Boeing Rental Service for Flying Car

Tohoku University

Boeing Student Project
At Tohoku University
December 7th, 2021

Hajime Kosada
Yuto Iwasaki
Golsa Tabe Jamaat
Hamashima Yudai
Hong Yifan
Ryota It
Shohei Nagahashi
Yuta Okubo
Yuki Tateno
Takumi Adachi
Ayumi Umemura
Tomoki Yoshikawa
Kotaro Kodama
Shin Dong Wook
Shirivastava Shlok
with help of
Mr. Morita,
Ms. Hatakeyama
Prof. Obayashi

BRIEF OF OUR PROJECT

May ~ July : Boeing Externship

Class	Date	Time	Topic	Lead Speakers
#1	May14 (Fri)	10:30-12:00	Boeing Overview	Miwa Kobayashi
#2	May 28 (Fri)	8:00-9:30	Environment - Boeing and Sustainable Aviation	Mark Augustyniewicz Environmental Sustainability, Products & Services
#3	Jun. 11 (Fri)	10:30-12:00	Aircraft Finance Overview Supplier Management	Nate Graddy (BCC) Phillip Chan (BCA)
#4	Jun. 25 (Fri)	10:30-12:00	Boeing Global Services – Commercial Services	Hiroaki Inuzuka (BCA & BGS)
#5	Jul. 9 (Fri)	10:30-12:00	Technology	BR&T Team

BRIEF OF OUR PROJECT

July ~ August : Decide on our topic

Rental Service For Flying Car

Group members : 15 students

- Technological Feasibility → Specification of Cora
- Finance → Estimation of cost and profit
- Legal and Illegal → Operation rules and systems

Image of Cora

September : Real Performance

QUESTIONS TO MR. SHAFFER

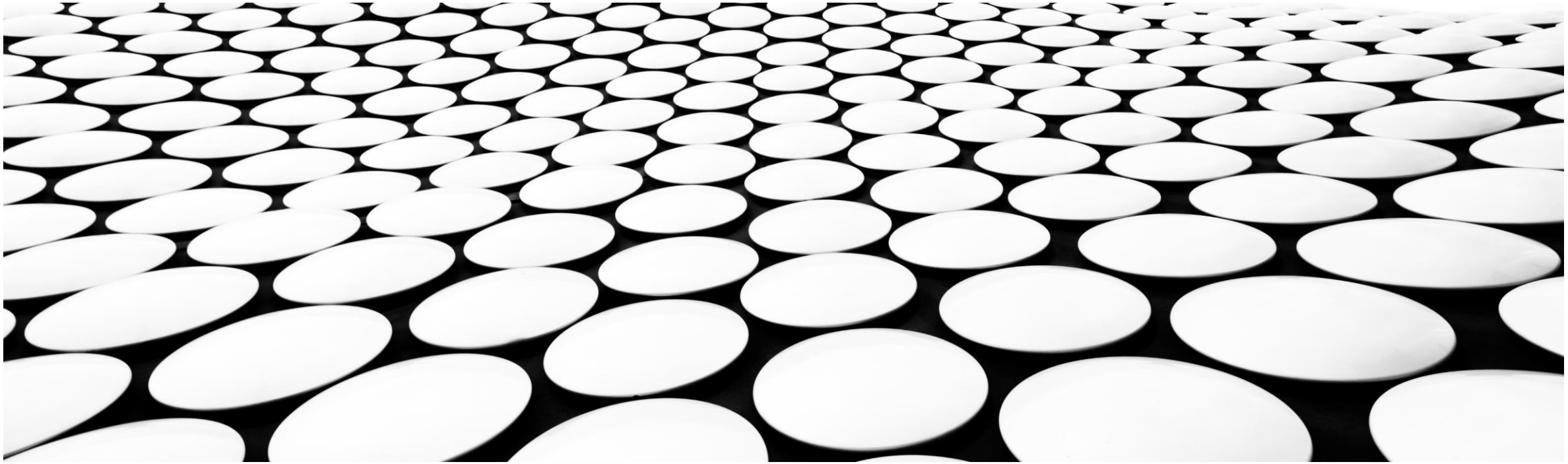
- What are the latest innovation which are going to appear in the Boeing's future innovation?
- Could you tell us the progress of flying car service using Wisk Cora?
- What skills are required to work in Boeing Japan?
- Could you tell us the details of business in Boeing Japan ?

Slides for Real Performance

OUTLINE

1. What is Our Flying Car Business?
2. Overview of Wisk Cora
3. Operation Rules and Systems
4. Estimations
5. Conclusion

WHAT IS OUR FLYING CAR BUSINESS?



WE ARE FACING…

- ✓ Population Increase in Cities

- ✓ Aging Ground Infrastructure

- Unable to keep up
- Extremely costly to repair and maintain

The **solution** is the **Sky.**

WHAT OUR FLYING-CAR BUSINESS IS ..

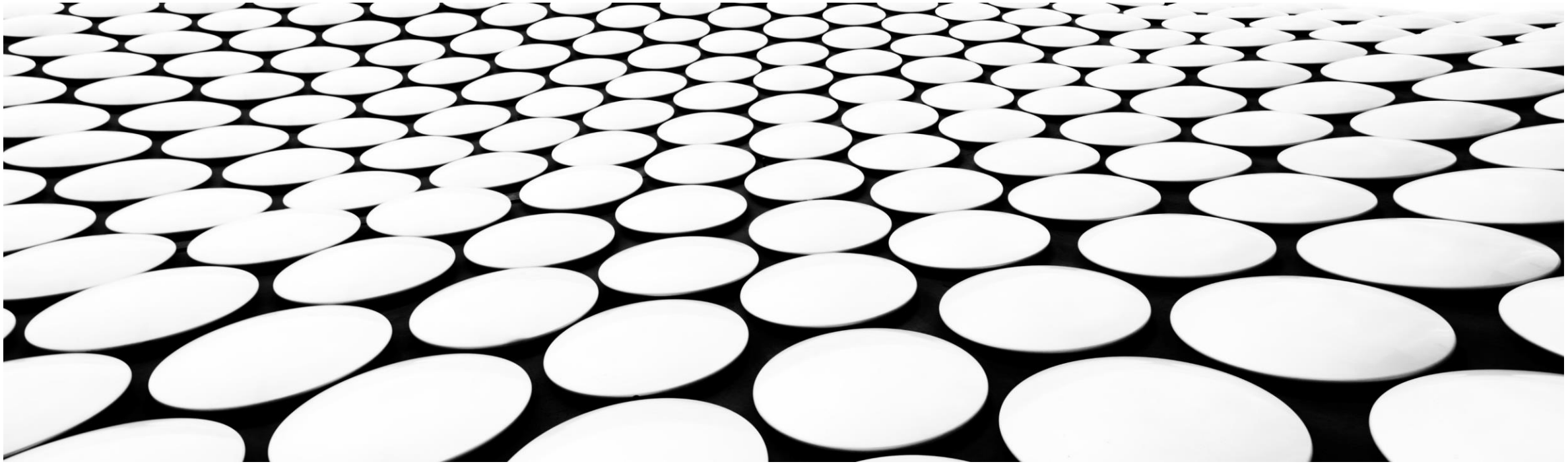
Inspired by **Times mobility co**.

Users can decide which car to reserve, where to rent it, and when to use it, just by using their cell phones.

Flying car instead of automobile.

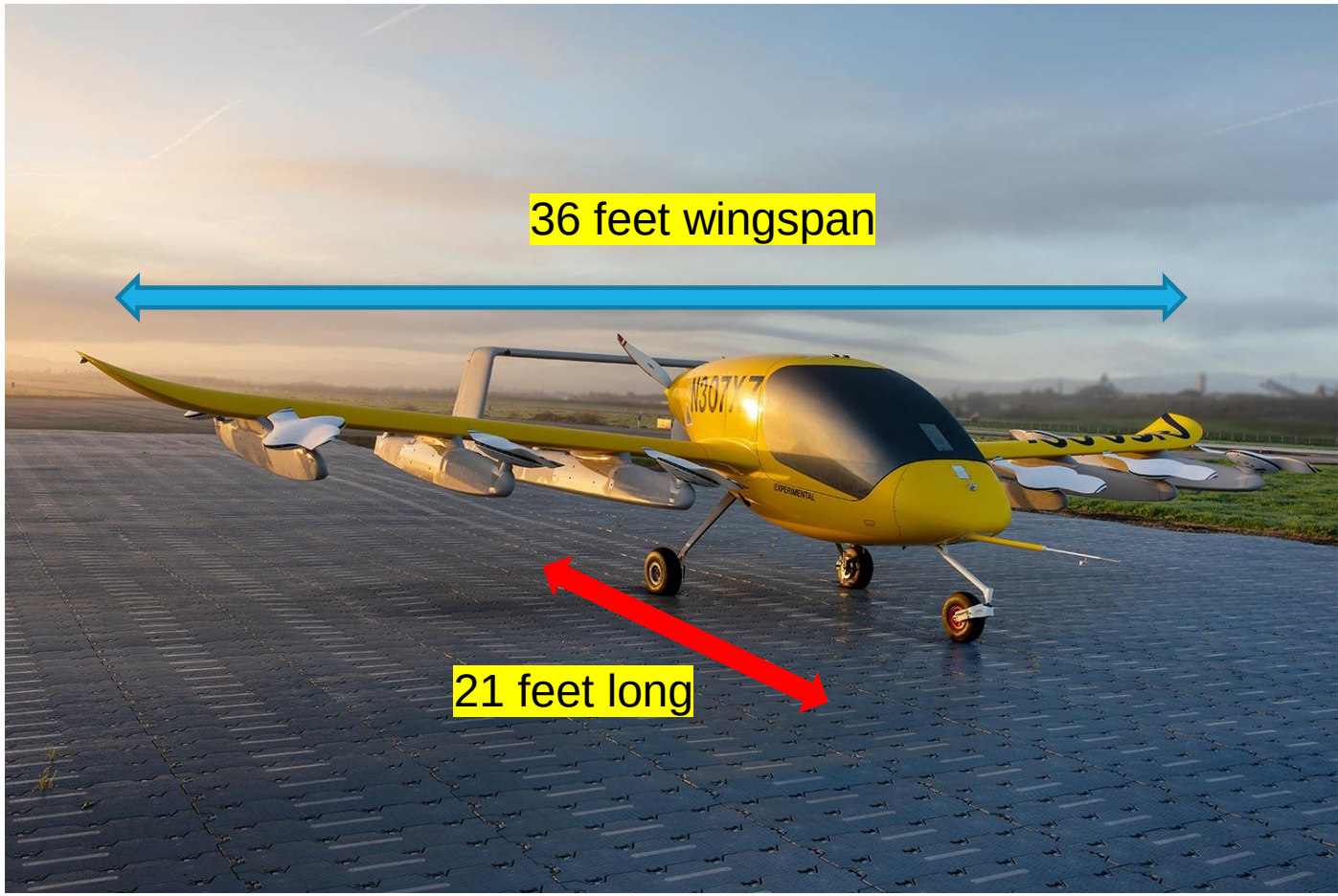
- No need for huge infrastructure equipment
- Longer distance with less stress and much shorter time
- Environmentally friendly
- Less human resources

OVERVIEW OF WISK CORA



SPECIFICATION OF CORA [1]

- **Power:** All-electric
- **Aircraft Classification:** eVTOL
- **Type of Flight:** Fixed wing, on a single propeller
- **Pilot Type:** Autonomous (no pilot)
- **Altitude:** 1500-5000 ft AGL
- **Vertical Lift:** 12 independent lift fans
- **Range:** About 40 km plus reserves
- **Speed:** About 180 km/h
- **Capacity:** 2 passengers



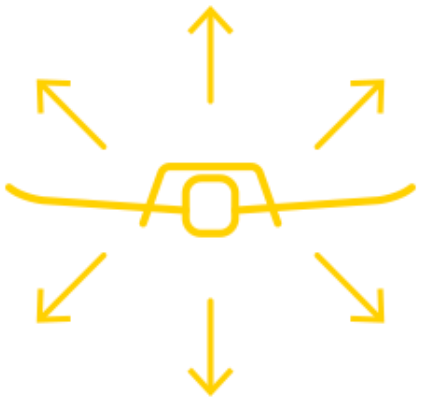
[1] “Wisk Autonomous Urban Air Mobility” https://wisk.aero/aircraft/ (Accessed 01 Sep. 2021)

Source of photo : https://wisk.aero/ (Accessed 01 Sep. 2021)

SAFETY DESIGN [1]

Autonomous Flight

Rotor Safety System



Redundant Systems

Parachute Descent (Emergency)

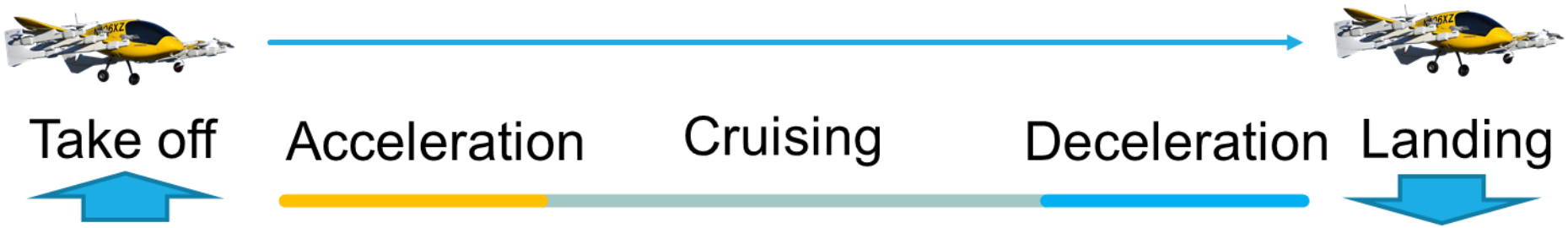
[1] “Wisk Autonomous Urban Air Mobility” https://wisk.aero/aircraft/ (Accessed on 01 September 2021).
Source of image : https://wisk.aero/ (Accessed on 01 September 2021).

MASS AND BATTERY DATA [2]

Total mass	1224 kg
Power required to hover	228 kW
Battery energy specific density	157 Wh/kg
Battery power density	735 W/kg
Minimum battery mass	310 kg
Battery mass	400 kg
Total battery energy	63 kWh
Battery mass to total mass ratio	33%

[2] Alessandro Bacchini and Enrico Cestino, “Electric VTOL Configurations Comparison” Aeronautics And Space Flight, 26 June 2019.

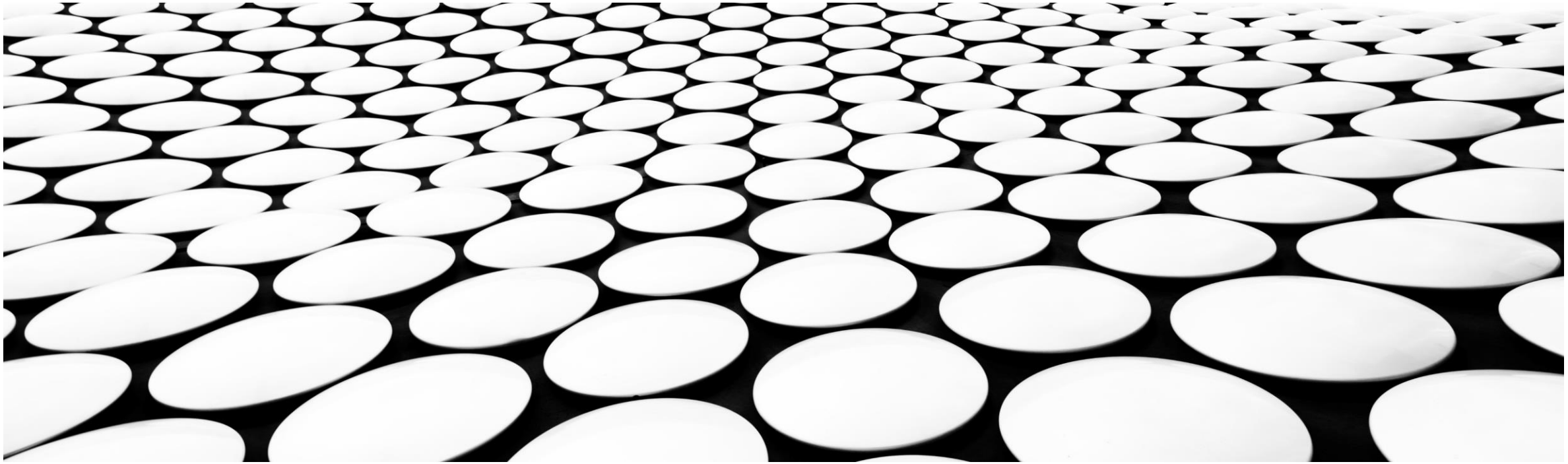
MISSION PERFORMANCE [2]



Takeoff and landing energy	1.9 kWh
Cruise Energy	2.0kWh
Acceleration/deceleration	$2m/s^2$
Acceleration energy	1.58 kWh
Deceleration energy	1.58 kWh

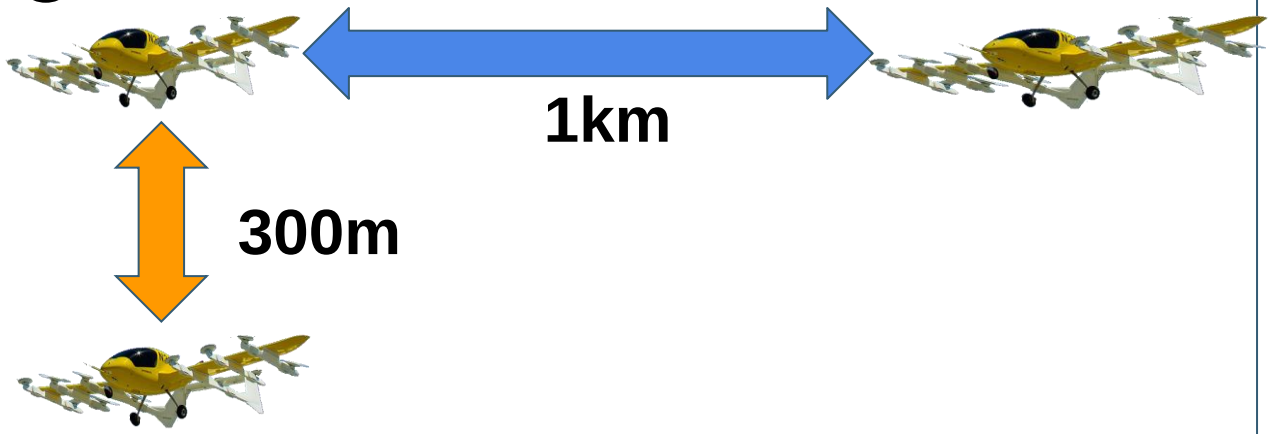
[2] Alessandro Bacchini and Enrico Cestino, “Electric VTOL Configurations Comparison” Aeronautics And Space Flight, 26 June 2019.

OPERATION RULES AND SYSTEMS

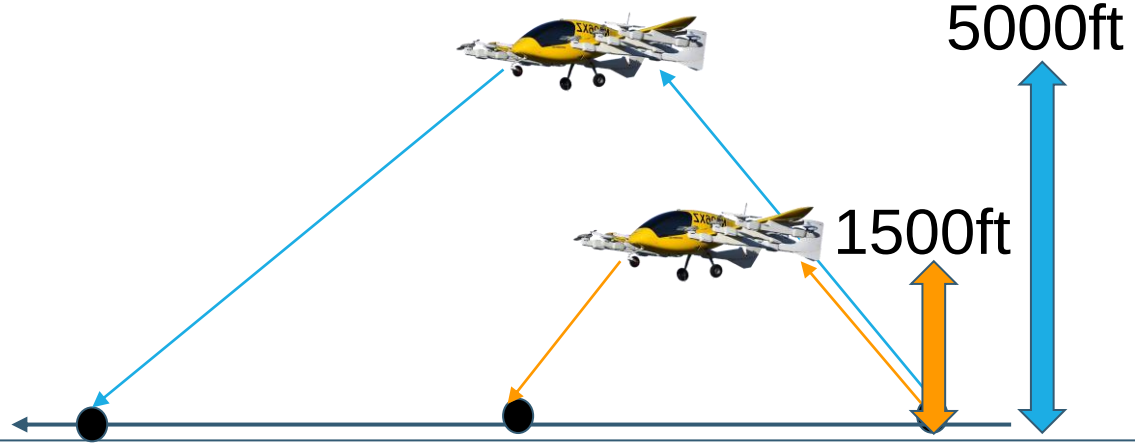


Operation Rules

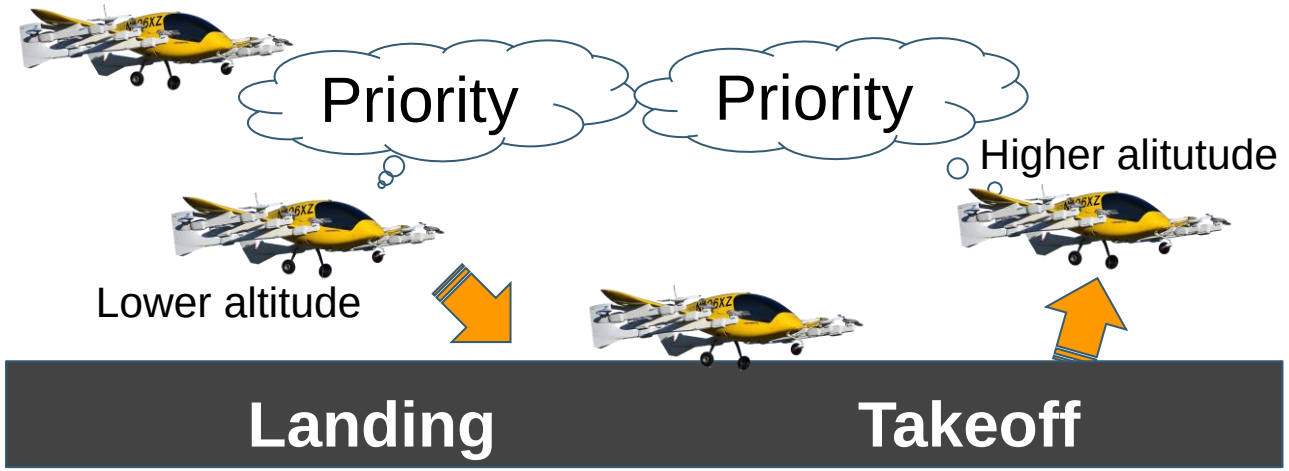
① Distance between cars



② Altitude depending on the goal



③ Landing and takeoff priority



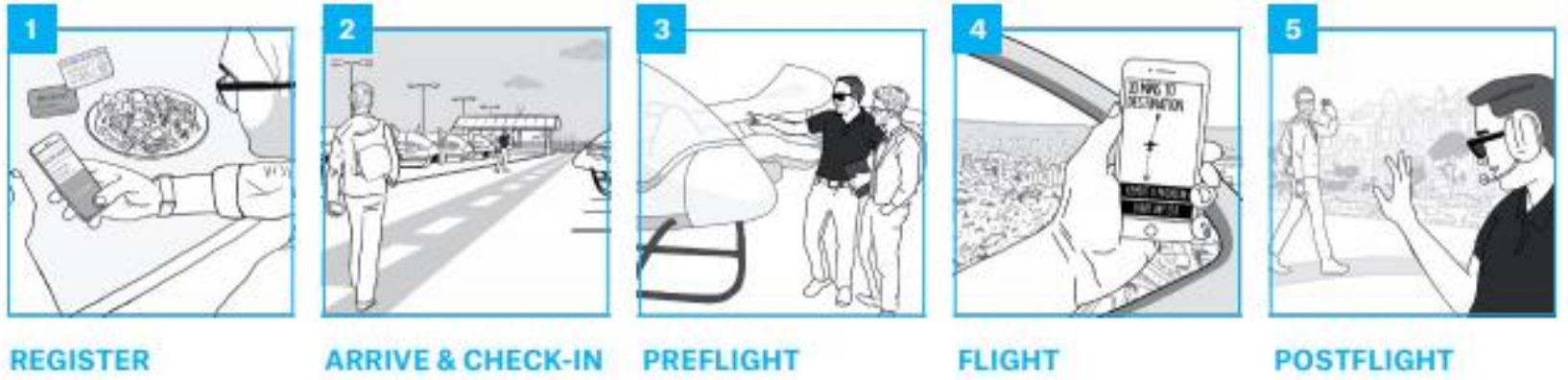
④ Suspension in bad weather

Hit lightning Bad Visibility Wind disruption (upper 15m/s)

Operation Systems

Steps of Using Flying Cars

1. Register
2. Arrive and Check-in
3. Preflight
4. Flight
5. Postflight



Target Areas

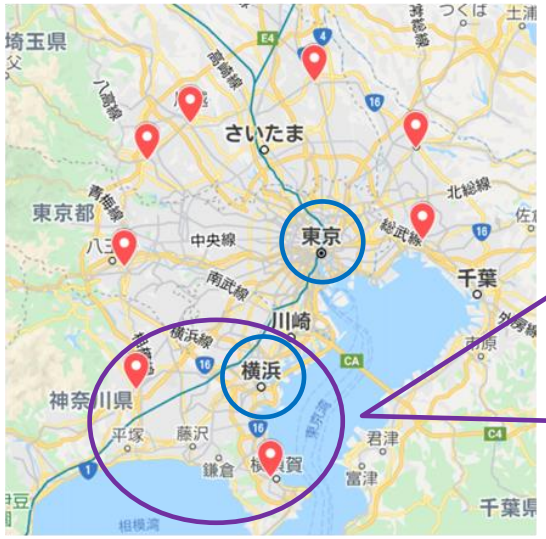
II

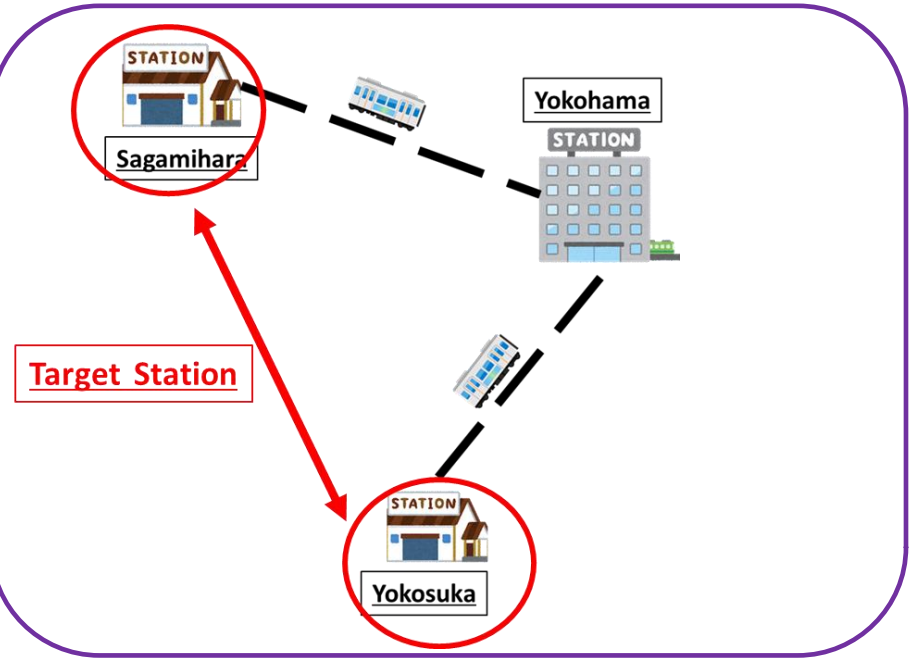
"Hub and Spoke System"

: Main Stations

: Target Stations

Tokyo Area



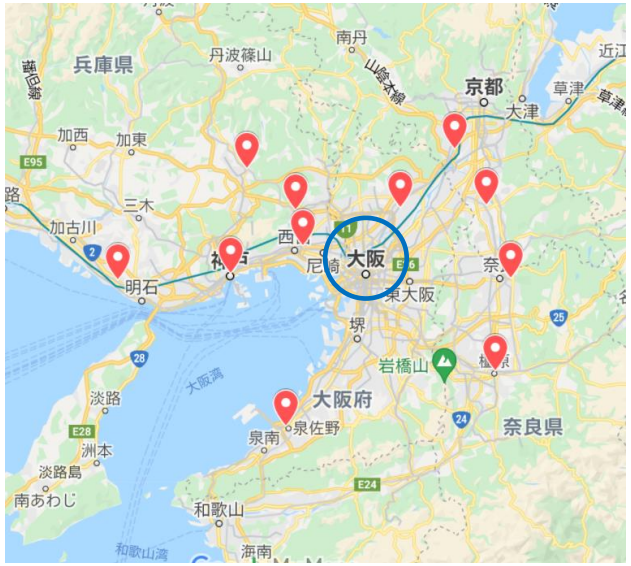


Target Stations

Tokyo Area

Iruma	入間
Kawagoe	川越
Hachioji	八王子
Honatugi	本厚木
Yokosuka	横須賀
Kasukabe	春日部
Kashiwa	柏
Funabashi	船橋

Osaka Area

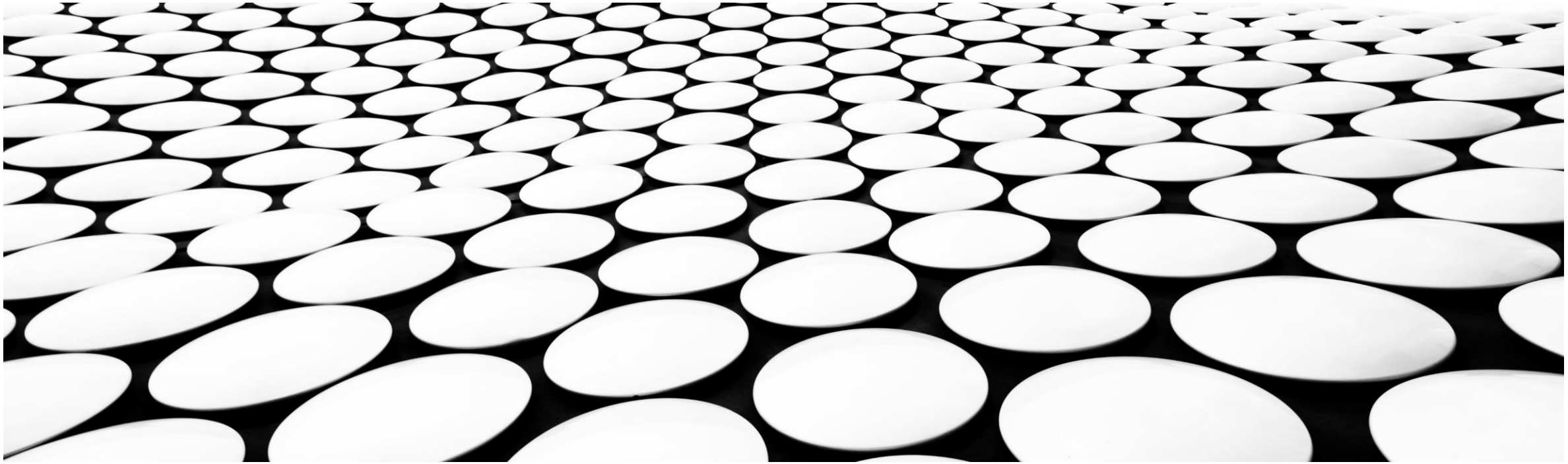


Nagaokakyo	長岡京
Okubo	大久保
Shintanabe	新田辺
Mita	三田
Takarazuka	宝塚
Sannomiya	三ノ宮
Nishimiyakitaguchi	西宮北口
Izumisano	泉佐野
Ibarakishi	茨木市
Kinkinara	近畿奈良
Yamatoyagi	大和八木

Nagoya Area

Toyota	豊田
Okazaki	岡崎
Kariya	刈谷
Kasugai	春日井
Ichinomiya	一宮

ESTIMATION OF COST AND PROFIT



Estimation of Customer

*CVR: Conversion Rate

Tokyo Area

*CVR=0.1%

Station Name	User [/day]	Potential[/day]
Iruma	33713	33.713
Kawagoe	47599	47.599
Hachioji	58760	58.76
Honatugi	154698	154.698
Yokosuka	68092	68.092
Kasukabe	71071	71.071
Kashiwa	252552	252.552
Funabashi	103879	103.879

Potential Customer: 790[/day]

Osaka Area

*CVR=0.1%

Station Name	User [/day]	Potential[/day]
Nagaokakyo	41610	41.61
Okubo	25445	25.445
Shintanabe	24474	24.474
Mita	35890	35.89
Takarazuka	45141	45.141
Sannomiya	249834	249.834
Nishimiyakitaguchi	100207	100.207
Izumisano	24520	24.52
Ibarakishi	58002	58.002
Kinkinara	55330	55.33
Yamatoyagi	31478	31.478

Potential Customer: 691[/day]

Nagoya Area

*CVR=0.1%

Station Name	User [/day]	Potential[/day]
Toyota	36470	36.47
Okazaki	48441	48.441
Kariya	101179	101.179
Kasugai	34781	34.781
Ichinomiya	54138	54.138

Potential Customer: 275[/day]

Cost of WISK

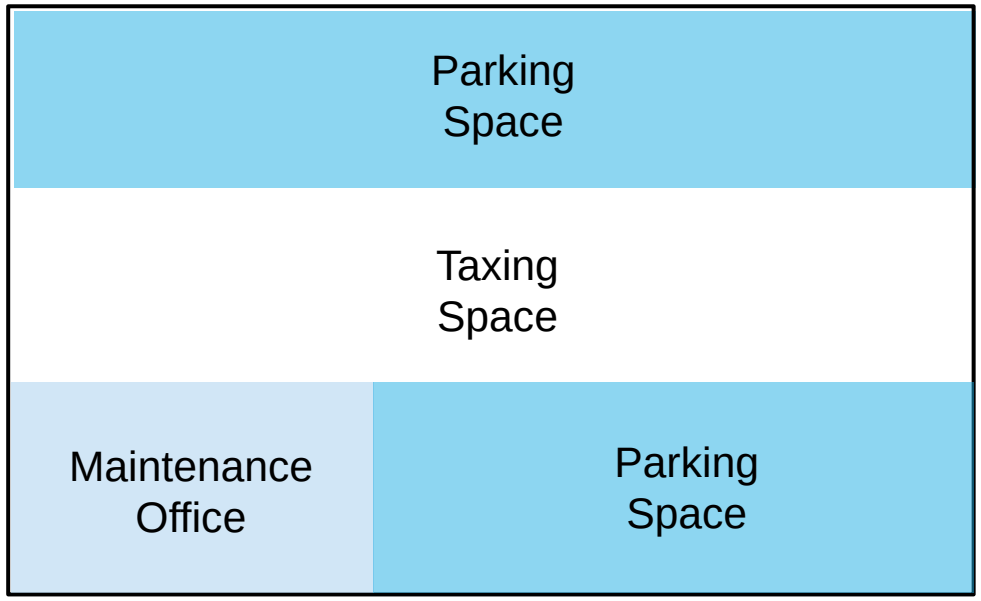
Assumption

Price: 40,000,000[yen]

Battery: 1,200,000[yen]

	Number of Flying Car	Cost of WISK [million yen]	Cost of Battery [million yen]
Tokyo Area	65	**2630**	**150**
Osaka Area	57	**2300**	**130**
Nagoya Area	22	**910**	**50**

Cost of Vertiport



- **Area of a flying car parking – 5m x 6m = 30m^2**
  - When 10 cars – 30m^2 x 10 = 300m^2
- **Predicting costs for parking/maintenance area**
  - Taxing place (assumed) = 150m^2
  - Office/maintenance area (assumed) =75m^2

Parking	:	Taxing	:	Maintenance
4	:	2	:	1

	Cost of Vertiport [million yen]
Tokyo Aera	**374**
Osaka Area	**990**
Nagoya Area	**144**

Cost of Fuel

40km Flight

Take off	Acceleration	Cruising	Deceleration	Landing
15[s] 1.9[kW]	625[m] 228[kw] 25[s]	38.75[km] 63[kw] 180[km/h]	625[m] 228[kw] 25[s]	15[s] 1.9[kW]

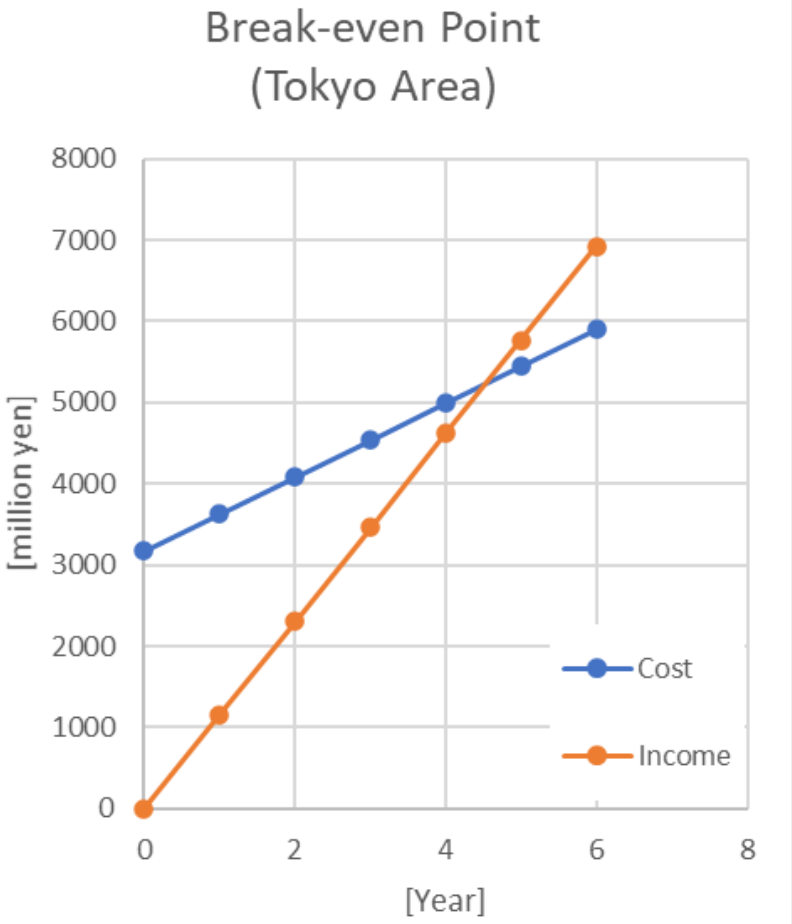
Consumption of electric capacity :
18.6 [kWh/flight]

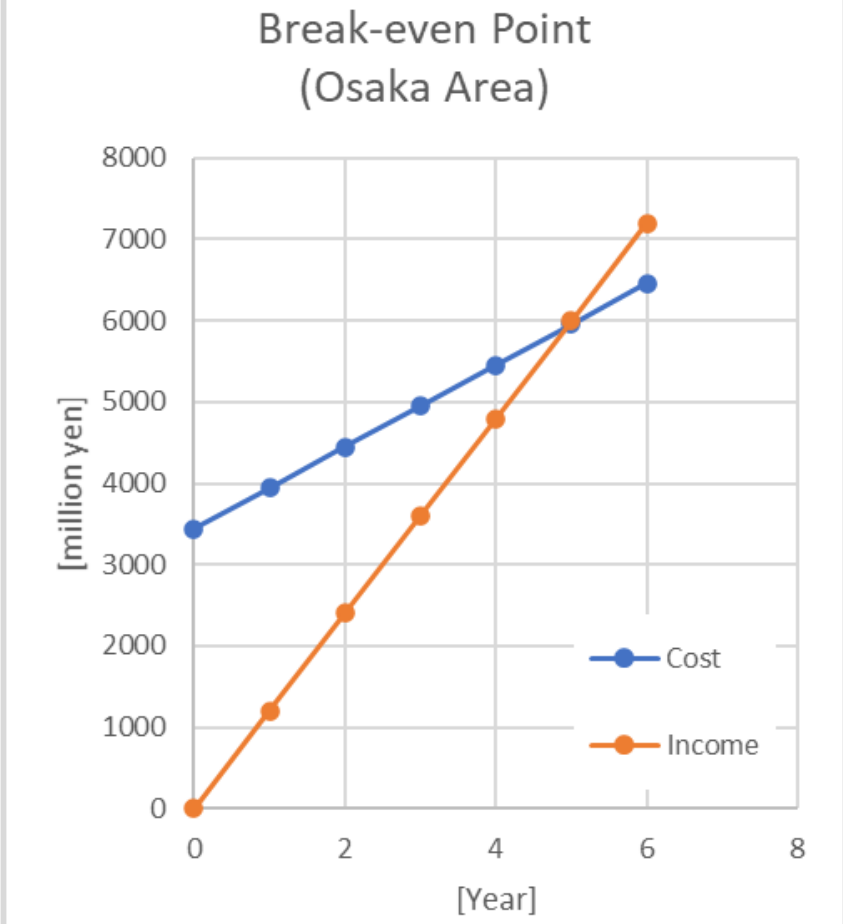
	Fuel Cost[million yen]
Tokyo Area	**90**
Osaka Area	**80**
Nagoya Area	**30**

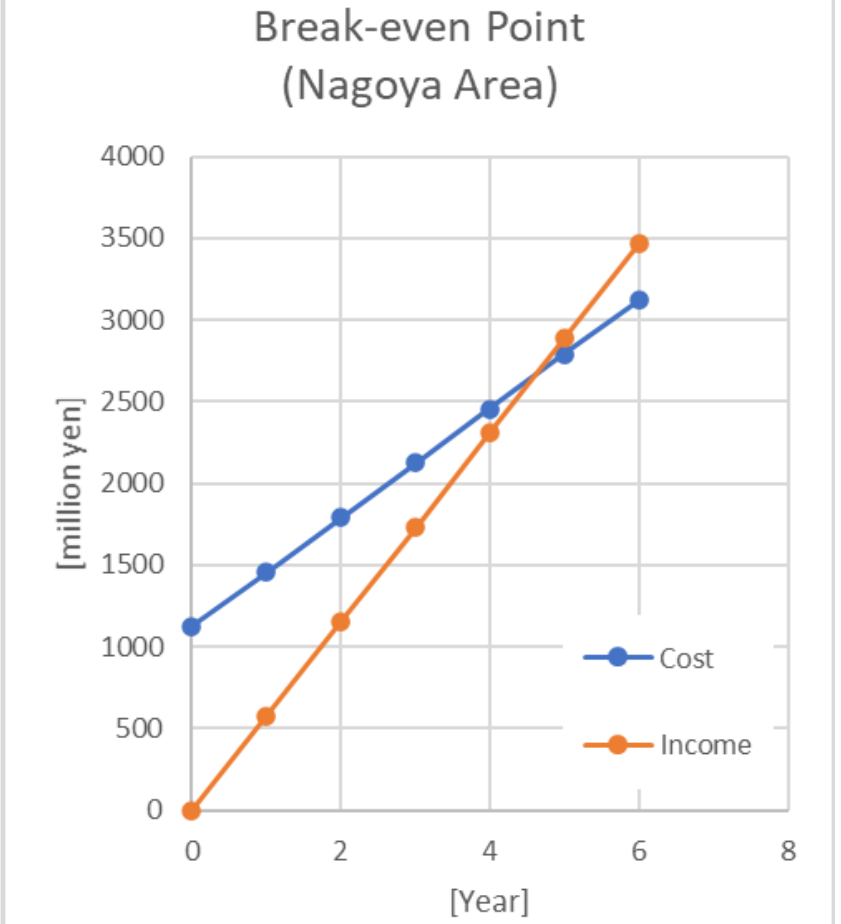
Income Statement

			Tokyo Area	Osaka Area	Nagoya Area
Income	Number of Flight [/day]		395	346	138
	Fare[yen/rental]		8,000	9,500	11,500
	Annual sales[million yen]		**1,154**	**1,200**	**577**
Cost	Variable cost	Fuel cost[million yen]	94	82	33
		Other cost[million yen]	100	100	100
	Fixed cost	Maintenance[million yen]	100	100	100
		Labor cost[million yen]	160	220	100
	Annual Cost[million yen]		**354**	**502**	**333**
Annual Profit [million yen]			**700**	**697**	**244**

Break-even Point of Each Area





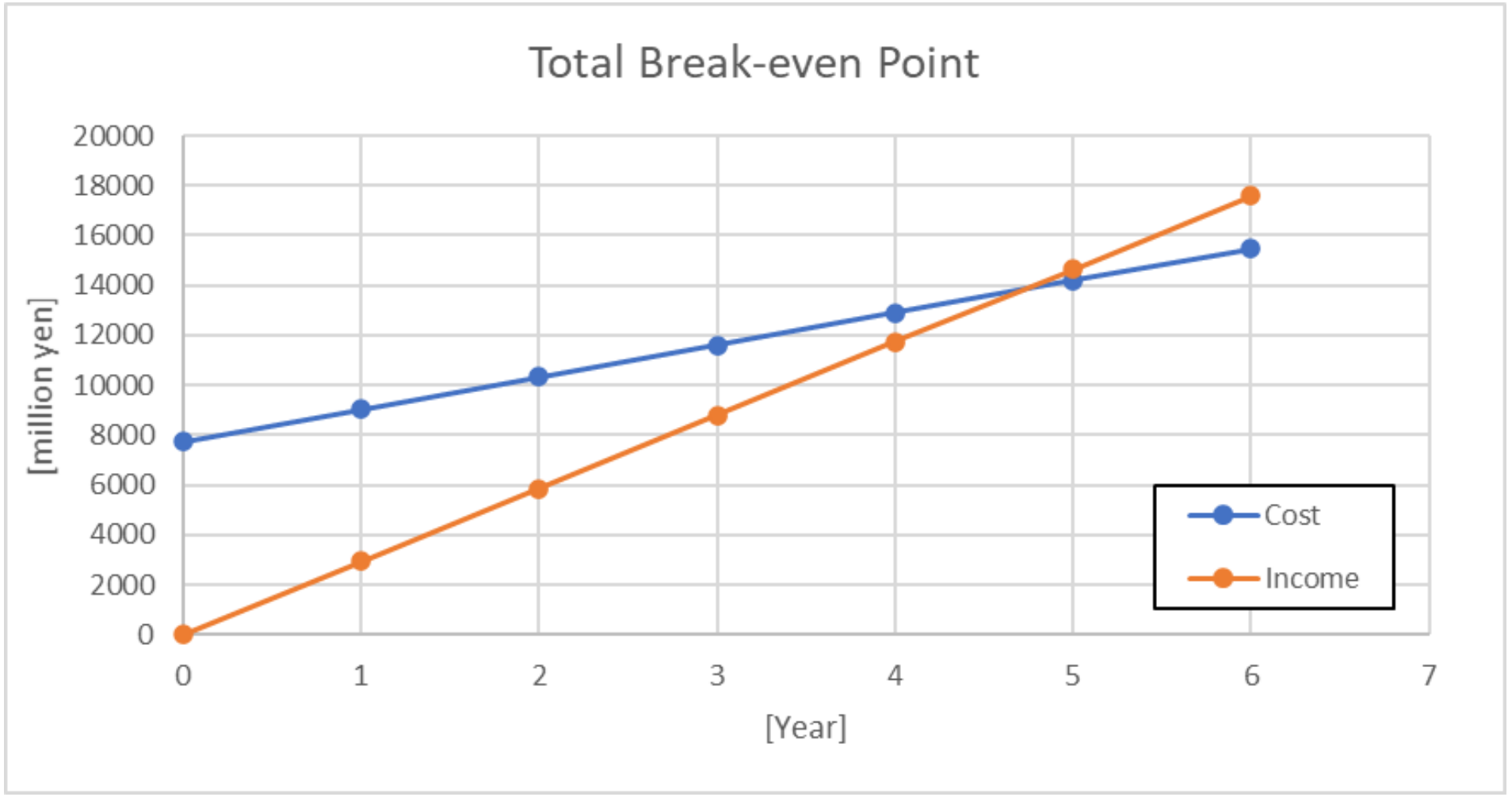


Break-even Point :
4.5[year], **5239**[million yen]

Break-even Point :
4.9[year], **5929**[million yen]

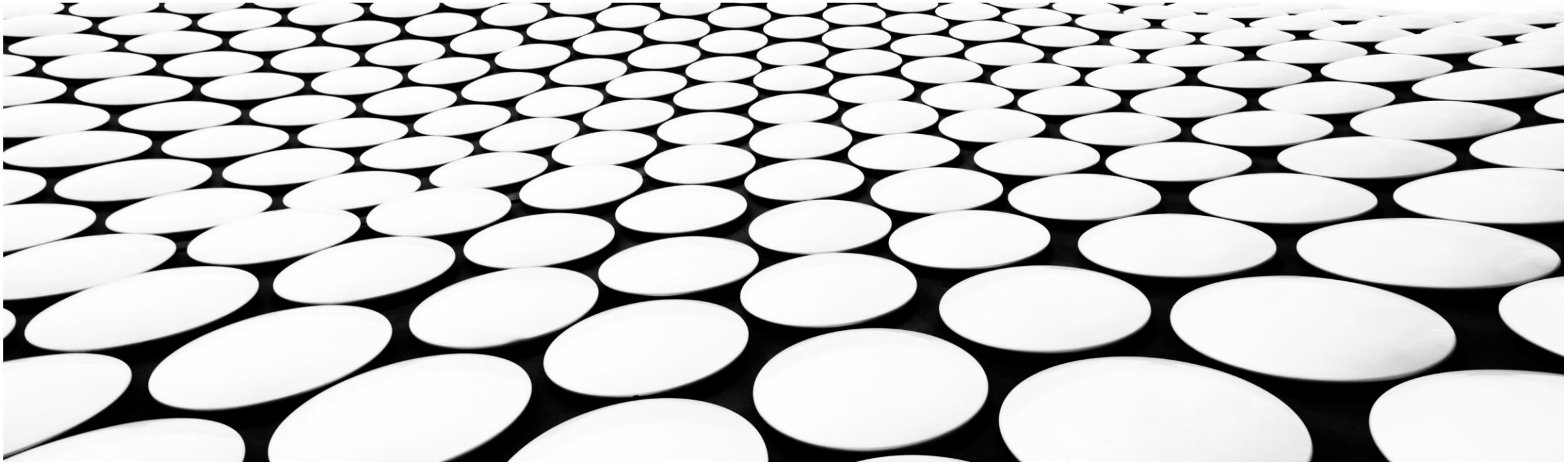
Break-even Point :
4.6[year], **2658**[million yen]

Total Break-even Point



Break-even Point : **4.7**[year], **13.8**[billion yen]

CONCLUSION



Our Flying Car Business

- ✓ Rental service for Flying Car
- ✓ Less stress and much shorter time

Overview of Wisk Cora

- ✓ All-electric = Environmentally friendly
- ✓ Autonomous UAM

Estimation

- ✓ Three Target Areas (Tokyo, Osaka and Nagoya Areas)
- ✓ Vertiports located in Target Stations.
- ✓ Optional batteries prepared in the vertiports.
- ✓ Break-even Point : **4.7**[year], **13.8**[billion yen]

Appendix

COMPARISON

VTOL, eco-friendly, maneuvering, Cruising Distance

	Cost(Yen)	VTOL	Power	Control	Cruising Distance
Liberty(Pal-v)	60 Million	○	engine	Piloted	600 miles
Cora(Kitty Hawk)	?	○	Electricity	Autonomous	25-60 miles
Sky Drive	40-50Million	○	Electricity	Piloted	18 miles
BlackFly	40 Million	○	Electricity	Autonomous	40 miles

Industry	Average CVR (Search)	Average CVR (Google display network)
Auto（自動車）	6.03%	1.19%
B2B（企業間取引）	3.04%	0.80%
Consumer Services（顧客サービス）	6.64%	0.98%
Dating & Personals（出会い）	9.64%	3.34%
E-Commerce（Eコマース）	2.81%	0.59%
Education（教育）	3.39%	0.50%
Employment Services（人材サービス）	5.13%	1.57%
Finance & Insurance（金融と保険）	5.10%	1.19%
Health & Medical（健康と医療）	3.36%	0.82%
Home Goods（家庭用品）	2.70%	0.43%
Industrial Services（工業系事業）	3.37%	0.94%
Legal（法律）	6.98%	1.84%
Real Estate（不動産）	2.47%	0.80%
Technology（テクノロジー）	2.92%	0.86%
Travel & Hospitality（旅行）	3.55%	0.51%

https://video-b.com/blog/webmarketing/conversion-average/

According to this book, some companies(3M, HP, ASAHI KASEI and so on) try to get the total surplus within five years.

We also decided the fare of our flying car
so that the break-even point is set within five years.

- Title :**新事業開発の戦略と組織**
―プロトタイプの構築とドメインの変革
- Author : Kozo Yamada (**山田　幸三**)
- Publisher : **白桃書房** (2000/5/1)
- Release date : 2000/5/1

Calculation Related to User of the Target Station

- Potential customer = User of the target station × 0.001(0.1%)
- The number of flight = Potential customer ÷ 2 (One Wisk can have two passengers)
- The number of wisk = The number of flight ÷ 6 (One wisk can operate 6 flight in a day.)

Calculation of Vertiport Cost

- Parking area [m^2] = The number of wisk × 30[m^2]
- Vertiport area [m^2] = Parking area [m^2] × 7/4　(Ratio→parking : taxing : maintenance = 4:2:1)
- Price of vertiport [m^2] = Price of land [yen/m^2] × Vertiport area [m^2]

Calculation of Fuel (Electricity)

- Electric capacity [kWh] = Electric power [kW] × Time [h] (If electric power is constant.)
- Cost of fuel [yen] = Electric capacity [kWh] × Price of electricity [yen/kWh]

REGARDING THE BATTERY PRICE

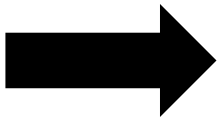
Calculated based on Nissan corporation

The price of 1 khw : about twenty thousand yen (¥ 20000)
The battery capacity of Wisk : about 60 kwh

Thus, the battery price is

$$20000\,\text{yen/kwh} \times 60\,\text{kwh} = 1200000\text{yen}$$

Regarding the Suspension of Wind disruption

Wind Velocity > 17m/s  Typhoon in Japan

Defined by Japan Meteorological Agency

Tokyo Area

https://www.haseko-sumai.com/kurashi/archive/detail_254.html

Honatsugi / 本厚木市

https://travel.rakuten.co.jp/mytrip/ranking/spot-yokosuka

Yokosuka / 横須賀市

https://www.city.kasukabe.lg.jp/plus1_days/kasukabe_plus1/monument.html

Kasukabe / 春日部市

https://gairanban.com/chiba/kashiwa/

Kashiwa / 柏市

https://gentosha-go.com/articles/-/25388

Funabashi / 船橋市

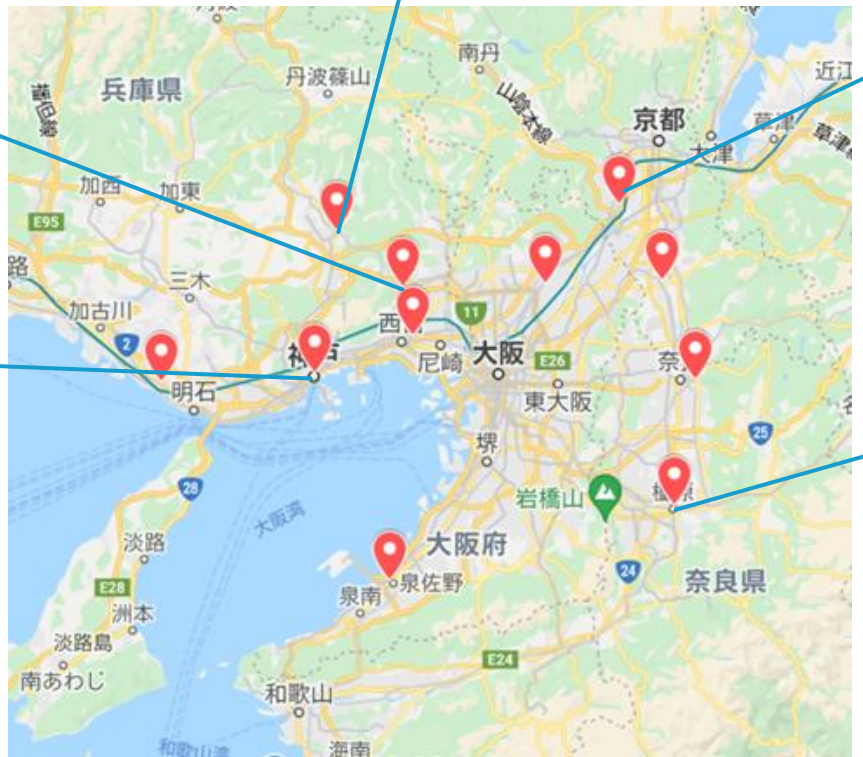
Osaka Area

Takarazuka / **宝塚**

Mita / **三田**

Nagaokakyo / **長岡京**

Sannomiya / **三ノ宮**



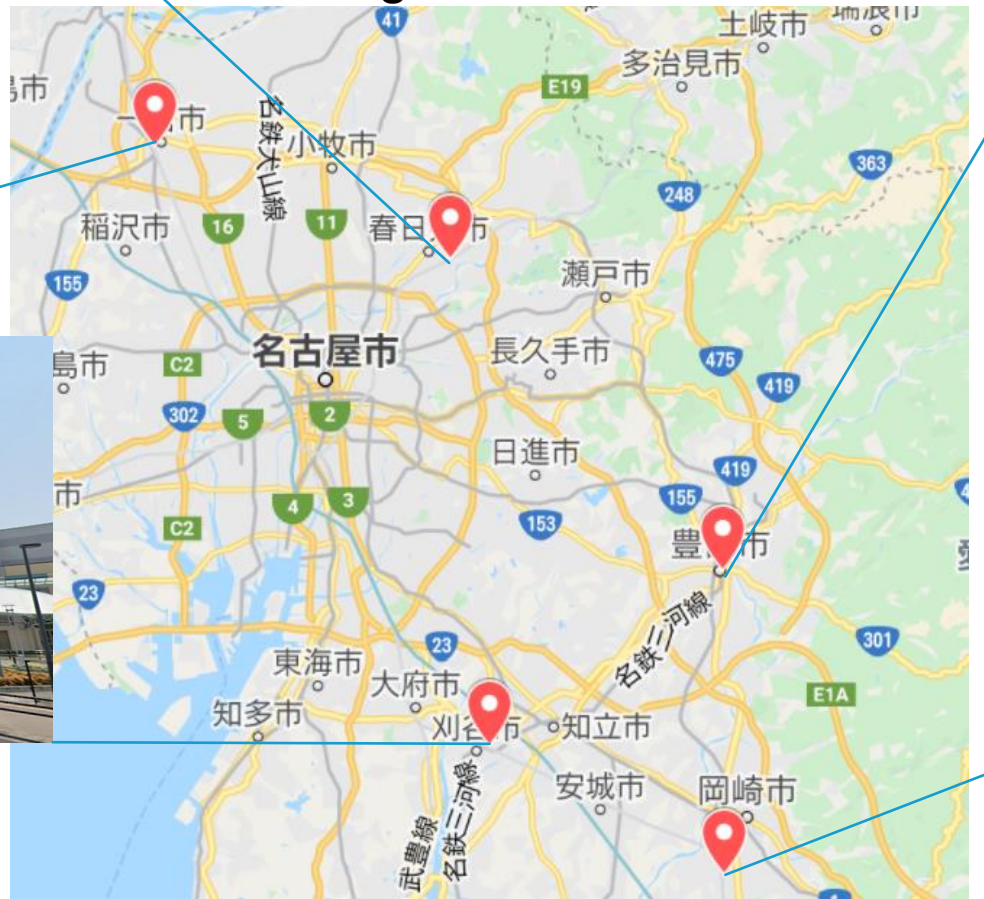
Yamatoyagi / **大和八木**

Nagoya Area

Kasugai / 春日井市

Ichinomiya / 一宮市

Toyota / 豊田市



Kariya / 刈谷市

Okazaki / 岡崎市