

# Unmanned Transportation Applications at First Level Air Infrastructure (FLAI)

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**Abstract.** Increasing complexity of infrastructure has growing need for maintenance that is accumulating cost in the long run. This report compares the simulation of traditional transportation to an aviation alternative. The focus is on the cost effectiveness and power efficiency of Vertical/Short Take-Off and Landing (V/STOL) vehicles. Author's motivation in this topic is from the project of designing a VTOL vehicle for multimodal transportation. The simulation of 100.000 people demonstrates efficiency of aviation infrastructure. Counting 11 billion for traditional infrastructure and 4 billion for equivalent VTOL vehicle carrying capacity. Affecting factors are energy, transportation modes, infrastructure and operation average the results. The simulation is simplistic model of infrastructure with normally distributed traffic, neglecting the effect of transition between vehicles, and the effect of wind magnitude and direction. The aviation method reduced distance up to 82% made travel time 92%, consumed 88% of the energy, when emissions show relatively equivalent quantity on both applications. The results of FLAI imply economic advantages over traditional infrastructure and suggest further research into the safe adoption of aviation infrastructure.

**Keywords.** Traffic congestion, Infrastructure, Mobility, Aeronautical engineering

## 1. Introduction

Road infrastructure and its maintenance devoted resources increase exponentially, unless traffic can be redirected to other transportation modes. V/STOL vehicle design has the effect of helicopter and efficiency of an airplane. Whilst not readily available in physical infrastructure due to heavy regulation and maintenance, this report compares their integration on the existing infrastructure by the efficiency of energy, mode, infrastructure, and operation. It is expected that ethereal path is faster but consumes more energy.

**Table 1.** Objects for the simulation

Energy	Mode	Infrastructure	Operations
Fossil Fuels	Car/ Taxi/Bus	Road/Rail/Ether	Population
Nuclear Fission	Train/Metro	Prevailing wind	Passengers
Hydroelectric	Airplane	Transport hubs	Convenience
Wind	Helicopter	Fuel stations	Idle operation
Photovoltaics	Ferry		
Biomass	Pedestrians		
Hydrogen	VTOL		

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2. Methods

Figure 1. A and B models illustrate traditional and V/STOL hierarchies and datapoints. The nodes A to N represent all terminals that an individual can stop by. Different arrow colors represent different transportation modes and the colored shapes dominating areas.

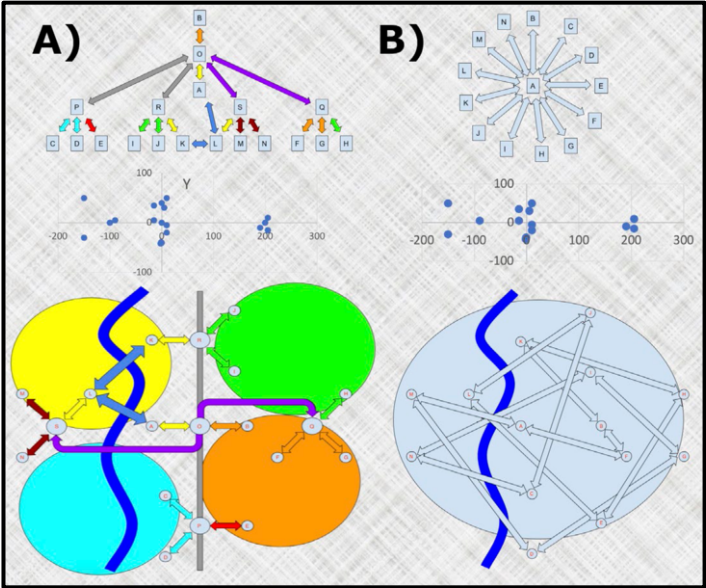


Figure 1. Data points for A) traditional infrastructure, B) VTOL infrastructure.

Table 2. show the different transportation modes and underlying investments. For comparison, the simulation A. has 63 km of road that cost 16m£, there are 24 thousand people using cars that cost 176 m£, and construction for urban parking has cost 20 m£; same comparison to rail, bus, metro, sea, aviation, and pedestrian. Whereas simulation B. has 1273 km of ether that cost nothing, there are 100 thousand people using vehicles that cost 3.75 M£ and landing areas that cost 50 m£. The model A. consider travelers who need more than one mode to reach destination, such as taking a taxi from the airport.

Table 2. Object parameters

Mode	Distance (km)	Users	Density (ppl/km)	Vehicle (t£)	Infrastr. (t£)	Terminal (t£)	Budget (t£)
Road	63	23529	371	176471	16509	19608	
Rail	240	35294	147	132353	224000	7647	
Bus	37	17647	483	66176	9491	7500	
Metro	206	88235	429	330882	1284093	7868	
Marine	75	11765	157	35651		10000	
Airspace	800	29412	37	7352941		1524510	
Helicopter	129	235	2	29412		441	
Pedestrian	4	11765	236				
Total	1555	217882	141	8123886	1534093	1577573	11235552
V/STOL	1273	100000	79	3750000	0	50000	3800000

Figure 2. A–E show variables affecting energy, application, infrastructure, and operation.

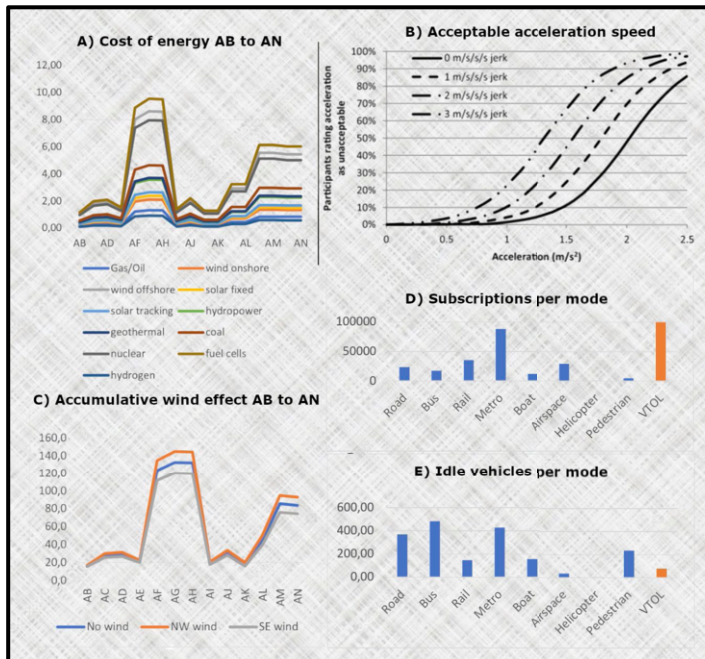


Figure 2. Critical analysis of a) energy, b) applications, c) infrastructure, and d and e) operations

Table 3. is the list of parameters used to simulate models A and B. The objects have no transition time and travel the entire path at full speed. The range limit the continuous travel by decelerating to zero velocity and accelerating again to full speed. The fuel type is affecting the emission and power consumed per kilometer.

Table 3. Simulation parameters

Object	Range (km)	Acceleration (m/s²)	Velocity (km/h)	Fuel	CO2 (g/km)	Power (W/km)
Car	100	2	100	Fossil	100	400
Bus	20	2	80	Fossil	90	300
Metro	40	2	100	Fossil	0	200
Train	100	2	100	Fossil	40	200
Airplane	1000	2	800	Fossil	100	300
Ferry	100	2	80	Fossil	120	60
Helicopter	100	10	200	Fossil	50	2600
Pedestrian	1	0.1	10	Biomass	0	0
VTOL	100	10	100	Renewable	150	600

3. Measurements

Figure 3. A. show increase in energy consumption over long distances (AF – AH) and equivalent on short distances, B. show reduction on each path (AB to AN), C. show reduction in overall duration, but technically not competitive with plane or helicopter.

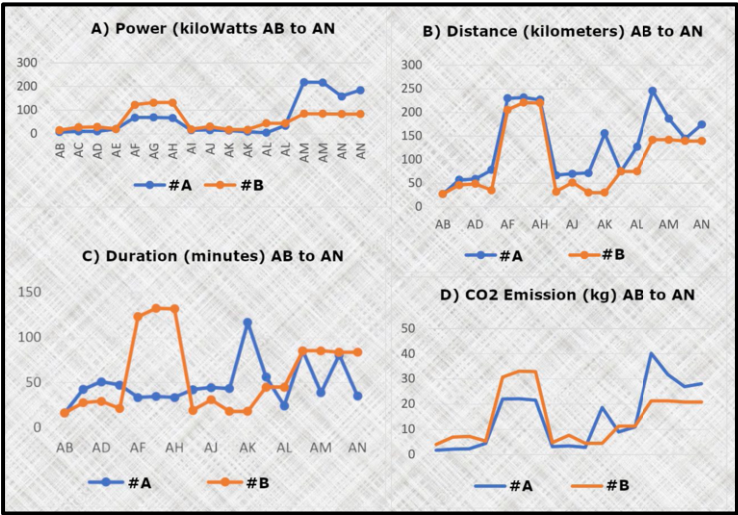


Figure 3. Simulation of the parameters a) power, b) distance, c) duration, d) CO2 emissions

4. Results

The average of each simulation in Figure 3. are shown in Figure 4., demonstrating that generally VTOL produces as much emission to traditional infrastructure, but has much less distance to travel, spends less time, and consumes less power respective to the graph.

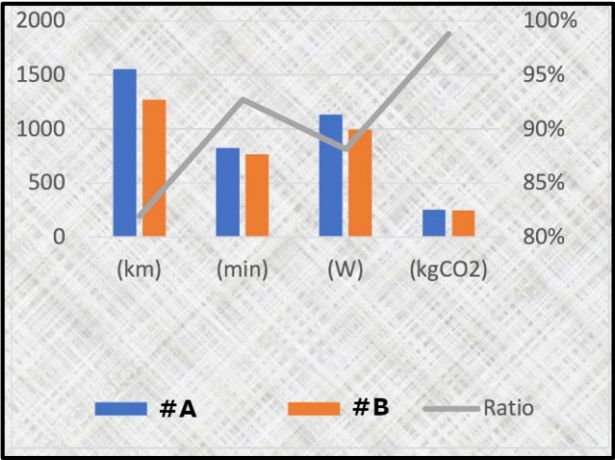


Figure 4. Results of the simulation

## 5. Discussion

Technical decisions on both models, A and B, were based on the current infrastructure. Model A cannot fully demonstrate the effect of transitioning from one mode to another or traffic jams. Model B assumes the amount of traffic remain the same. To include the model A transition requires stochastic analysis of traffic patterns, which can be used to create abstract simulation for model B traffic. However, the effect is negligible within the scope of this report. Major findings were the reduction in distance and integration cost. Power, emission, mobility and duration are subject to closer analysis of the traffic.

This implies the feasibility of V/STOL vehicle commercialization, which is already agenda for many carmakers<sup>[3]</sup> and regional development.<sup>[2]</sup> Due uncertainties the adaptation could be most effective when the vehicles adopt pay-as-you-go services.<sup>[4]</sup> While consuming more power, research has shown good results in utilizing solar energy during a flight.<sup>[5]</sup> Delivery on demand at specific location is showing general interest in logistics<sup>[6]</sup> and transportation.<sup>[7]</sup> Automation of these vehicles may be essential due the amount of training required on manually operated vehicles. Digitally driven trajectory would be able to avoid areas sensitive to noise, which would equal to car generated tire noise. And integrate technology to avoid collusion with other vehicles in the air.<sup>[1]</sup> The application requires more resiliency from manmade hazards than land vehicles due the adverse effects of falling vehicles. The adaptation will make new jobs and make others obsolete, which imply the need for new skills. This intelligent control come with serious cyber threat that have potentially more adverse effect than land vehicles. Security is developing and possible cyberattacks might be avoided with right technologies.<sup>[8]</sup>

## 6. Conclusion

The comparison of traditional infrastructure to flying cars within 100,000 user economy presented feasible result for the integration of V/STOL vehicles. Comparing the effects of energy, mode, infrastructure and operations, the results indicate better performance at short distances, worse or equivalent in longer distance when the factors are averaged.

Average savings in implementation reduced from 11 billion to 4 billion pounds, shorter routes by 18%, faster journeys by 7%, more energy efficient paths by 12% and emissions about the same. The simulation is crowded, and the natural traffic patterns are mitigated. The transition time between traditional model can cause more difference in the duration and power consumption. Realistic traffic patterns might increase the benefit of using V/STOL vehicles. Technical and political challenges exist in the integration of the vehicle. Security technology and capital allocation are open for further research.

The physical infrastructure of V/STOL vehicles emerge data driven control and development of new skills. While enabling efficient transportation alternative, the mode is adaptable to different environments, allowing habitation of environments otherwise out of reach, and deployment of architecture to achieve most functional infrastructure. Further research is made on: *Safe adoption of emerging technologies: review of the skills needed and readiness of the engineering sector*; *Safety of digital and data driven systems: capability mapping*; And *Safety of physical infrastructure*.

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