOLs), as well as planning for the eventual construction and operation of a network of vertiports in regions of the U.S. and elsewhere around the world. Here in Southern California, plans are underway to construct and operate such an "air taxi" network in the next few years, with autonomous flight capabilities available by the end of this decade.

The purpose of this study is to estimate the economic impact of an emerging and growing Urban Air Mobility (UAM) sector on the city of Long Beach, California, and the Los Angeles-Orange County metropolitan area in which it is located. The city of Long Beach is situated on the border between the two counties and will, therefore, be at the center of a Los Angeles-Orange County UAM network. A six-vertiport system is initially considered across this region, ultimately expanding to a ten and finally a twenty-vertiport system.

Initial operations will be piloted with the expectation that as the network scales up, piloted operations will be joined by supervised autonomous operations later in this decade. Autonomous operations are expected to enable increased throughput, additional cost efficiencies, and most importantly the safe scaling of the network. As operations scale with autonomy, so will the anticipated benefits for the communities in terms of mobility and sustainability, that can contribute to economic and workforce development and quality of life goals. This study applies to the UAM industry as a whole, inclusive of both piloted and unpiloted aircraft.

The economic impact of these phases is measured in terms of jobs created, associated income generated, and economic output produced. The study also estimates the sector's fiscal impact, that is, tax revenues generated in each phase.

Economic impact analysis measures the multiplier or ripple effect of the sector on the overall economy through its supply chain and spending out of wages. For example, an initial expenditure on wages or payment to a supplier triggers a series of downstream expenditures as goods or services are procured and as earned wages are spent. These waves of expenditures are added to the initial expenditure to determine the overall or total economic impact. Thus, the total impact on the economy is greater than the sum of the sector's initial expenditures, whether they are expenditures on construction or operations.

Urban Mobility 2021 Report *(p.42)*

STUDY SPONSORSHIP AND COLLABORATION

This study, conducted by the Office of Economic Research (OER) at California State University of Long Beach (CSULB), was commissioned by the Long Beach Economic Partnership (LBEP) and received financial support from Wisk Aero, a California-based aerospace manufacturer developing autonomous electric vertical takeoff and landing aircraft (eVTOLs) designed to be utilized as sustainable air taxis. Under the auspices of the Long Beach Economic Partnership (LBEP), Wisk and CSULB collaboratively engaged the industry members of the LBEP Advanced Air Mobility (AAM) Working Group to collect and develop data and background information that formed the foundation of the study's economic impact analysis. Working group members Skyports, Supernal, Joby, Black & Veatch, SMG Consulting, AURA Network System, and Overair were consulted and provided feedback on report inputs. While the information provided by the working group has been incorporated into this report as appropriate, the information or views provided in this report are those of CSULB and the LBEP and may not reflect those of the working group members.

SCOPE AND ASSUMPTIONS

AREA AND USE CASE

This study will cover the geographic areas of the city of Long Beach, California, and the Los Angeles-Orange County metropolitan area in which it is located. This study accounts for air taxi passenger services only, for which the industry supporting the study had data, and not cargo applications. However, the energy and communication infrastructure envisioned in this study would have capacity to support additional activities such as cargo transport applications. If the passenger-based activities analyzed in this study were augmented with cargo activities, the network could potentially generate a larger economic impact than that estimated here.

NETWORK SIZE / SCALING SPEED / OPERATION TYPES

This study considers three network sizes, containing six, ten, and twenty vertiports. The process of construction, commencing operations, and expansion is expected to take place over a period of 15 to 20 years for the larger networks. However, all dollar figures in the report are given in 2023 dollars to readily enable analysis and comparisons that are independent of the actual timeline that is pursued.

A six-vertiport network is considered a small but reasonable starting network size for meaningful operations and impact calculations. Initial construction will be gradual, and we understand that there may be two vertiports operating before there are six. A fully-scaled network would consist of twenty vertiports. A network of ten vertiports was also considered to account for the potential of slower growth within the notional timeframe.

UAM will likely start with piloted operations; however, as autonomous flights are the key to scaling, there will likely be a time when piloted and autonomous flights coexist. Each type of operation has different requirements.

On one hand, piloted operations require at least one pilot per aircraft, as well as backup pilots for contingencies. This approach may become increasingly costly as UAM scales.

On the other hand, autonomous operations will require an in-region Flight Operation Center (FOC) where unmanned aerial vehicle supervisors, staff, and technical personnel will run the operations for the network. This is akin to the role of a control tower at an airport. Multi-vehicle supervisors will start out monitoring one-to-one, with the expectation that the ratio will increase alongside technological developments. This will result in cost efficiencies that will ultimately outweigh the higher initial investment in infrastructure.

NUMBER OF OPERATIONS AND VERTIPORT THROUGHPUT

Vertiports will vary in size, based on available land, permitting requirements, and throughput needs. All vertiports have airside and groundside components. The airside components include the touchdown and landing zones within the final arrival and takeoff areas (FATOs), and they also include the gates at which the aircraft are parked for passenger embarking/disembarking and turnaround. A FATO is analogous to the runway in current commercial aviation, while a gate is similar to gates for the aircraft at airports. We considered two types of vertiports: one FATO with four gates and two FATOs with ten gates. For each network size, we assumed about 25% of the vertiports will have two FATOs and the rest will have one FATO. So the initial network would likely have four vertiports with one FATO and two vertiports with two FATOs, for a total of six vertiports with a cumulative 8 FATOs.

Throughput estimates for each network were based on mobility demand modeling data, and the vertiport operational considerations of the relevant vertiports. We are also considering aircraft carrying up to four passengers. To evaluate if a ground trip can be captured by UAM, the modeling evaluates existing ground commuting patterns and associated time savings over the entire multimodal journey.

	Initial Six-Vertiport Network	Intermediate Ten-Vertiport Network	Final Twenty-Vertiport Network
Number of flights per day*	423	982	1661
Average flight time (minutes)	17	16	15
Number of aircraft needed	52	68	120

*The increase will be gradual, as the initial network will start with 2 vertiports and then expand.

INCLUDE MAINTENANCE, REPAIR, AND OPERATIONS (MRO) COST BASED ON THE EXPECTED REQUIRED MAINTENANCE

One or more maintenance facilities from one or more providers will be needed in the region to provide maintenance. The maintenance building would also double as storage where aircraft unable to stay on the landing pads would park overnight.

Maintenance, Repair, and Operations (MRO) costs and facility size were determined by taking the number of predicted flight hours per aircraft and the space needed for parking per aircraft.

INFRASTRUCTURE ASSUMPTIONS (VERTIPORT, COMMUNICATIONS, ELECTRICAL UPGRADES)

To simplify the model, we did not differentiate between greenfield and brownfield vertiport infrastructure and took an average CAPEX and OPEX value, based on the literature and industry inputs, with separate estimates for one FATO and two FATO. We included, per vertiport, a provision for the cost to upgrade the electrical infrastructure in order to accommodate the charging necessary for electric aircraft

Concerning communications infrastructure, we accounted for non-recurring and recurring engineering costs necessary for the infrastructure updates allowing for autonomous operations.

DATA AND METHODOLOGY

Regional economic impact analysis generally involves two essential components: data and a regional economic model. A wide array of economic data may be used to describe the activities of a firm, an industry, or an entire region. Economic impact analysis specifically uses data on expenditures as opposed to sales, revenues, and profits to limit the possibility of double-counting economic activity in the analysis.

Wisk Aero and other firms involved in the eVTOL and broader UAM industry provided data that was used to develop expenditure profiles for both construction and operations. The expenditure profiles were refined over several months and many iterations, as the economic research team worked with representatives of the participating firms to develop realistic estimates of construction costs and operating costs for the new UAM network.

The construction phase of UAM consists of expenditures related to site acquisition and preparation, infrastructure construction, facilities construction, and the installation of communications and network equipment. The UAM network is first assumed to consist of six vertiports linked via network operations facilities. The network facilities include communications systems used for traffic control, a reservations and customer relationship management system, and where applicable, an autonomous vehicles piloting, navigation, and operations system. In this study, the typical vertiport will have a takeoff and landing area and a passenger terminal. The vertiport system will also be supported by maintenance facilities where aircraft are maintained, repaired, and stored when not in service. The network will be expanded from six to ten vertiports, and eventually, to twenty vertiports, in response to increases in demand over time.

Expenditures Associated with Construction and Operations Phases	
Construction Phase	**Operations Phase**
Site preparation	Vertiport operations
Infrastructure construction	Network operations
Facilities construction	Customer support activities
Communications and other network installations	
Upgrade electrical grid	Excluded: Passenger/visitor spending

The operations phase of implementation consists of the expenditures associated with the operation and maintenance of the vertiports, operations and maintenance of the aircraft, customer service functions, and network support, which includes flight control and other activities. In general, operations expenditures were assumed to increase in scale as the vertiport system expanded from six to ten to twenty vertiports. Estimation of the economic impact of passenger and visitor spending that occurs in conjunction with the use of the vertiport system is beyond the scope of this study, but based on past experience with economic impact analysis projects, it would be expected to generate a substantial additional contribution to the overall impact.

The expenditure data is used as an input to a regional economic impact model of the two-county Los Angeles-Orange County Metropolitan Area (LA MSA), a large geographic region with a population of 13 million residents, that the proposed eVTOL system will initially serve. Because the city of Long Beach is located on the border of Los Angeles and Orange counties, it is an ideal location for an initial stage vertiport site that will serve customers and draw its workforce from both counties.

The regional economic impact model is developed by IMPLAN, one of the most widely used regional modeling platforms. The model, which is calibrated to represent inter-industry linkages of the industries across the post-pandemic Los Angeles-Orange County economy, is used to estimate the impact of the new network on the regional economy.

Wisk Aero and other firms provided expenditure estimates for the construction and operation of the vertiport system. This data enabled the researchers to develop expenditure profiles for both the construction and annual operations of three scenarios: Initial, Intermediate, and Final system configurations. Each of these configurations serves to represent snapshots in time of the growing vertiport system, with each configuration being larger than its predecessor.

The analysis is conducted in two phases. The Construction and Capital Expenditures phase (hereafter referred to as the Construction phase) represents one-time impacts associated with creating the initial network and expanding it over time. The Operations phase represents the ongoing impacts that are related to the ongoing activities of the network over time as it progresses from the initial six-vertiport system through its expansions.

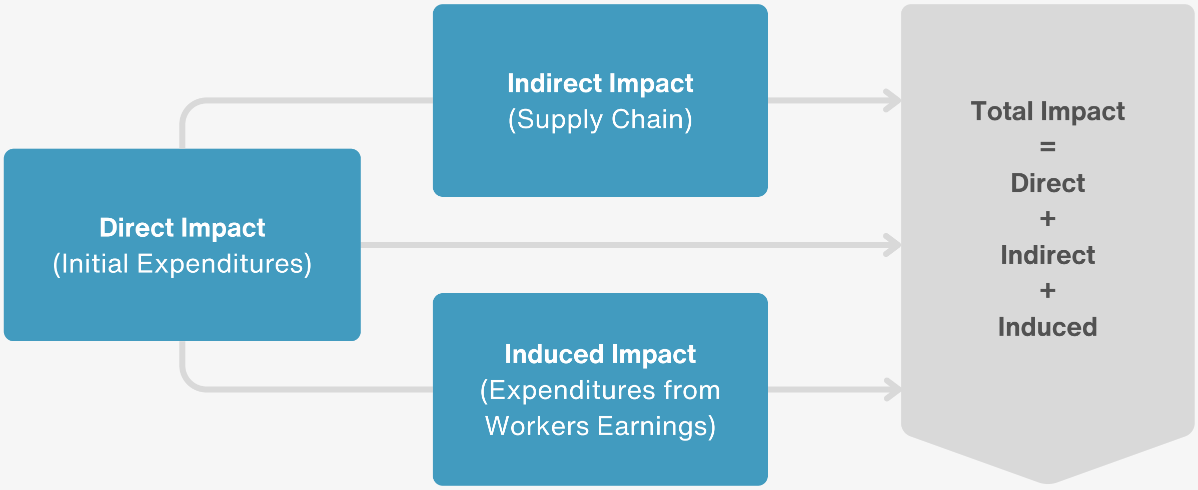
Using the inputs from the expenditure profiles, the model determines downstream purchases of labor and other inputs by vendors in local supply chains that are triggered by industry activity. It then calculates the full multiplier or ripple effect of those expenditures on the regional economy, including the spending that stems from income earnings. The model also accounts for leakages that result when input purchases or hires are made outside the region, thus leaking out of the regional economy.

To provide a more detailed breakdown of impacts, the model categorizes economic contributions as direct, indirect, and induced:

- *Direct impacts consist of the initial round of spending that is undertaken by firms in the industry in the form of purchases of goods and services from suppliers, payroll and other operating expenditures, and capital expenditures.*
- *Indirect impacts refer to subsequent business-to-business supply-chain purchases of inputs that stem from the initial or direct construction and operation of UAM facilities.*
- *Induced impacts stem from spending that enters the local economy as workers employed by the UAM industry and its suppliers receive labor income, much of which is spent on purchases of local goods and services.*

The total impact of the UAM industry on the local economy is the combined total effect of the direct, indirect, and induced impacts.

ECONOMIC IMPACT: SUM OF THE PARTS

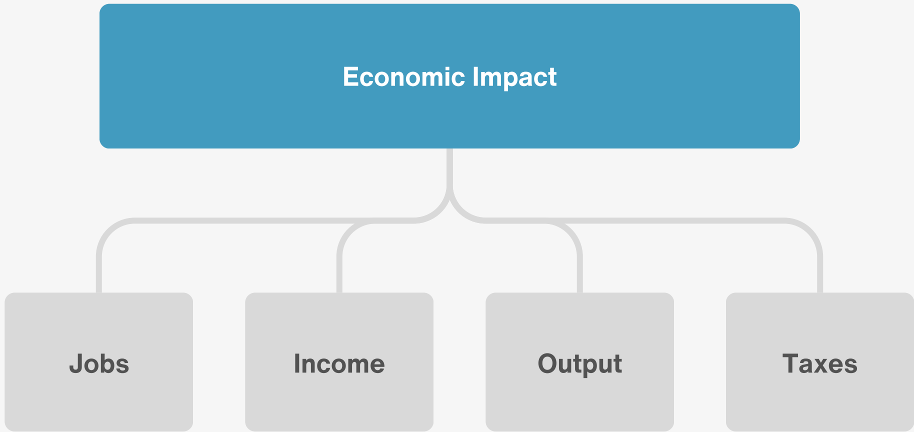


Having identified the direct expenditures, indirect expenditures, and induced expenditures that are part of the Construction phase and the Operations phase, the regional economic impact model estimates the full impact of the two phases as the initial expenditures work through the Southern California economy. Economic impacts are represented in terms of three different measures:

- *Jobs*
- *Income*
- *Economic output or activity*

Additionally, the fiscal impact is estimated, measured in terms of tax revenues generated at the federal level and at the combined state-local level.

MEASURING ECONOMIC IMPACT



ANALYSIS & RESULTS: ECONOMIC IMPACTS

Detailed data and estimates of construction and operations expenditures were provided by Wisk Aero and other members of the LBEP Advanced Air Mobility (AAM) Working Group. These were assembled into expenditure profiles and used to estimate the economic impacts resulting from the one-time construction phase and recurring year-to-year operations phase of the network. The analysis began with an initial system of six vertiports, which was expanded to ten, and ultimately, twenty vertiports. For each of these system sizes, there were two economic impact estimates – one-time impact of the construction phase and recurring annual impact of the operations phase – for a total of six economic impact estimates. The economic impact of each phase is described in this section.

CONSTRUCTION PHASE

he initial configuration of the vertiport system consists of six vertiports and supporting network infrastructure. Construction of the six vertiports includes site acquisition, site preparation, and construction of the takeoff and landing area, passenger terminal, and maintenance facilities for $82.0 million.

It is assumed that vertiports will be established at sites that will be leased rather than purchased. The construction phase is expected to last three years, half of which includes an option on the site at $50,000/year, followed by 1.5 years of full lease payments during which the vertiport is constructed. The lease expense pays for the entire site, including space for final arrival and takeoff areas (FATOs) and terminals, aircraft maintenance facilities, and office space for administrative, operations and network support functions that may or may not be located onsite. Additional outlays are associated with upgrading the electrical grid to provide the charging capacity required to recharge aircraft batteries in a timely manner. Finally, there are significant outlays for communications and flight operations control. As shown in the table, most construction spending outlays 'scale up' as the size of the vertiport system grows from six to ten to twenty vertiports.

Construction Expenditures by System Size: Incremental and Total Expenditures				
Input	6 Vertiports	10 Vertiports	20 Vertiports	Total
Site acquisition/Lease	$6,825,000	$3,900,000	$10,725,000	$21,450,000
Site preparation and constuction	$37,800,000	$21,600,000	$59,400,000	$118,800,000
Electrical grid upgrade to create/increase capacity for aircraft charging	$16,000,000	$8,000,000	$24,000,000	$48,000,000
Flight operations control (FOC): purchase/installation of computer hardware, software	$329,100	$0	$0	$329,100
Communications	$16,130,000	$2,022,900	$2,690,457	$20,843,357
Maintenance facility		$3,150,000	$8,460,000	$16,560,000
Total expenditures	**$82,034,100**	**$38,672,900**	**$105,275,457**	**$225,982,457**

Six-Vertiport System

As shown in the following table for the six-vertiport system, construction costs account for nearly half ($37.8 million or 46.1%) of all capital and construction expenditures, followed by communications infrastructure expenditures at $16.1 million (19.7%) and upgrading the electrical grid at $16.0 million (19.5%).

6 Vertiport System: Construction Input Expenditures		
Input	Amount	Share of Total
Site acquisition/Lease	$6,825,000	8.3%
Site preparation and constuction	$37,800,000	46.1%
Electrical grid upgrade to create/increase capacity for aircraft charging	$16,000,000	19.5%
Flight operations control (FOC): purchase/installation of computer hardware, software	$329,100	0.4%
Communications	$16,130,000	19.7%
Maintenance facility	$4,950,000	6.0%
Total expenditures	**$82,034,100**	**100.0%**

The economic impact of the Construction phase of the network is as follows:

- *803 jobs, including 472 direct jobs and 331 indirect and induced jobs.*
- *$67.5 million in labor income, including $42.4 million in direct income and $25.1 million in indirect and induced income.*
- *$153.9 million in output, consisting of $82.0 in direct output and $71.9 million in indirect and induced output.*

Construction Impact: 6 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	471.5	$42,405,661	$82,034,100
Indirect/Induced	331.2	$25,136,399	$71,870,788
Total	**802.7**	**$67,542,060**	**$153,904,888**

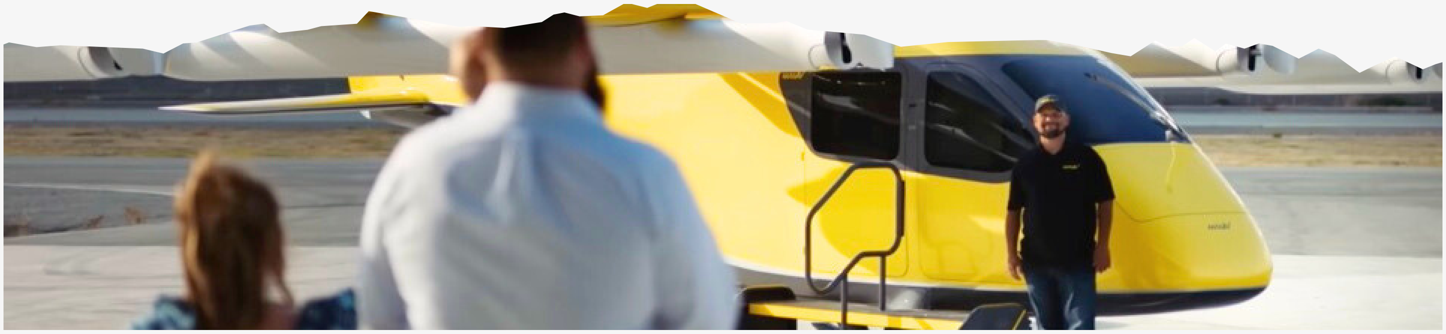
Based on these estimated results:

- *The output multiplier for the Construction phase is 1.9, meaning that every $1 million in direct expenditures results in $1.9 million in total output for the metro area economy.*
- *The jobs-to-expenditures multiplier is 9.8. That is, for every $1 million in direct expenditures, 9.8 jobs are created.*
- *The average wage per job is $84,140 per year.*

Ten-Vertiport System

The incremental and total expenditure inputs and associated economic impact results for the ten-vertiport system appear below.

10 Vertiport System: Construction Input Expenditures			
Input	**6 Vertiport Total**	**10 Vertiport Incremental Expenditure**	**10 Vertiport Total**
Site acquisition/Lease	$6,825,000	$3,900,000	$10,725,000
Site preparation and constuction	$37,800,000	$21,600,000	$59,400,000
Electrical grid upgrade to create/increase capacity for aircraft charging	$16,000,000	$8,000,000	$24,000,000
Flight operations control (FOC): purchase/installation of computer hardware, software	$329,100	$0	$329,100
Communications	$16,130,000	$2,022,900	$18,152,900
Maintenance facility	$4,950,000	$3,150,000	$8,100,000
Total expenditures	**$82,034,100**	**$38,672,900**	**$120,707,000**



In the course of expanding from a six-vertiport system to a ten-vertiport system, there are increases in most expenditure categories:

- *An additional $3.9 million in site acquisition and leasing, followed by $21.6 million in site preparation and construction associated with the additional four vertiports.*
- *Additional expenditures to upgrade electrical system capacity ($8 million) and to increase maintenance facility capacity ($3.2 million).*
- *Incremental expenditures on communications of just over $2 million.*

Expansion from a six-vertiport system to a ten-vertiport system triggers the following incremental impacts on jobs, labor income, and output:

- *A total of 360 additional jobs, including 207 jobs associated with the direct impact, along with 153 indirect and induced jobs.*
- *$29 million in additional labor income, of which $17.2 million is associated with the direct impact and $11.8 million is associated with the indirect and induced impacts.*
- *$72.5 million in additional output, which includes an initial direct outlay of $38.7 million and indirect and induced effects totaling $33.9 million.*

Incremental Construction Impact: 10 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	207.2	$17,249,147	$38,672,900
Indirect/Induced	153.1	$11,750,969	$33,865,276
Total	**360.2**	**$29,000,116**	**$72,538,176**

Twenty-Vertiport System

The next expansion phase described in this study represents growth from a ten to a twenty-vertiport system. The incremental expenditures appear in the following table. In expanding the system from ten vertiports to twenty vertiports, there will be a near-doubling of total expenditures. That said, increases in individual expenditure categories are a function of increases in capacity that are required to accommodate expansion in the number of flights and related activities. The table also shows cumulative total expenditures that enter the regional economy as a result of constructing the entire twenty-vertiport system, that is, summing the incremental outlays over the six, ten and twenty-vertiport construction phases.

20 Vertiport System: Construction Input Expenditures			
Imput	**Employment**	**20 Vertiport Incremental Expenditure**	**Output**
Site acquisition/Lease	$10,725,000	$10,725,000	$21,450,000
Site preparation and constuction	$59,400,000	$59,400,000	$118,800,000
Electrical grid upgrade to create/increase capacity for aircraft charging	$24.000.000	$24,000,000	$48,000,000
Flight operations control (FOC): purchase/installation of computer hardware	$329,100	$0	$329,100
Communications	$18,152,900	$2,690, 457	$20,843,357
Maintenance facility	$8,100,000	$8,460,000	$16,560,000
Total expenditures	**$120,707,000**	**$105,275,457**	**$225,982,457**

The resulting economic impact will also be nearly twice that of the first two phases of construction, with a total of 971 additional jobs created, $77.4 million in labor income generated, and $197.2 million in additional output produced in the local economy.

Incremental Construction Impact: 20 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	556.4	$45,568,061	$105,275,457
Indirect/Induced	414.1	$31,849,353	$91,911,784
Total	**970.5**	**$77,417,414**	**$197,187,241**

Altogether, the effect of constructing a twenty-vertiport system will result in the creation of 2,133 jobs, generate $174.0 million in labor income and $423.6 million in economic output for the region.

Comulative Construction Impact: 20 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	1,235.1	$105,222, 868	$105,275,457
Indirect/Induced	898.3	$68,736,721	$197,647,849
Total	**2,133.4**	**$173,959,589**	**$423,630,306**

Based on these estimated results:

- *The output multiplier for the Construction phase is 1.9, meaning that every $1 million in direct expenditures results in $1.9 million in total output for the metro area economy.*
- *The jobs-to-expenditures multiplier is 9.4. That is, for every $1 million in direct expenditures, 9.4 jobs are created.*
- *The average wage per worker over the three construction phases is $79,800 per year.*

While construction of the vertiport system will undoubtedly involve the creation of jobs in the construction sectors themselves, it also triggers job growth in the broader economy. As shown in the Detailed Industry Jobs Impact Table, a total of 167 jobs are created in computer systems design, followed by 125 in other real estate services, and 39 in employment services, with job creation also occurring in retail, restaurant services, and additional local industries. Taken together, approximately 2/3 (68%) of all jobs created during construction occur in the top ten industries.

Detailed Industry Jobs Impact: 20 Vertiport System Construction

Industry	Employment
Construction of other new nonresidential structures	729
Construction of new power and communication structures	253
Computer systems design services	167
Other real estate	125
Employment services	39
Retail - Building material and garden equipment and supplies stores	33
Full-service restaurants	30
Limited-service restaurants	30
Architectural, engineering, and related services	26
Truck transportation	24
Subtotal - Top 10 Industries	1,457
Total Jobs - All Industries	**2,133**
Top 10 as share of Total Jobs	**68%**

OPERATIONS PHASE

The Operations phase involves operating the eVTOLs as they fly on routes between the individual vertiports, the air traffic control required to track and guide their movements around the network and in relation to other aircraft in the airspace, ground operations, services related to passengers, and customer service functions associated with ticket reservations, both online and on-site through customer service agents. Site costs must also be included. These include leasing, utilities, and facilities maintenance for both the vertiports and network support buildings.

The expenditures that serve as inputs for the Operations phase are predicated on estimated operations for each vertiport and for the overall network: the number of aircraft, the number of flights, the number of passengers, related ground activities, network operations, aircraft charging, and periodic maintenance of aircraft. It also incorporates activities that are typical of flight facilities that serve passengers, such as facilities maintenance, ticketing, and other customer services. It is important to note that incremental costs are not simply scaled up in going from six to ten to twenty vertiports, but rather estimated in relation to increases in the underlying variables mentioned above, for example, number of flights, number of passengers, and so on.

Six-Vertiport System

For the initial six-vertiport network, the operations phase will result in an estimated $29.6 million in annual ongoing operating expenditures, distributed across several categories. More than $10 million of the $29.6 million in operational expenditures for the six-vertiport system will be devoted to payroll expenditures. There are also significant outlays on aircraft maintenance and repair ($4.6 million), leasing expenses ($4.6 million), and utilities and aircraft charging ($3.6 million).

Detailed Industry Jobs Impact: 20 Vertiport System Construction			
Input	**6 Vertiports**	**10 Vertiports**	**20 Vertiports**
Vertiport operations payroll expenditure	$5,250,000	$8,250,000	$16,500,000
Vertiport operations maintenance	$2,290,000	$5,180,000	$8,260,000
Vertiport building maintenance	$210,000	$330,000	$660,000
Utilities and aircraft charging	$3,600,000	$4,800,000	$9,600,000
Equipment and machinery rental	$800,000	$1,200,000	$2,400,000
Office and administrative services	$600,000	$1,000,000	$2,000,000
Flight operations control (FOC) payroll expenditure	$4,950,000	$6,150,000	$10,050,000
FOC building maintenance	$208,806	$260,361	$427,917
Aircraft repairs and maintenance	$4,591,175	$10,362,555	$16,526,220
Communications expense	$2,454,000	$3,263,820	$4,340,881
Leasing expense: vertiport footprint + office functions	$4,200,000	$6,600,000	$13,200,000
Leasing expense: FOC location	$400,000	$400,000	$400,000
Total expenditures	**$29,553,981**	**$47,796,736**	**$84,365,018**

The recurring annual economic impact of network operations includes:

- *320 jobs, including 176 direct jobs and 144 indirect and induced jobs.*
- *$29.6 million in labor income, including $18.4 million in direct income and $11.1 million in indirect and induced income.*
- *$59.9 million in output, consisting of $29.6 in direct output and $30.3 million in indirect and induced output.*

Recurring Annual Operations Impact: 6 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	176.4	$18,431,436	$29,553,981
Indirect/Induced	143.7	$11,119,221	$30,296,795
Total	**320.1**	**$29,550,656**	**$59,850,776**

These are recurring annual impacts on the local economy. That is, for every year it is operational, the six-vertiport system will generate 320 total jobs, $29.6 million in labor income, $59.9 in regional output, and sustain an average income of $92,300 per worker. The multiplier effects are as follows:

- *The output multiplier for the Operations phase is 2.0, meaning that every $1 million in direct expenditures results in $2.0 million in total output for the regional economy.*
- *The output-to-jobs multiplier is 10.8. That is, for every $1 million in direct expenditures, 10.8 jobs are created.*

Ten-Vertiport System

As the vertiport system expands from six to ten vertiports, operating expenditures increase in relation to their underlying determinants, such as number of flights, number of passengers, and other operating parameters. Total direct expenditures will increase from $29.6 million for the six-vertiport system to $47.8 million with the ten-vertiport system. Given the profile of direct expenditures for the ten-vertiport system as shown above, the annual economic impact is estimated at 542 jobs, $52.0 million in labor income, and $98.3 million in total output.

Recurring Annual Operations Impact: 10 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	298.1	$33,333,546	$47,796,736
Indirect/Induced	243.9	$18,669,585	$50,546,363
Total	**542.0**	**$52,003,131**	**$98,343,099**

Again, these impacts are estimated to occur on a yearly basis during the period of time when the system has a total of ten vertiports.

Twenty-Vertiport System

As the vertiport system reaches twenty vertiports, the maximum size that is described and modeled in this analysis, operating expenditures increase in scale. At $84.4 million, total operating expenditures for a twenty-vertiport system are nearly 80 percent larger than that of a ten-vertiport system.

Given the profile of direct expenditures for the twenty-vertiport system shown above, the resulting annual economic impact is estimated at 942 jobs, $90.3 million in labor income, and $173.3 million in total output, and an average wage of $95,800.

Recurring Annual Operations Impact: 20 Vertiport System			
Impact Type	**Employment**	**Labor Income**	**Output**
Direct	517.0	$57,609,574	$84,365,018
Indirect/Induced	425.0	$32,666,885	$88,949,147
Total	**942.0**	**$90,276,459**	**$173,314,165**

The results may be interpreted as follows:

- *The output multiplier for the twenty-vertiport system is estimated at 2.0, meaning that every $1 million of initial expenditure generates a total of $2 million in output.*
- *The jobs-to-expenditures multiplier is 11.2, meaning that 11.2 jobs are created for every $1 million of initial expenditures.*

To reiterate, the operational impacts are estimated on a recurring yearly basis during the period of time when the system has a total of twenty vertiports. For example, over a 10-year period, the twenty-vertiport system will sustain 942 positions or workers who earn a total of $900.3 million in wages and $1.73 billion in output.

Moreover, once the twenty-vertiport system is fully operational, it will create jobs beyond the vertiport facilities themselves, including 72 jobs in real estate, 21 jobs in other computer related services, 19 jobs in employment services, and 31 jobs in restaurant services, all contributing to the total increase of 942 jobs. Total jobs among the top 10 industries account for 68% of all estimated jobs to be generated on a recurring annual basis once the twenty-vertiport system is operational.

Detailed Industry Jobs Impact: 20 Vertiport System Operations	
Industry	**Employment**
Support activities for transportation	450
Other real estate	72
Other computer related services, including facilities management	21
Employment services	19
Full-service restaurants	16
Limited-service restaurants	15
Individual and family services	12
Dry-cleaning and laundry services	11
Services to buildings	11
Hospitals	11
Subtotal - Top 10 Industries	638
Total Jobs - All Industries	**942**
Top 10 as share of Total Jobs	**68%**

ANALYSIS & RESULTS: FISCAL IMPACTS

The construction and operations phases of establishing and operating a vertiport system in the Los Angeles-Orange County region result in fiscal as well as economic impacts. Fiscal impacts are represented in terms of estimated tax and other government revenues that are generated because of the underlying economic activity. They are estimated at the state/local level, the federal level, and in total.

For the construction phase, an estimated $57.4 million in total revenue is generated for the fully built-out system of twenty vertiports. This includes $22.7 million in state and local revenues and $34.7 million in federal revenues, with the breakdown of these amounts shown in the following table.

Cumulative Tax Impact: 20 Vertiport System Construction			
Impact	**State/Local**	**Federal**	**Total**
Direct	$6,461,176	$21,643,044	$28,104,220
Indirect/Induced	$16,256,401	$13,056,773	$29,313,175
Total	**$22,717,577**	**$34,699,817**	**$57,417,395**

As a result of ongoing operations of the fully built out twenty vertiport system, an estimated $29.4 million in recurring total annual revenue is generated, including $12.0 million in state and local revenues and $17.4 million in federal revenues, with the breakdown of these amounts shown in the table below.

Recurring Annual Tax Impact: 20 Vertiport System Operations			
Impact	**State/Local**	**Federal**	**Total**
Direct	$5,185,421	$11,121,422	$16,306,843
Indirect/Induced	$6,811,877	$6,314,775	$13,126,652
Total	**$11,997,297**	**$17,436,197**	**$29,433,495**

Again, over a hypothetical ten-year operating horizon, the twenty-vertiport system will generate $120.0 million in state and local revenue, $174.3 million in federal revenue, for a total of $294.3 million in tax revenues.

CONCLUSION

The vertiport network that is described and analyzed in this report offers a new transportation technology that has the potential to increase mobility for residents of the Southern California region, while also potentially alleviating congestion and contributing to the region's goals of economic development and sustainability. This study estimates the economic benefits of the construction, rollout, and expansion of such a system. It also estimates the tax benefits that are associated with this activity.

This study offers a conservative estimate of the potential benefits of the vertiport system. Estimates of additional benefits that are beyond the scope of this study include:

→ *Economic impact of spending on the part of the eVTOL passengers that occurs in conjunction with traveling on the vertiport system: parking services, purchases of food and sundries, etc.*

→ *Economic impact of congestion relief on the existing transportation network that may occur as passenger volume on the vertiport network grows, shifting from other travel modes where congestion relief may bring time and cost savings.*

→ *Economic impact of expanding the network activities to include cargo-based operations, offering an alternative to ground-based cargo activities.*

Future research into each of the economic impacts of these dimensions of the vertiport system will undoubtedly add to the overall impact that is estimated here.

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