eVertiSKY

ECOSUSTAINABLE INFRASTRUCTURE FOR eVTOL

Enabling the New Transportation Economy

Your Gateway to the Future of Urban Air Transportation

State of Texas UAM

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AGENDA

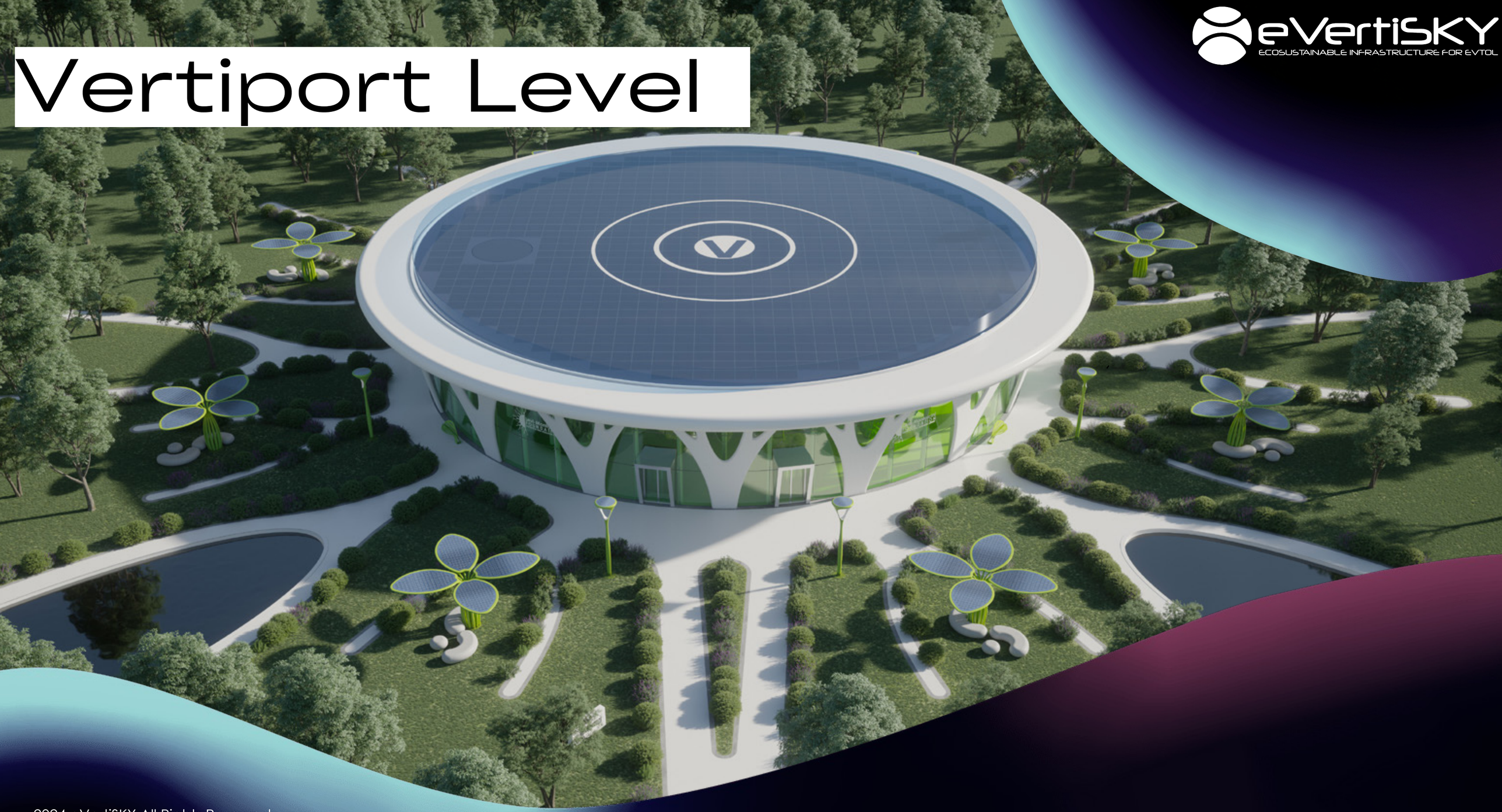
UAM Ecosystem's Economic Drivers:

- Vertiport Level
- Sector Level
- City Level

ABOUT

	What Cities Care About?	UAM Feasibility Study Process	UAM Living Labs	UAM Integration
1	How does UAM align with our city's long-term transportation goals?	Evaluate UAM compatibility with city's future transport needs.	Pilot UAM projects to test scalability and impact.	Integrate UAM into the city's transportation strategy.
2	What do residents think about integrating UAM into their daily commute?	Survey public interest and concerns.	Trial UAM services and gather community feedback.	Adapt UAM services based on continuous public input.
3	Which urban spaces can accommodate UAM facilities without disruption?	Identify viable locations through environmental assessments.	Test UAM operations in selected areas to assess impact.	Deploy UAM infrastructure in proven locations.
4	How can architectural designs integrate UAM seamlessly into our urban fabric?	Plan architectures that match local aesthetics and laws.	Develop and test designs that integrate UAM into cityscapes.	Implement successful pilot designs city-wide.
5	What is the strategy for a soft launch of UAM services?	Plan phased UAM deployment.	Conduct limited real-world operations to refine systems.	Start UAM services in strategic areas to evaluate performance.

Vertiport Level



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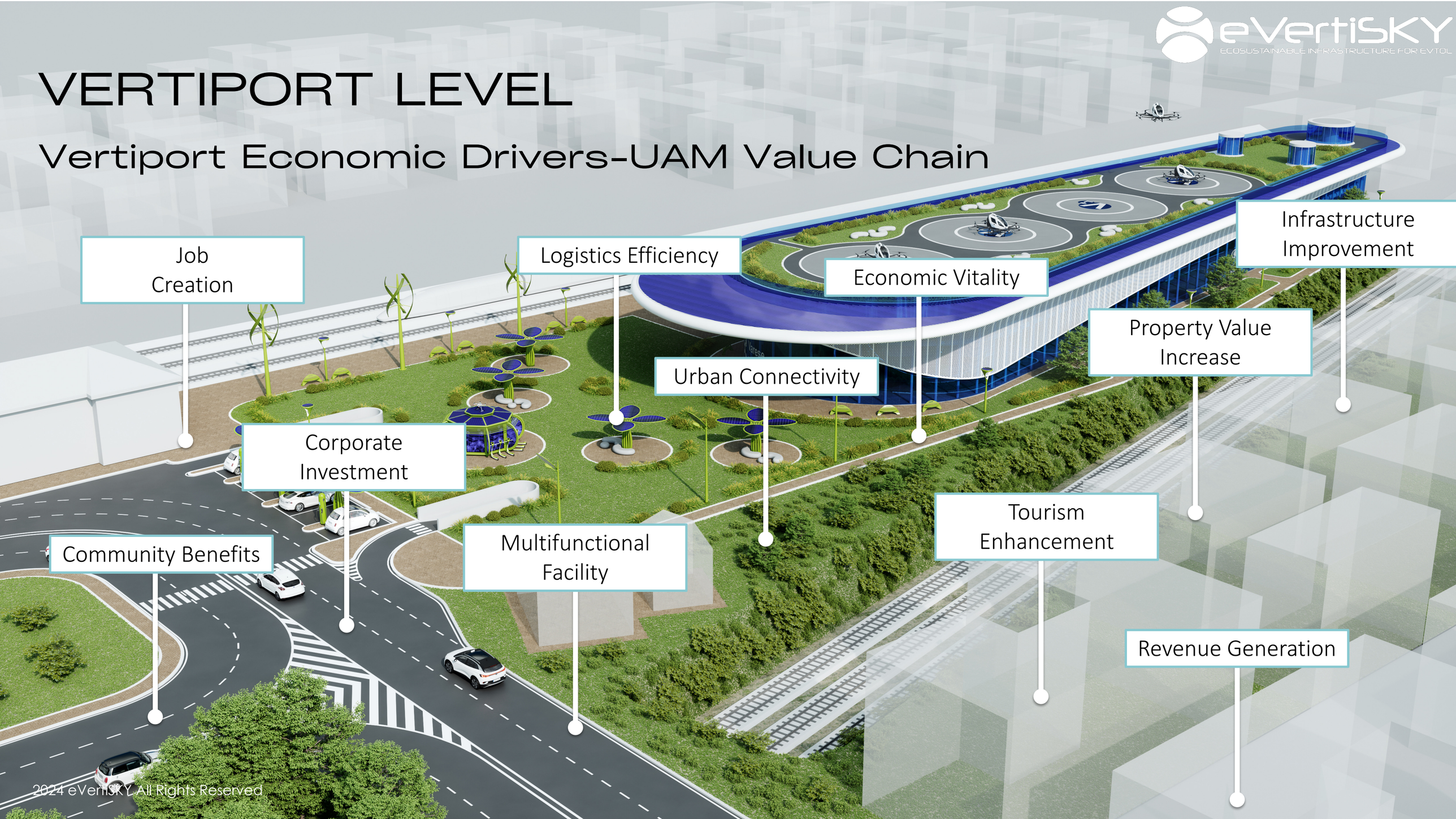
VERTIPORT LEVEL

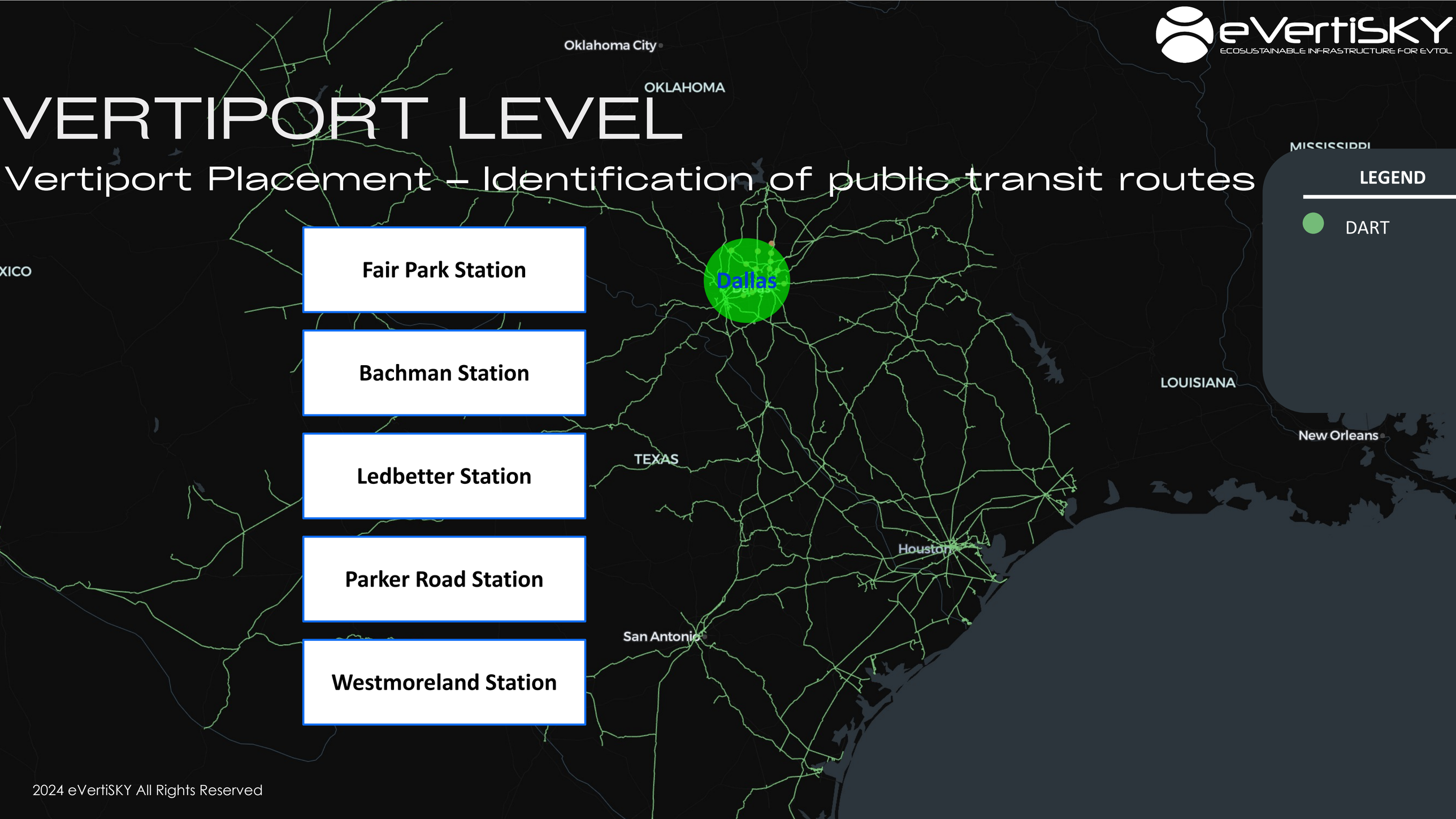
Vertiport Economic Drivers-UAM Value Chain



VERTIPORT LEVEL

Vertiport Placement – Identification of public transit routes

- **Fair Park Station**
- **Bachman Station**
- **Ledbetter Station**
- **Parker Road Station**
- **Westmoreland Station**

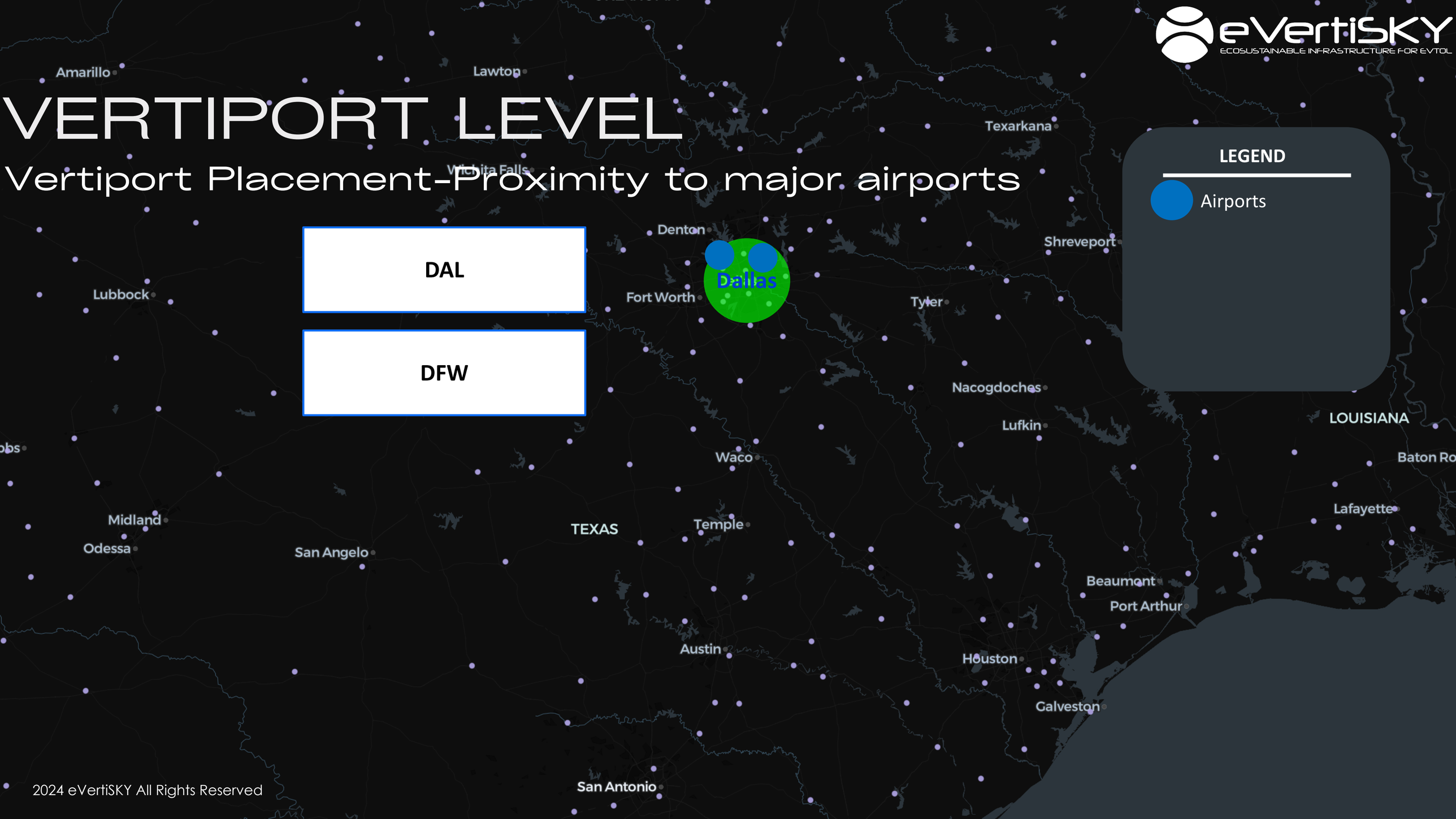


VERTIPORT LEVEL

Vertiport Placement-Proximity to major airports

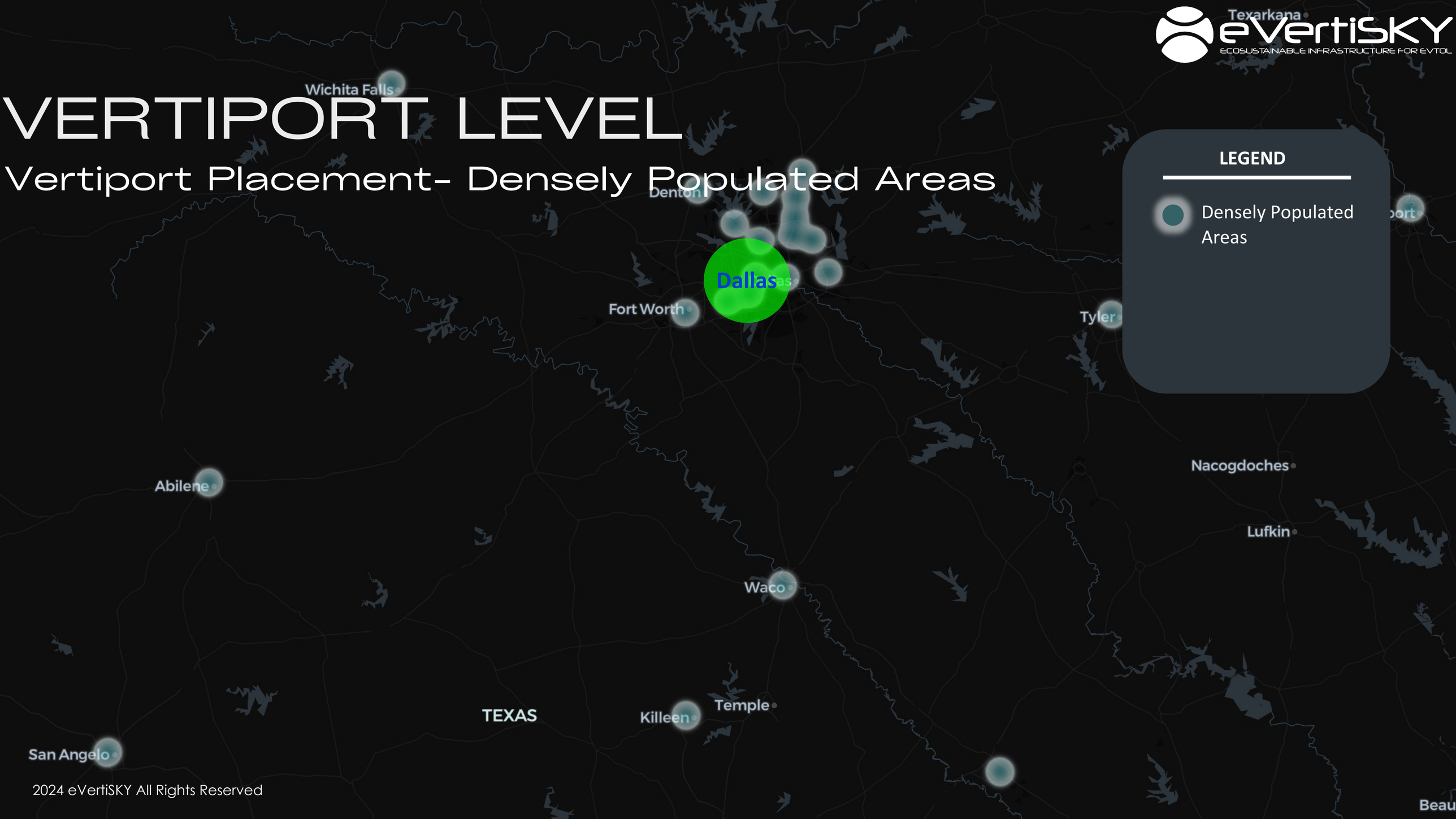
DAL

DFW



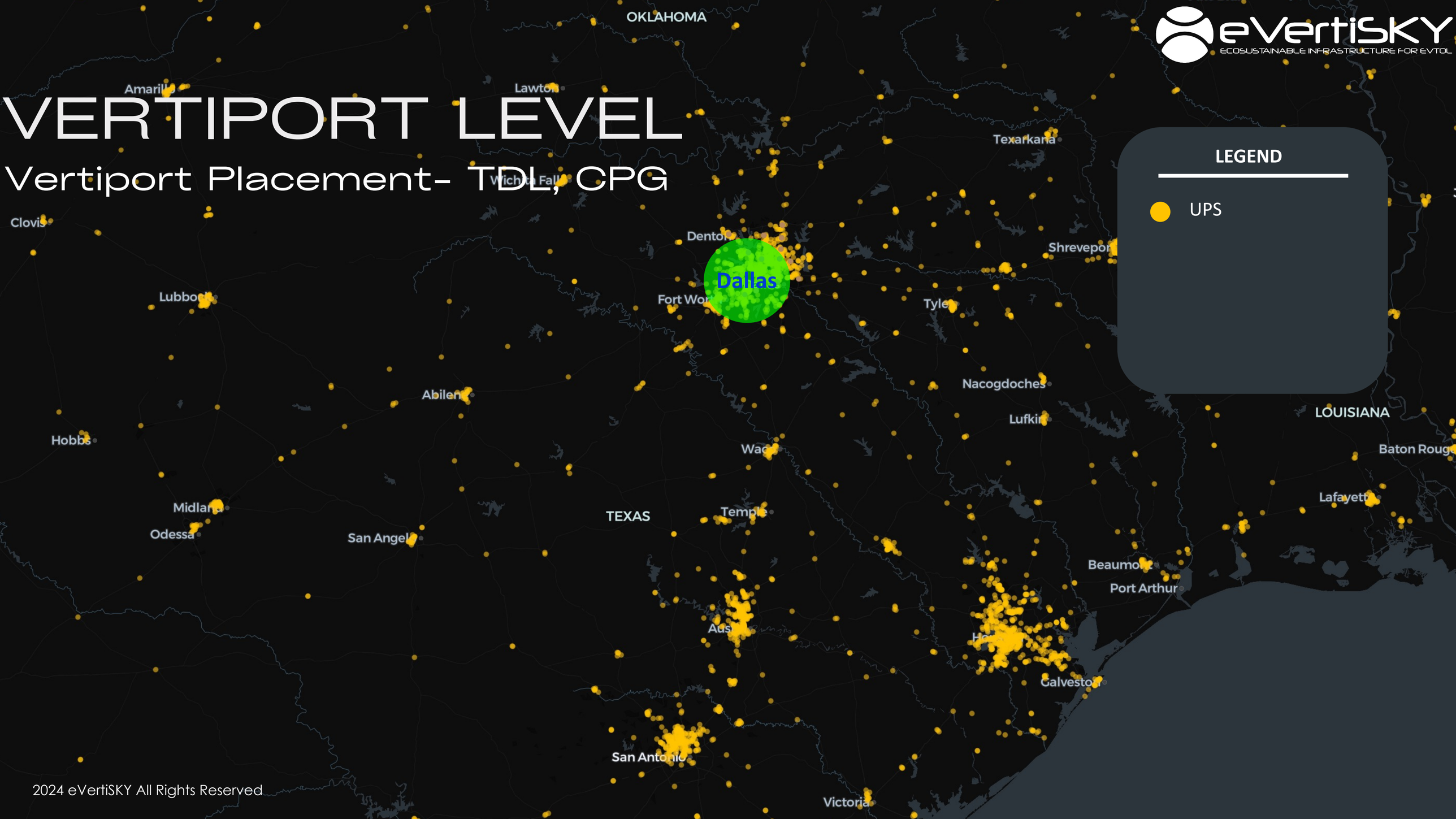
VERTIPORT LEVEL

Vertiport Placement- Densely Populated Areas



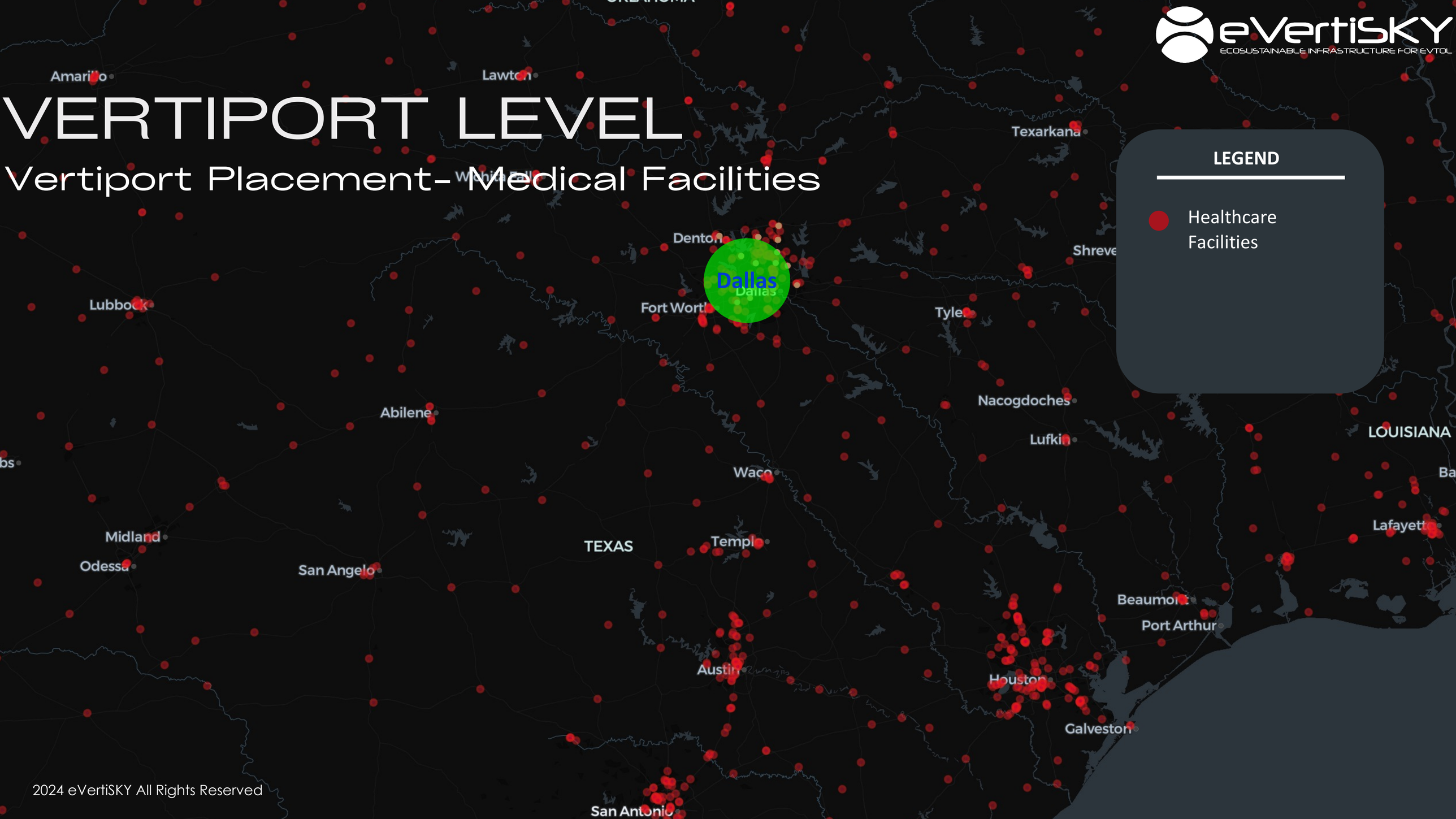
VERTIPORT LEVEL

Vertiport Placement- TDL, CPG



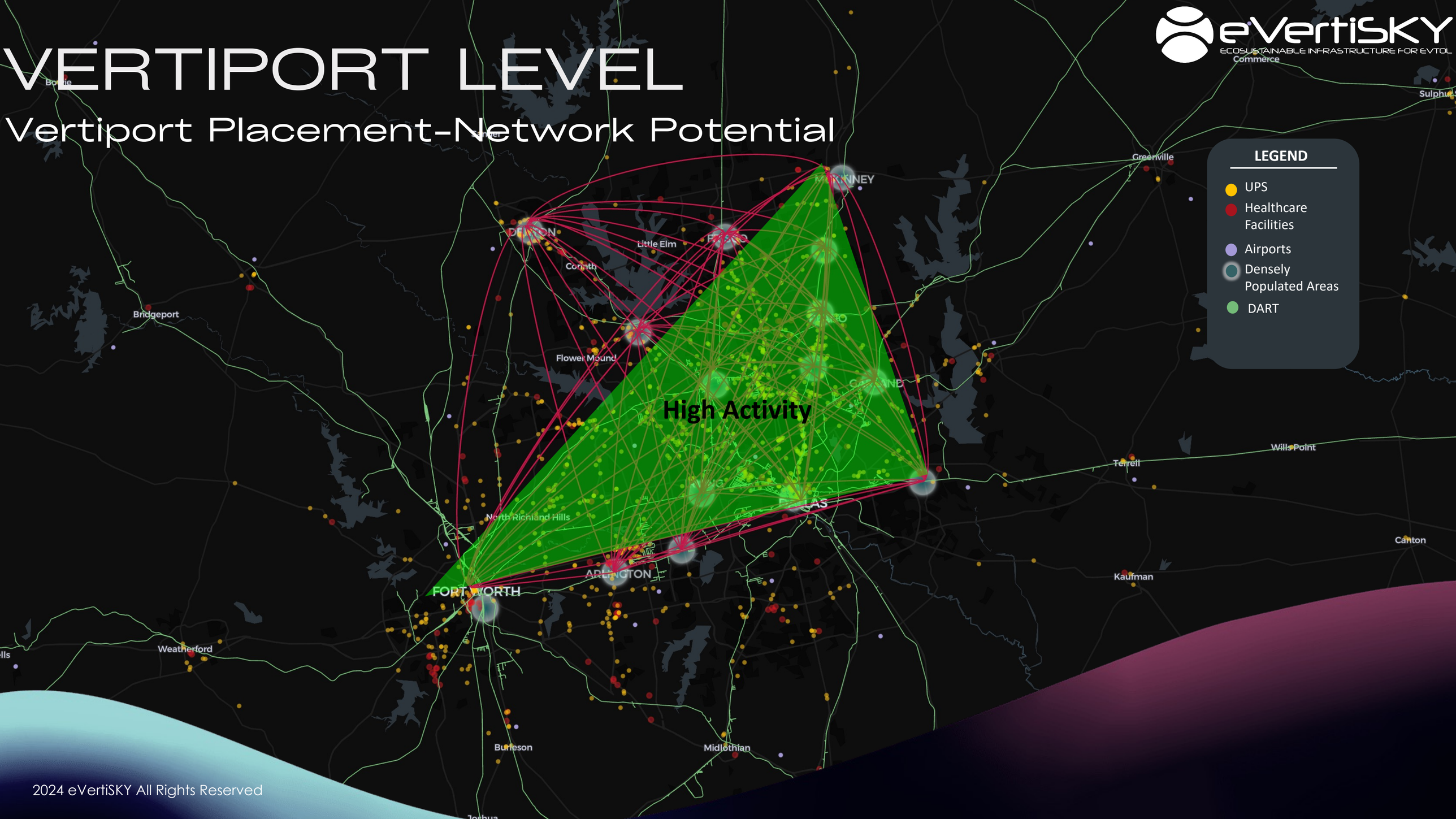
VERTIPORT LEVEL

Vertiport Placement- Medical Facilities



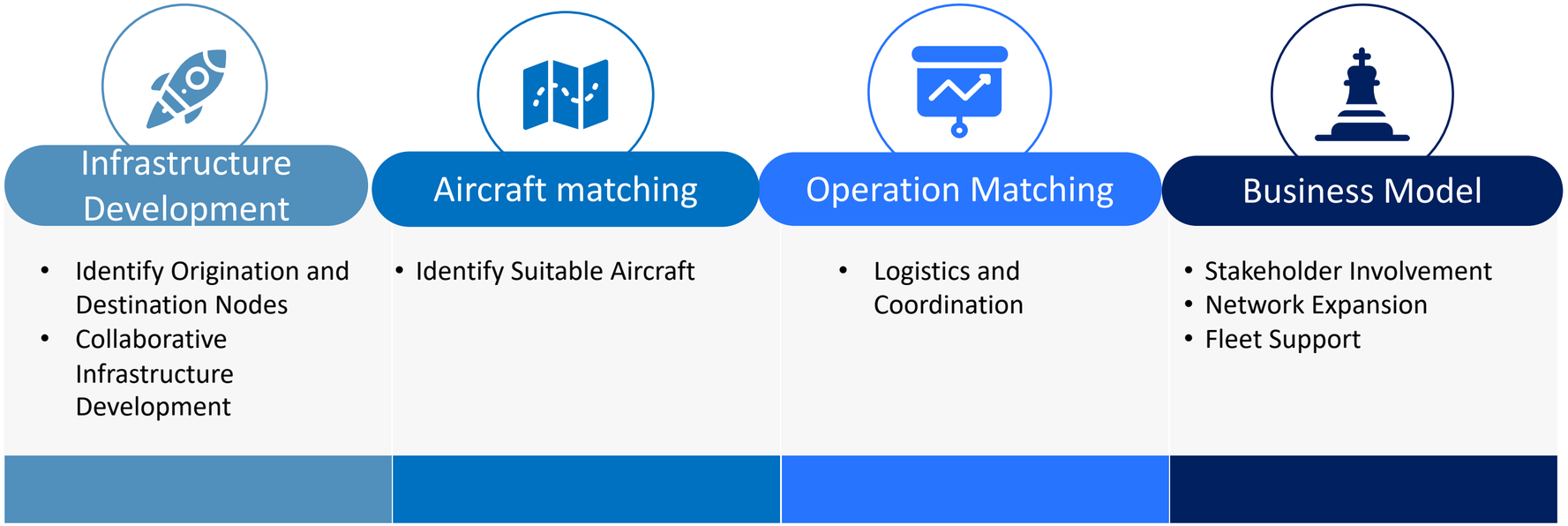
VERTIPORT LEVEL

Vertiport Placement-Network Potential



VERTIPORT LEVEL

Vertiport Business Model



VERTIPORT LEVEL

Vertiport Ownership Models

VERTIPORT LEVEL

Vertiport Value Analysis

Cost Value

Budget planning, wise spending.

Exchange Value

Revenue from fees, services, storage and maintenance.

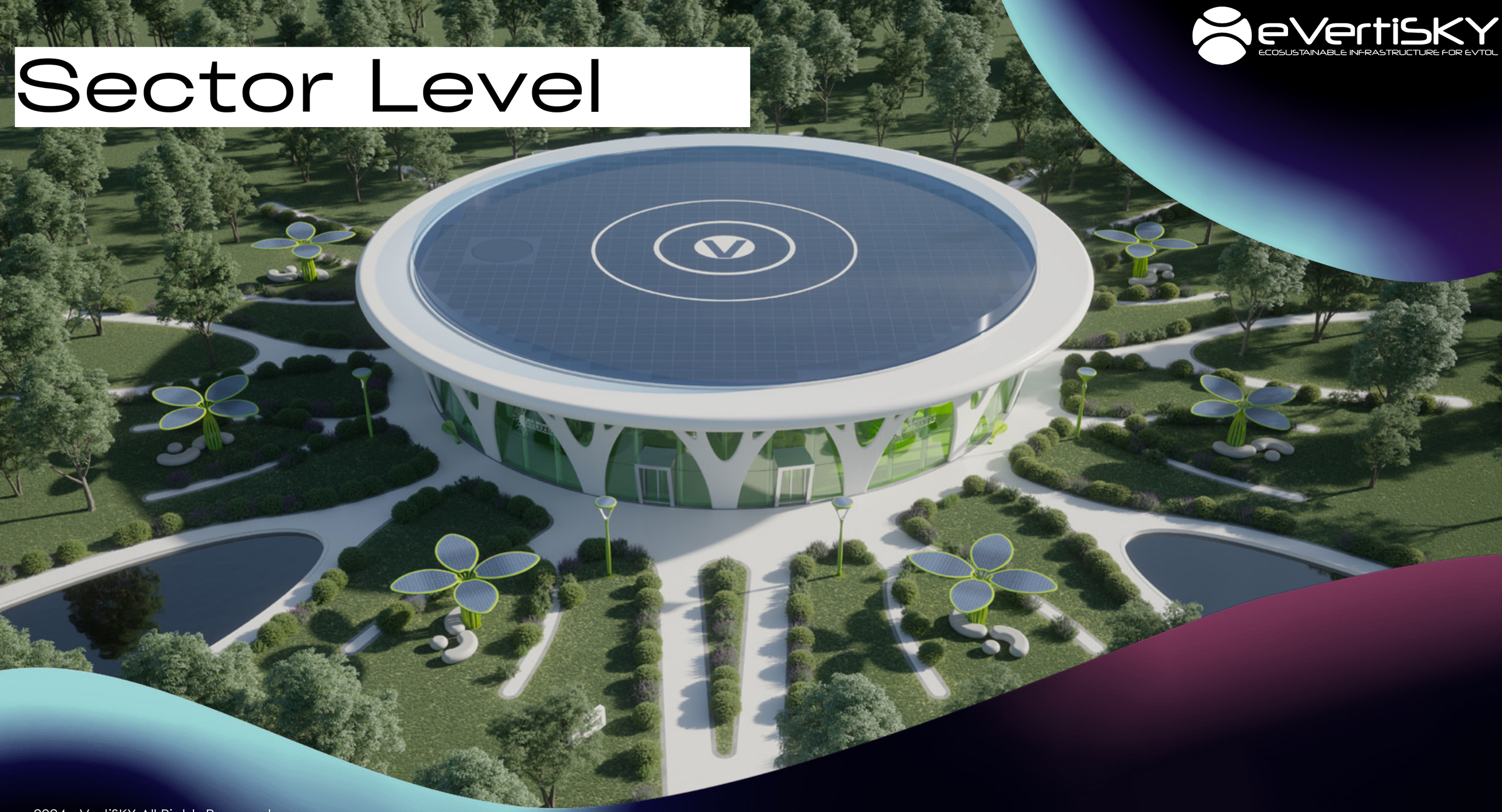
Use Value

Infrastructure quality and user-experience.

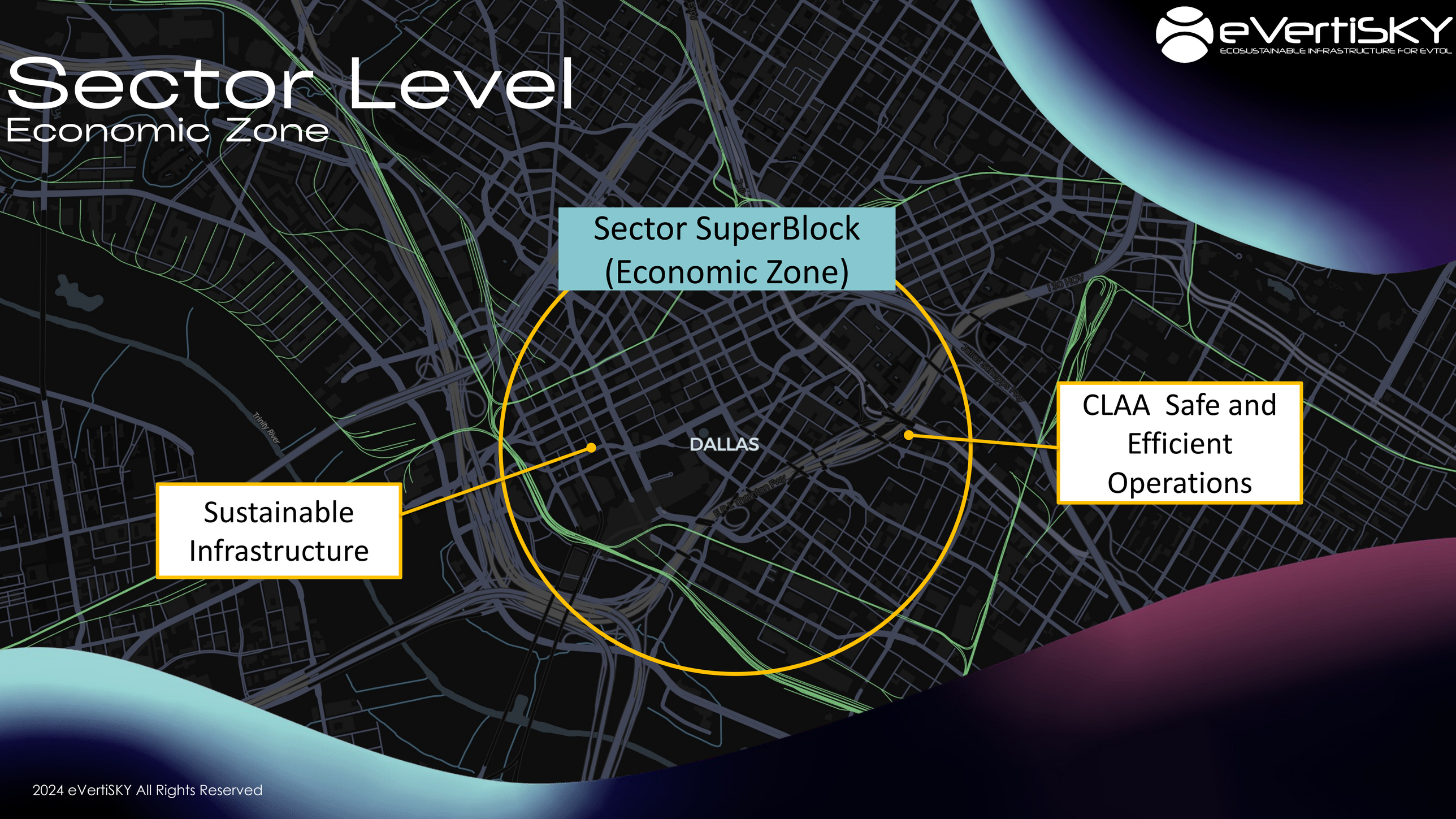
Esteem Value

User perception.

Sector Level



Sector Level
Economic Zone

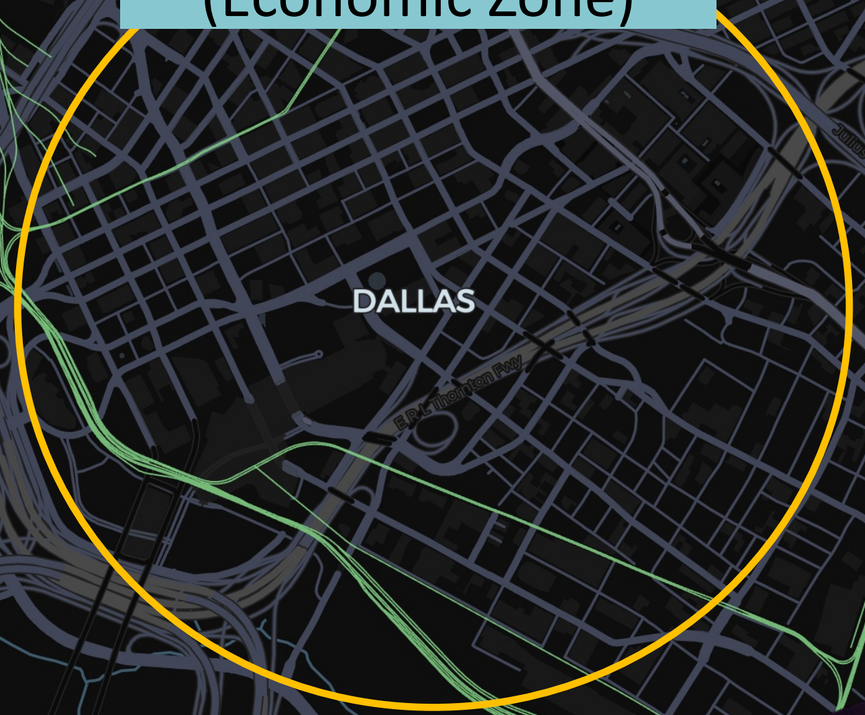


Sector Level

City Classification

- **Prime Candidates** (good profile) UAM) for cities over 100 sq mi
- **Primary Candidates** (network profile) for UAM for cities over 200 sq mi
- **Primary Candidates** for Regional Air Mobility (RAM) for cities under 100 sq mi

Sector SuperBlock (Economic Zone)

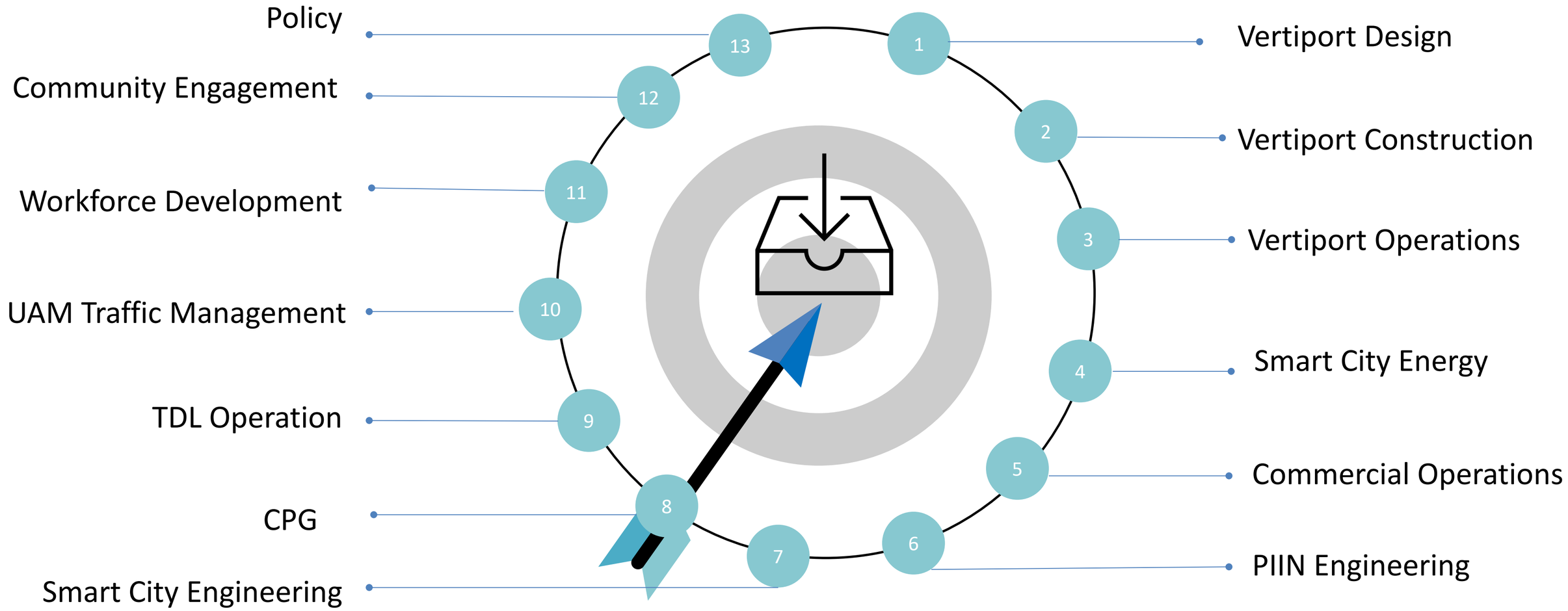


DALLAS, TX

- Total Square Miles: 6004.4
- Category: **Primary Candidate for UAM**
- Flyable Sectors:22.7

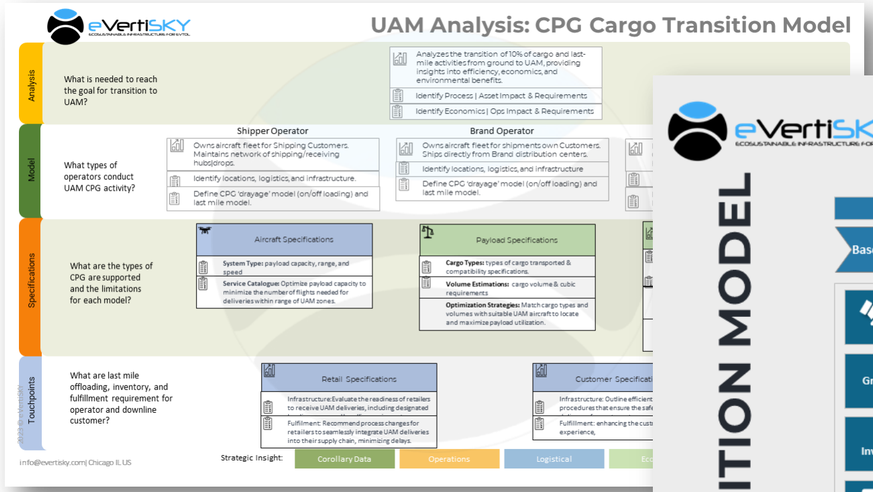
SECTOR Level

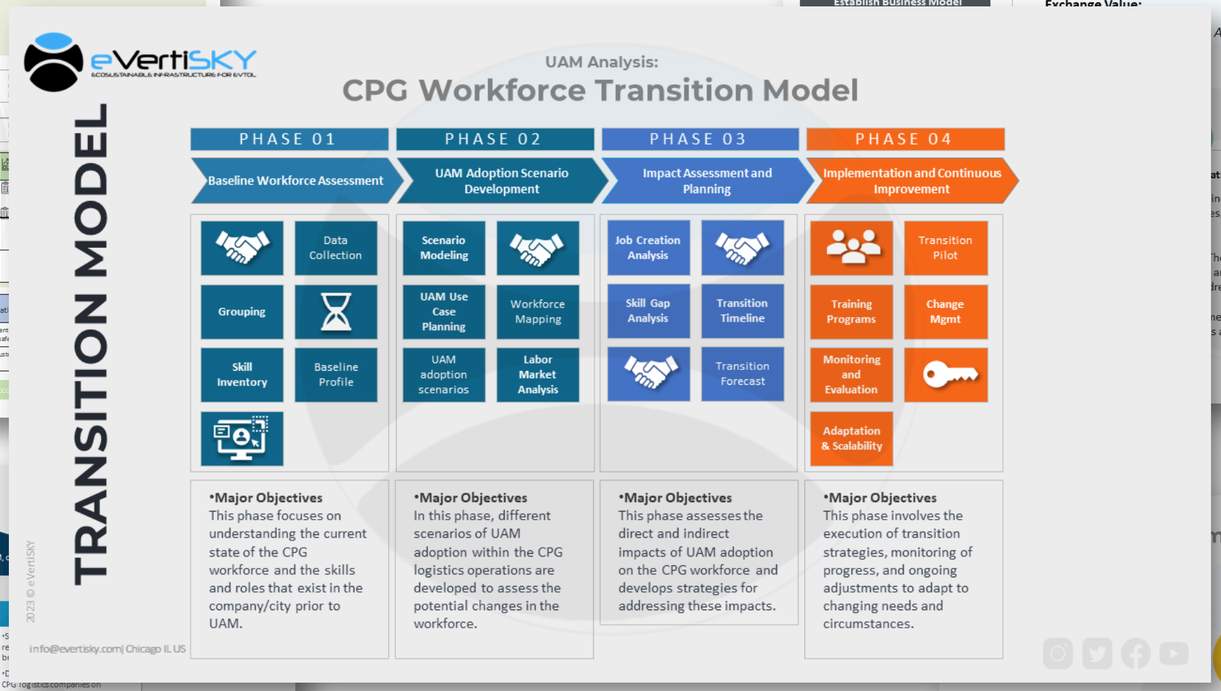
Job Creation

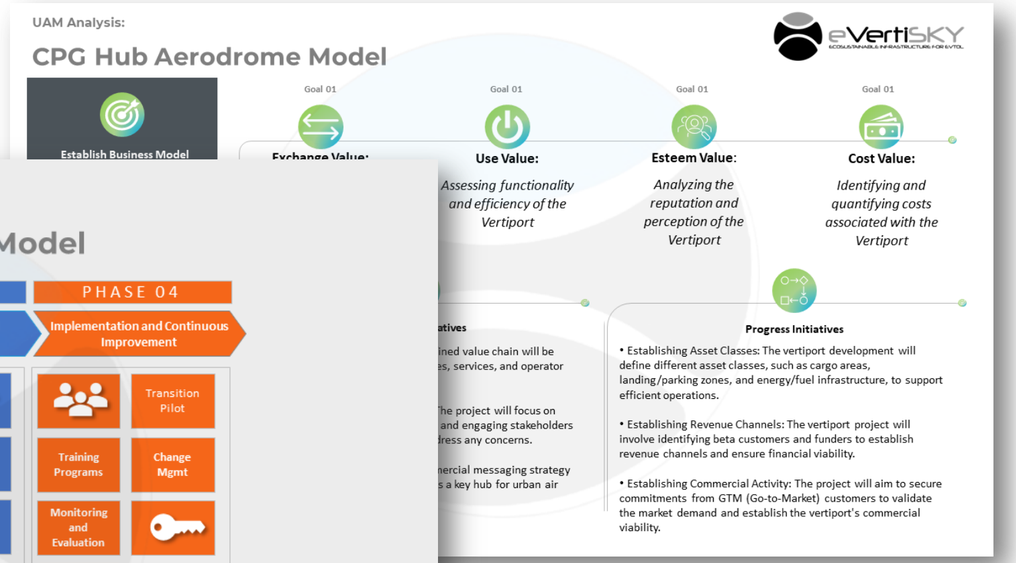


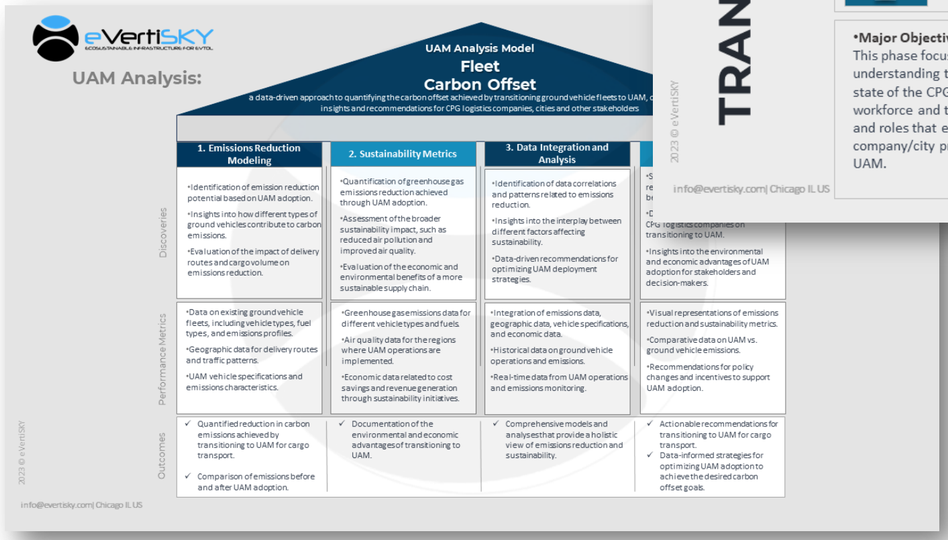
SECTOR LEVEL

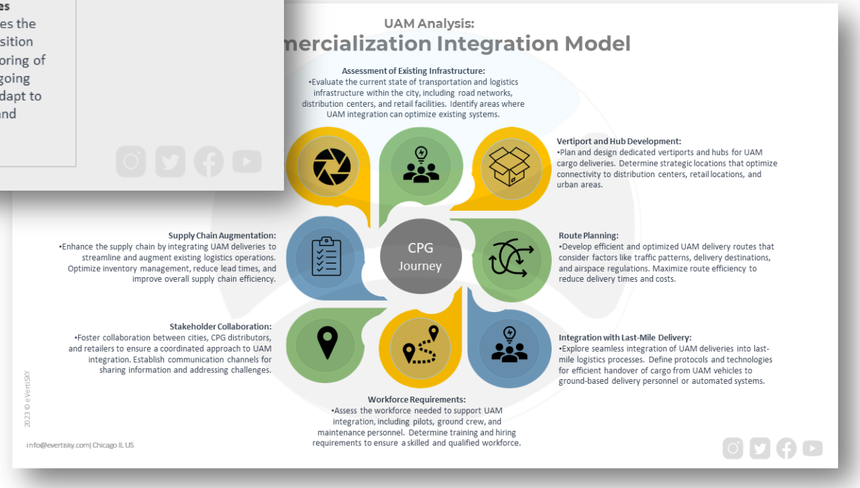
UAM Transition Models









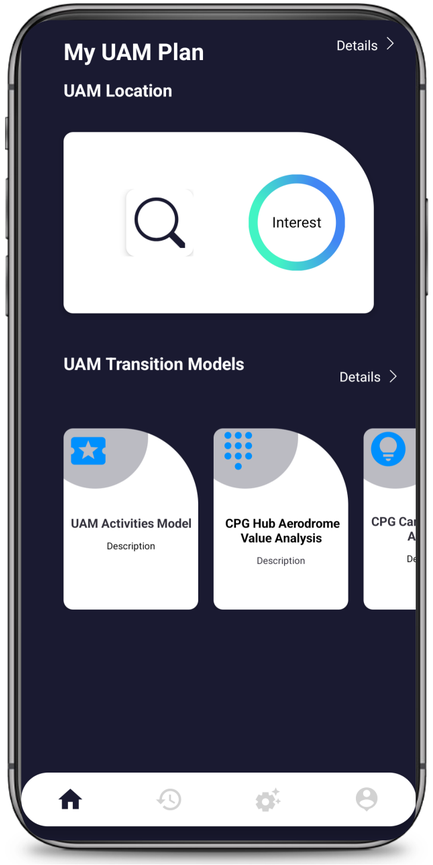


COMPANION APPS

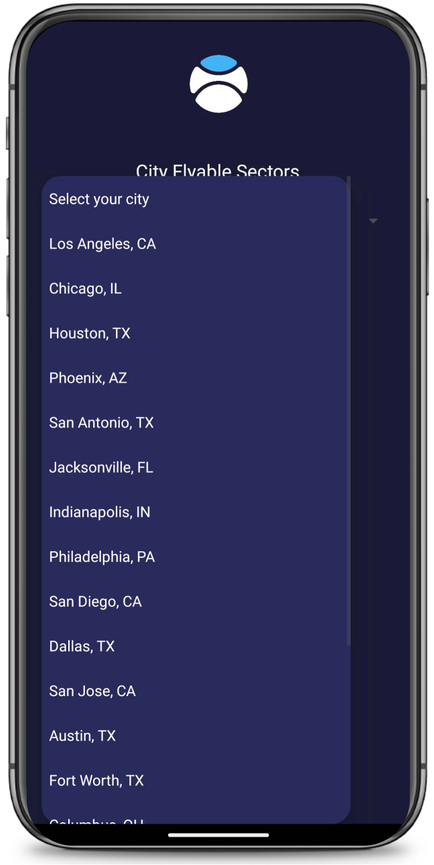
UAM Transition Models

The images/videos depict components analyzed within a specific Urban Air Mobility (UAM) Transition Model.

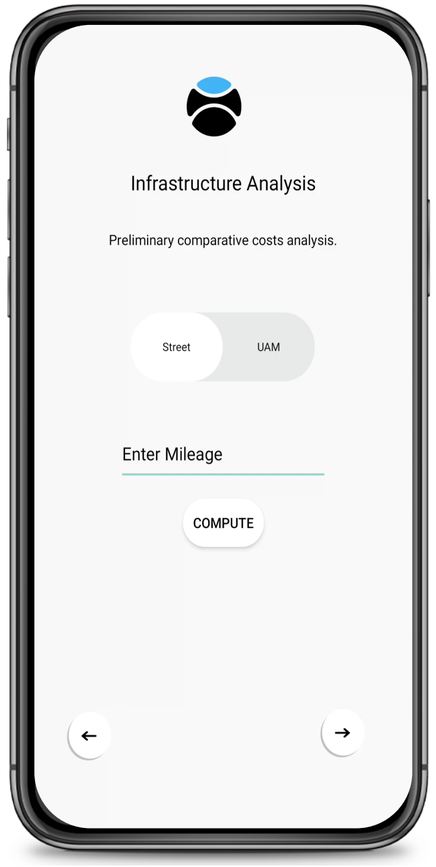
*Note: Each transition model necessitates the consideration of additional data and segments.



Transition Models

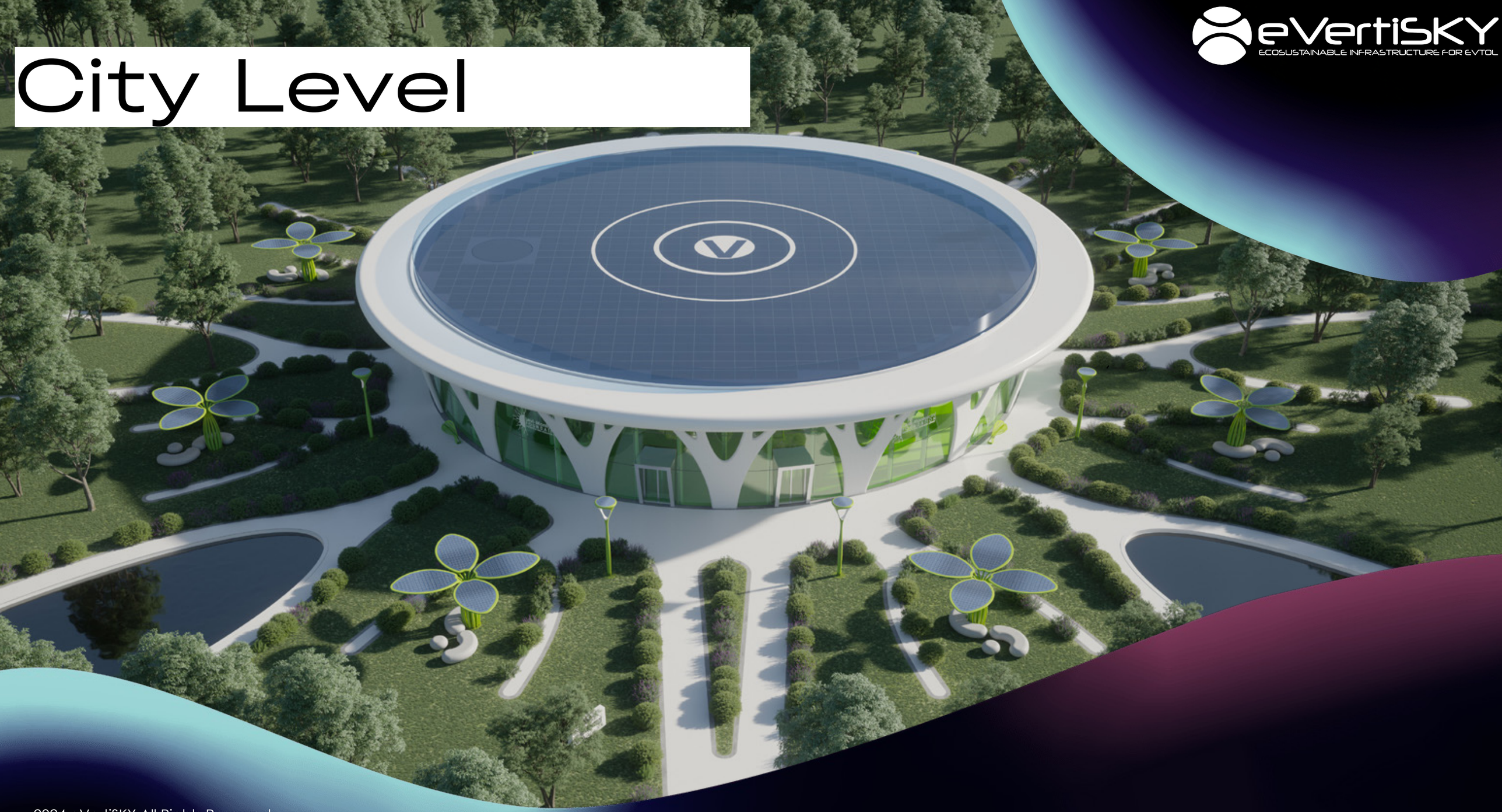


City Classification



Infrastructure Analysis

City Level



CITY LEVEL

Vertiport Network

High Traffic Activity

Route Value

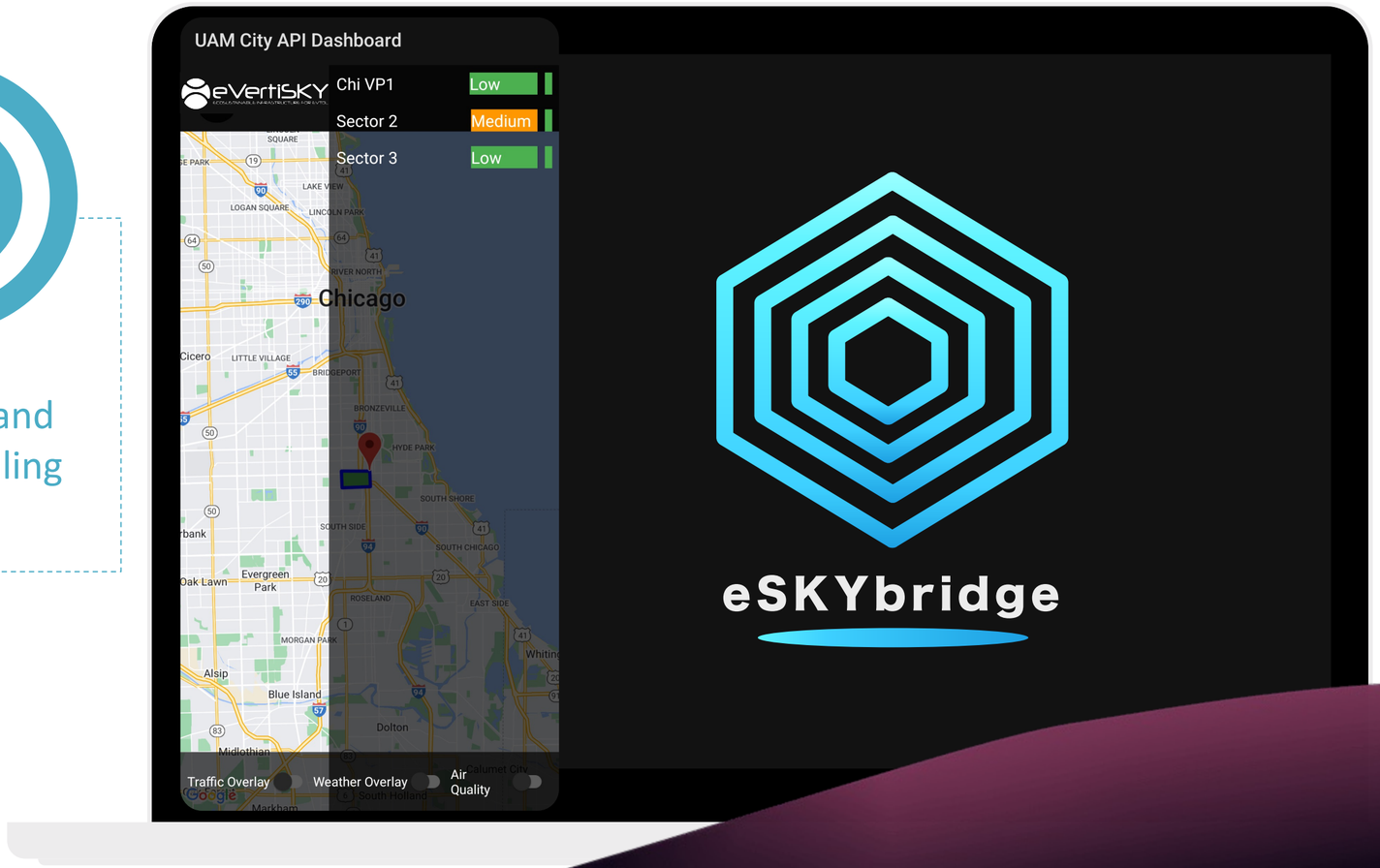
CITY LEVEL

City Command & Control

eSkyBridge CityAPI Dashboard

Expose Citywide UAM Ground and Airspace Asset

Route Use and Land Fee Billing



What Cities Care About?

- UAM Feasibility Study Process
- UAM Living Labs
- UAM Integration

THANK YOU!

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State of Texas UAM

ELECTRIFICATION OF GENERAL AVIATION FLEET

North Central Texas Council of Governments

Dr. Stephen P. Mattingly
Nithisha Reddy Gudipati
Mino Aji
Ma Anjelika Pineda

UTA THE UNIVERSITY OF TEXAS AT ARLINGTON

STUDY GOALS

- ❑ Requirements for electrification
- ❑ Lifecycle Cost
- ❑ Cost Benefit Analyses
- ❑ Introduction of survey

CHECKLIST FOR ELECTRIFICATION

1. Electric aircraft: Electric motors, Reliability, Flying time, Efficiency of power distribution, Battery (energy density and power density), Design life
2. Operational needs: Schedule, Turnaround time
3. Charging infrastructure: Battery, Charging capacity, Charging time, Cost, Usage, Design life

…CONTINUATION

4. Grid capacity and Power requirements: Power capacity, Increased load from electrification, Possibilities of grid upgrade
5. Alternate energy resources: Solar Photovoltaic, Battery storage, Integrating distributed energy resources
6. Regulatory framework: Airworthiness standards: aircraft engines (14 CFR Part 33)
7. Financial considerations

FOSSIL FUEL AIRCRAFT EMISSIONS

EMISSIONS

- CO_2 and water vapor
- Nitrogen oxides (NO_X)
- Unburned hydrocarbons
- Carbon monoxide (CO)
- Sulphur oxides
- Traces of hydroxyl family and nitrogen compounds
- Small amounts of soot particles

HEALTH IMPACTS

- Morbidity
- Mortality
- Cancers
- Acute Exposure Mortality
- Acute Respiratory Symptoms Days
- Adult Chronic Bronchitis
- Asthma

HEALTH IMPACT FACTOR

- Cost of health damage due to air pollutant emissions
- $ Conversion factors from a 2016 study (Alrafea et al., 2016)

CO	NO_2	$PM_{2.5}$	SO_2
0.64	73.85	83.36	24.50

- 2016 to 2023 health care inflation rate: 22%

AlRafea, Kamal, Ali Elkamel, and Sabah A. Abdul-Wahab. "Cost-analysis of health impacts associated with emissions from combined cycle power plant." *Journal of cleaner production* 139 (2016): 1408-1424.

FOSSIL FUEL EMISSIONS

Table 3-2. Experimental data for use in validation. The size of the color bars is proportional to the magnitude of the emissions burden for HC (orange), CO (pink), NO_x (green) and tPMm (blue).

Engine	Full Tests	HC Avg g/LTO	Variability % at 95% Conf	CO Avg g/LTO	Variability % at 95% Conf	NOx Avg g/LTO	Variability % at 95% Conf	tPMm Avg g/LTO	Variability % at 95% Conf
Full Engine									
General Electric CF34-3A1	1	292		7315		1278		7.04	
Engine Family	Count								
Lycoming O-320	16	258	38%	4083	47%	32	246%	0.90	120%
Lycoming IO-360	4	598	116%	4387	47%	44	434%	2.04	358%
Lycoming O-360	6	406	95%	4924	58%	16	220%	1.68	186%
Lycoming IO-520	1	968		6960		13		1.95	
TCM O-470	1	391		3441		11		1.02	
Lycoming O-540	3	747	236%	6457	108%	21	32%	3.06	444%
Lycoming IO-540	4	795	115%	8483	96%	39	212%	3.33	230%
Horse Power Family									
diverse Prop-200hp	35	346	112%	4056	51%	26	255%	1.27	169%
diverse Prop-300hp	10	753	95%	7078	79%	27	171%	2.83	188%
diverse Prop-160hp	25	275	75%	3841	52%	25	256%	1.00	123%

Tara I. Yacovitch; Zhenhong Yu; Scott C. Herndon; Rick Miake-Lye, Exhaust Emissions from In-Use General Aviation Aircraft, TRB's Airport Cooperative Research Program (ACRP) Research Report 164, National Academies of Sciences, Engineering, and Medicine

ELECTRIC AIRCRAFT

- Emerging research and development
- Manufacturers: Airbus, Boeing, Pipistrel, Lilium, Joby Aviation, Eviation Aircraft, Electra Aero, Beta Technologies
- First electric aircraft: Pipistrel Alpha electro 2-seater
- Velis Electro by Pipistrel is certified to use in 30 countries
- Pricing: $140,000

Charging Infrastructure

- Similar to electric vehicle charging infrastructure.
- Requires higher power outputs and fast charging
- High power demand
- High-power chargers capable of delivering a large amount of electricity in a short period are crucial.
- Advanced cooling systems
- Manufacturers: **Green motion & Pipistrel**, **Beta Technologies**, Chargepoint, Boeing, Siemens

BENEFIT

- Reduced emissions: CO, NO_2, $PM_{2.5}$
- Fossil fuel cost
- Lower maintenance costs

COST

- Electric Aircraft cost
- Infrastructure investments
- Electricity costs

- All costs and benefits are annualized based on interest rates

LIMITATIONS AND ASSUMPTIONS

- Factors like fuel flowage fees, land leases, hanger rentals are not considered in this study.
- Aircraft based costs like maintenance costs and yearly depreciation are also not considered.
- Installation of charging infrastructure depends on airport layout plan and supporting electrical work. The cost associated with installation is airport dependent.
- Charging equipment cost is $200k/charger
- Fossil Fuel cost is $5.40/gallon[2]
- Fuel costs are calculated assuming one flight hour per one takeoff and landing[1,2]
- Electrical charging costs are $5 for one hour of flight time[3]

1. Aircraft cost calculator (ACC); https://www.aircraftcostcalculator.com/AircraftOperatingCosts
2. Planephd data model; https://planephd.com/wizard/manufacturers/
3. Windy app blog: Meet the main electric planes companies; https://windy.app/blog/electric-planes-companies.html

ELECTRIFICATION SCENARIOS

Flight schools

- Only flight school aircraft converted to electric

- All operations are electric
- 50% of operations are electric
- 25% of operations are electric
- 10% of operations are electric

Entire Airport

- All aircraft based at airport converted to electric

- All operations are electric
- 90% of operations are electric
- 80% of operations are electric
- 65% of operations are electric

BENEFIT COST ANALYSIS

$$B/C = \frac{(Health\ Impact\ cost + fuel\ cost)}{(electrification\ cost + infrastructure\ cost + electricity\ cost)}$$

Airport	100% flight school electrification		50% flight school electrification		25% flight school electrification		10% flight school electrification	
	min	max	min	max	min	max	min	max
Arlington Municipal (GKY)	7.96	8.44	7.52	8.44	6.38	7.82	5.24	8.44
Grand Prairie Municipal (GPM)	9.44	9.48	9.40	9.48	9.33	9.48	9.77	10.16
Fort Worth Spinks (FWS)	6.84	7.89	5.97	7.78	4.99	8.19	2.96	6.99
Fort Worth Meacham	7.46	7.63	6.74	7.04	5.66	6.09	3.83	4.33
Fort Worth Alliance (Perot Field)	3.90	4.14	3.78	4.28	3.39	4.28	2.70	4.57
Addison	8.49	8.49	8.49	8.49	9.02	9.02	9.61	9.61
Dallas Executive	6.41	6.72	5.93	6.48	4.66	5.39	3.22	4.19
Denton Enterprise	6.63	6.92	5.81	6.26	4.55	5.14	2.95	3.62
Lancaster Regional	1.29	1.29	1.27	1.27	1.23	1.23	1.04	1.04
McKinney National	8.75	8.75	8.75	8.75	8.75	8.75	7.96	7.96
Mesquite Metro	7.15	7.16	7.14	7.16	7.11	7.16	7.54	7.68
Bridgeport Municipal	1.30	1.30	1.49	1.49	1.09	1.09	0.61	0.61
Caddo Mills Municipal	4.16	4.16	3.41	3.41	3.17	3.17	0.94	0.94
Cleburne Regional	5.21	5.21	4.27	4.27	3.14	3.14	1.50	1.50
Decatur Municipal	1.28	1.28	1.21	1.21	1.08	1.08	0.61	0.61
Gainesville Municipal	5.20	5.20	4.97	4.97	3.24	3.24	1.59	1.59
Granbury Regional	4.99	4.99	3.91	3.91	2.57	2.57	1.17	1.17
Mid-Way Regional	4.97	4.97	4.62	4.62	4.52	4.52	2.57	2.57
Mineral Wells	7.21	8.52	6.84	9.65	4.41	7.06	2.14	3.91
North Texas Regional	8.78	9.88	8.18	10.31	8.36	14.44	6.64	8.68
Rockwall Municipal	6.34	7.10	5.60	6.90	4.53	6.53	2.36	3.91
Terrell Municipal	6.92	6.92	6.09	6.09	4.91	4.91	2.51	2.51
Aero Country	2.51	2.51	1.39	1.39	0.73	0.73	0.30	0.30
Bourland Field	7.36	7.36	7.85	7.85	5.41	5.41	2.80	2.80
Hicks Airfield	7.03	7.03	6.32	6.32	5.27	5.27	3.62	3.62
Northwest Regional	10.62	10.62	9.17	9.17	7.21	7.21	3.60	3.60
Parker County	9.01	9.01	8.17	8.17	7.59	7.59	4.15	4.15
Sycamore Strip	0.76	0.76	0.39	0.39	0.20	0.20	0.08	0.08

Benefit-Cost Ratios for Electrification of Flight schools

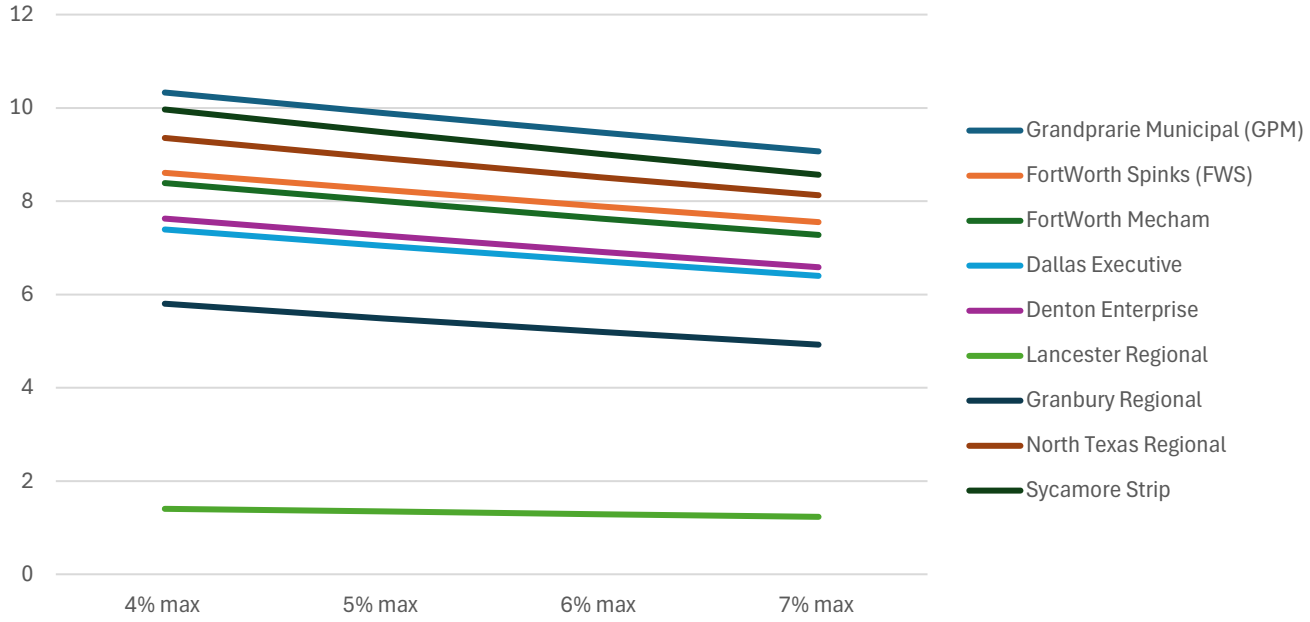
Airport	100% entire airport electrification		90% entire airport electrification		80% entire airport electrification		65% entire airport electrification	
	min	max	min	max	min	max	min	max
Arlington Municipal (GKY)	4.00	8.44	3.78	8.44	3.53	8.44	2.82	8.93
Grand Prairie Municipal (GPM)	8.62	9.48	8.86	9.77	8.62	9.72	8.43	10.06
Fort Worth Spinks (FWS)	2.44	6.71	2.44	6.59	2.08	6.45	1.56	6.21
Fort Worth Meacham	2.40	2.84	2.40	2.64	2.04	2.44	1.50	1.83
Fort Worth Alliance (Perot Field)	3.77	4.14	3.85	4.24	3.74	4.21	3.58	4.25
Addison	8.49	8.49	8.66	8.66	8.56	8.56	8.99	8.99
Dallas Executive	1.40	2.07	1.40	1.92	1.16	1.76	0.85	1.32
Denton Enterprise	2.49	3.11	2.49	2.91	2.12	2.69	1.60	2.09
Lancaster Regional	1.30	1.30	1.32	1.32	1.33	1.33	1.64	1.64
McKinney National	8.75	8.75	8.61	8.61	8.69	8.69	9.24	9.24
Mesquite Metro	6.92	7.16	6.87	7.11	7.03	7.35	7.17	7.67
Bridgeport Municipal	1.30	1.30	1.47	1.47	1.40	1.40	1.88	1.88
Caddo Mills Municipal	1.42	1.42	1.50	1.38	1.25	1.25	0.91	0.91
Cleburne Regional	1.16	1.16	1.17	1.07	0.97	0.97	0.69	0.69
Decatur Municipal	1.33	1.33	1.28	1.28	1.36	1.36	1.64	1.64
Gainesville Municipal	1.15	1.15	1.14	1.05	0.97	0.97	0.72	0.72
Granbury Regional	2.25	2.25	2.28	2.12	1.92	1.92	1.47	1.47
Mid-Way Regional	1.52	1.52	1.53	1.42	1.28	1.28	0.98	0.98
Mineral Wells	1.85	6.19	1.90	6.50	1.57	6.06	1.15	5.61
North Texas Regional	4.88	9.07	4.89	9.11	4.40	9.16	3.54	9.23
Rockwall Municipal	2.52	5.34	2.49	5.03	2.18	5.08	1.67	4.57
Terrell Municipal	2.22	2.22	2.26	2.09	1.89	1.89	1.39	1.39
Aero Country	0.14	0.14	0.14	0.13	0.12	0.12	0.08	0.08
Bourland Field	2.63	2.63	2.73	2.54	2.30	2.30	1.76	1.76
Hicks Airfield	1.41	1.41	1.41	1.29	1.17	1.17	0.85	0.85
Northwest Regional	0.82	0.82	0.82	0.74	0.66	0.66	0.50	0.50
Parker County	4.49	4.49	4.56	4.29	3.92	3.92	3.09	3.09
Sycamore Strip	0.19	0.19	0.19	0.17	0.15	0.15	0.11	0.11

Benefit-Cost Ratios for Electrification of Entire airport

Airport	100% entire airport electrification	90% entire airport electrification	80% entire airport electrification	65% entire airport electrification
Arlington Municipal (GKY)	1.29	1.18	1.06	0.75
Grand Prairie Municipal (GPM)	1.20	1.10	0.99	0.70
Fort Worth Spinks (FWS)	0.90	0.82	0.74	0.52
Fort Worth Meacham	1.41	1.29	1.17	0.83
Fort Worth Alliance (Perot Field)	3.43	3.43	3.33	3.05
Addison	0.63	0.57	0.51	0.36
Dallas Executive	0.70	0.64	0.57	0.41
Denton Enterprise	1.23	1.13	1.02	0.73
Lancaster Regional	1.29	1.30	1.32	1.61
McKinney National	1.94	1.78	1.62	1.17
Mesquite Metro	1.34	1.22	1.11	0.81
Bridgeport Municipal	1.22	1.36	1.29	1.64
Caddo Mills Municipal	0.95	0.90	0.81	0.58
Cleburne Regional	0.70	0.64	0.58	0.40
Decatur Municipal	1.33	1.28	1.36	1.64
Gainesville Municipal	0.63	0.57	0.52	0.37
Granbury Regional	1.26	1.16	1.04	0.76
Mid-Way Regional	0.98	0.91	0.81	0.60
Mineral Wells	0.88	0.81	0.72	0.51
North Texas Regional	1.53	1.40	1.27	0.90
Rockwall Municipal	1.43	1.30	1.19	0.87
Terrell Municipal	1.15	1.06	0.95	0.67
Aero Country	0.03	0.02	0.02	0.01
Bourland Field	0.57	0.52	0.47	0.33
Hicks Airfield	0.66	0.60	0.54	0.38
Northwest Regional	0.27	0.25	0.22	0.17
Parker County	1.96	1.81	1.63	1.17
Sycamore Strip	0.11	0.10	0.09	0.06

Benefit-Cost Ratios for Replacement of fossil fuel aircraft with electric aircraft at full price

SENSITIVITY ANALYSIS



Benefit-Cost analysis for electrification of flight schools at different interest rates

KEY FINDINGS

- Even if only 10% of total operations are with electric powered aircraft, converting the flight school aircraft fleets appears promising at most airports
- With 100% of the flight operations electrified
  - Average BCA for converting the flight school fleets in the NCTCOG region is around 6 to 6.2.
  - Average BCA for converting all aircraft in the NCTCOG region is around 2.92 to 3.34.
  - Regional BCA reduces to 1.11 when all fossil fuel aircraft are replaced with electric aircraft at full price.
    - This reduces to 0.78 when only 65% of flight operations are electric aircraft.
- Sensitivity analysis of the BCA at different interest rates shows that the B/C ratios decrease an increase in interest rates.
- Aero country and Sycamore strip are the only airports with B/C<1 even at 4% rates.

SURVEY INTRODUCTION

- Awareness and Perception: Technology and development
- Purchase Intent: cost, charging time, safety, flying time, availability of models
- Incentives and Motivation: tax credits, direct rebates, environmental concerns
- Usage Patterns: type of trips, flying time
- Knowledge level: understanding the technology, evolving market
- Comparative Perception: reliability, overall value, maintenance, operation
- Factors influencing purchase: initial cost, battery range, resale value
- Decision Triggers: Test drives, demo
- Barriers to Adoption: single charge flying time, batteries & its degradation, infrastructure concerns
- Transition from Gasoline: gas & electricity price

FUTURE RESEARCH

- Launching the survey with IRB approval.
- Additional sensitivity analysis can be performed with respect to fuel costs and charging infrastructure installations.
- Contacting each airport in NCTCOG region to gather fleet specifications and operations data (by aircraft/engine type)

QUESTIONS?

THANK YOU!