2021

iEROM

International Electric Rotorcraft Manufacturers

F-HeliX

AN OPTIONALLY-PILOTED eROTORCRAFT WITH PROPELLERS-DRIVEN ROTOR
Powered by Liquid Hydrogen Fuel Cell

PREPEARE TO THE FUTURE

Table of contents

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International Electric Rotorcraft Manufacturers

F-HeliX

1

Executive Summary

Executive summary (2)

Progress to date

- Development of eVTOL concept starting from existing SH4 light helicopter platform
- Proof of validity of initial concept
- Optimisation of the design to produce best-in-class efficiency rotors and ensure stability
- Initial discussions with EASA on certification process

Swiss Safety Research SA
Advanced Technologies for Safety

EASA
European Aviation Safety Agency

PennState
Vertical Lift Research
Center of Excellence

m4 AEROSPACE ENGINEERING

Result

"Mission performance is in line with, if not superior, to NASA's concept vehicles for VTOL air operations"

Pennsylvania State University

Next steps

Having successfully completed the conceptual phase and optimised the design, we are seeking US$ 10m to build the prototype using the existing SH4 platform and to obtain Type Certification as next step towards production

Vision

"To become the leading eVTOL Original Equipment Manufacturer (OEM) player of the next decade, providing safe and eco-friendly vehicles accessible to everyone"

Felice Vinati (CEO IEROM SA)

Executive summary (1)

By 2030, more than 60% of world's population will live in cities. Traditional ways of urban transportation continue to contribute to congestion and pollution. One answer is to take to the sky and develop urban air travel as a viable alternative to ground transportation

Market

Urban air mobility market size 2035

Passenger transportation[1]

US$ 21 bn	US$ 11 bn
Intracity	City-to-city

eVTOL

- eVTOL represents a new mode of mobility featuring vertical take off and landing capability (VTOL), electrification of lift and thrust and potential automation of controls

Unique features of eVTOL
- ✓ Vertical take off and landing
- ✓ Electrification of lift and thrust
- ✓ Automation of controls

- More than 80 companies, including start ups and major automotive and aircraft manufacturers, have entered the field of eVTOL aircraft development

Why F-Helix?

Disadvantages of current projects

Intended to be fully autonomous	Acceptability / costs / timing
Require the development of new platforms	Costs / timing
Ad-hoc regulations needed	Costs / timing
No autorotation	Safety issue

Advantages of F-Helix

Initially piloted	Solves psychological barrier issue / timing
Based on an existing platform	Cheaper / faster implementation
Autorotation	Solves safety issue
Categorised as rotorcraft	No ad-hoc regulation required

Source: Elaboration on (1) Performance and design optimisation of the F-Helix eVTOL concept, Penn State 2019 (2) The future of vertical mobility, Porsche Consulting, 2018 (3) Deloitte report, The elevated future of mobility, 2019

Notes: (1) US$ 32 bn also includes related services

Key investment highlights

Attractive addressable market
Addressable market for passenger eVTOL aircrafts expected to be in excess of US$ 32bn by 2035

Shorter go-to-market and cost advantages
Concept based on existing platform, reduces costs and simplifies certification process

Safety
Autorotation capability ensures highest flight safety standards

Light organisation structure
Contracted a visionary, tech-savvy and experienced team

2

Market overview

UAM - Overview

Vertical mobility ecosystem, a new way of life

"A safe and efficient system for air passenger and cargo transportation within an urban area, inclusive of small package delivery and other urban Unmanned Aerial Systems (UAS) services, that supports a mix of onboard/ground-piloted and increasingly autonomous operations" NASA

- Vertical mobility to become an integral part of overall urban mobility in connection with first- and last-mile modes of transport
- Competitive way to cover distances of 20 km or more since limited investments in infrastructures needed

The promise of Urban Air Mobility

- Decongest Road Traffic
- Decrease Pollution
- Improve Mobility
- Reduce Strain on Existing Public Transport Network
- Reduce Transport Time
- Reduce Traffic Accidents

UAM use cases*

USE CASE 1 – Air Taxi (Passenger)
The Air Taxi use case is a near-ubiquitous (or door-to-door) ridesharing operation that allows consumers to call vertical take-off and landing aircraft (VTOLs) to their desired pickup locations and specify drop-off destinations at rooftops throughout a given city. Rides are unscheduled and on demand like ridesharing applications today. Vehicles are autonomously operated and can accommodate 2 to 5 people at a time, with an average load of 1 passenger per trip

USE CASE 2 – Air Metro (Passenger)
Resembles current public transit options such as subways and buses, with pre-determined routes, regular schedules, and set stops in high traffic areas throughout the city. Like in the Air Taxi case, vehicles are autonomously operated and can accommodate 2 to 5 passengers at a time, with an average load of 3 passengers per trip

USE CASE 3 – Private vehicle (Passenger)
In substitution / integration to cars

OTHER USES
Last Mile Delivery, First Response, Military, Construction, Entertainment

Source: The future of vertical mobility, Porsche Consulting, 2018
Deloitte report, The elevated future of mobility, 2019
*Notes: * F-Helix focus*

UAM - Overview

Challenges

Regulations

Technological maturity

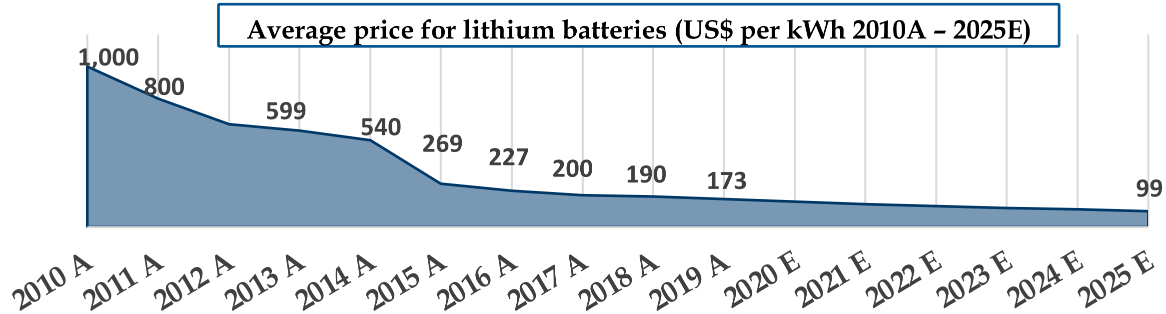
Psychological barriers

Infrastructures

Safety

Air Traffic Management

Pivotal role of batteries: path to more performance and reduced costs (US $)



- Batteries account for ca. 30% of electric vehicles' costs
- Still a non efficient way to store energy (lithium batteries storage 250 Wh/Kg vs. fuel storage of 13.000 Wh/Kg)
- Both private and public institutions are investing in battery innovations to drive the change in a market expected to reach US$ 250 bn by 2025

Upcoming innovations, such as the solid-state batteries, the metal-air batteries, and the lithium sulphur batteries, are expected to sensibly increase (up to 5x) batteries' storage capacity, while lithium batteries are becoming cheaper and more efficient

The most promising battery technologies

Lithium Ion Batteries

(current model)

Lithium ion batteries, first introduced in 1991, can store between 150 and 250 watt-hours per kilogram

Solid State Batteries

(based on current research)

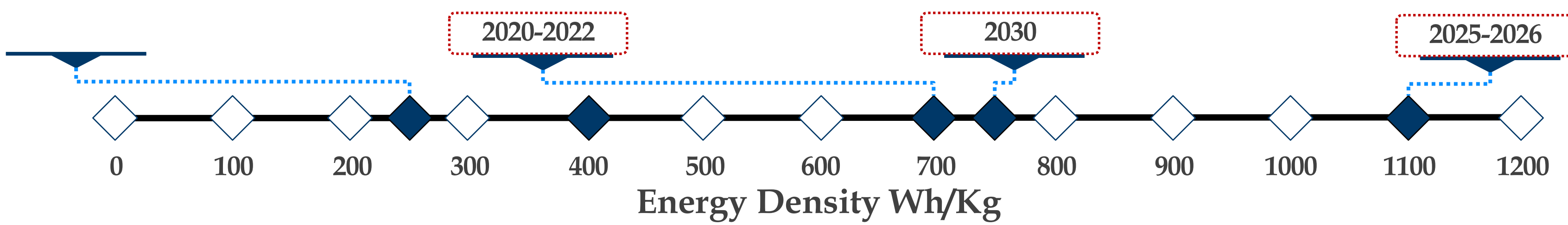
The liquid electrolyte must be replaced with a solid one; they are much smaller, lighter, efficient and safer than current lithium ion batteries

Metal-Air Batteries

In perspective, the focus is on metal-air batteries, where the metallic lithium of one of the two electrodes reacts directly with the air oxygen, thus greatly reducing both the weight and the cost

Lithium Sulphur Batteries

They will have 5 times the capacity of current lithium batteries. Furthermore, sulphur is much easier to find and cheaper than lithium. It is believed that the production will start within the next 4/5 years

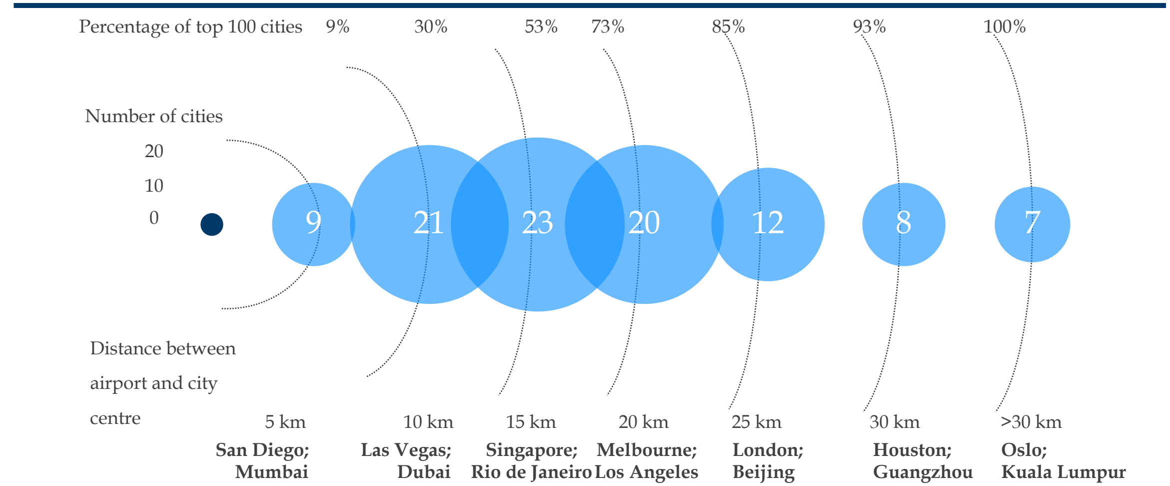


Source: Bloomberg New Energy Finance, 2017
Sole 24 Ore, Batterie al Litio, Italia in partita per una contesa da 250 milioni, Oct 2019; Sole 24 Ore, Batterie ad alta carica evolutiva, Sept 2017
European Institute of innovation and technology, 2019

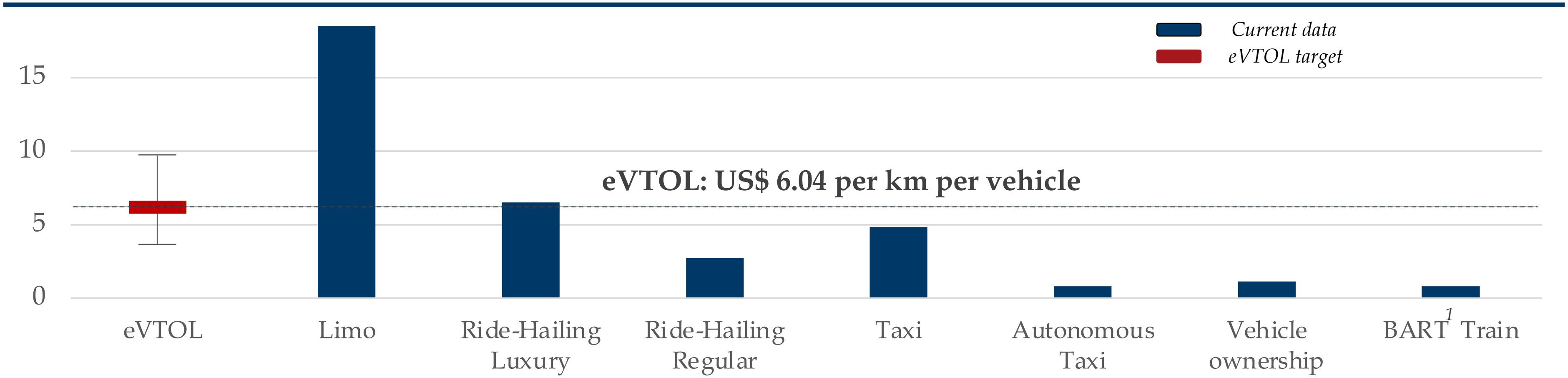
UAM – Sizing up the market

- Currently, urban mobility in large cities is dominated by public (c.40%) followed by private transport (c.33%), taxis account for c.3%
- Early adopters of air taxis likely to be airport shuttle trips (taxis), and, to a lesser extent, private transportation
- Airborne taxis could also gain from private transport (low utilization rates for cars, sharing economy) and light helicopters (safer, quieter, and less expensive)
- Technology will create latent demand
- Costs for air taxis planned to be comparable to premium ride hailing services
- Early adopters likely to be large cities more open to technological development, with a high GDP/ capita and in need for a more efficient day to day-day way of transport (eg. London, Dubai, Singapore, Shanghai)

93 out of 100 major cities have a major airport within 30km of their respective city centres



Cost will not be a key driver for air taxis – Need to be autonomous to be somewhat competitive on cost, but still not as cheap as autonomous taxis



Source: Citi research, Passenger transport mode shares in world cities (Nov. 2011)
Citi GPS, Global perspective and solutions, September 2019
Volocopter white paper, June 2019
Notes: (1) Bay Area Rapid Transit

UAM – Sizing up the market

- The combined market for inspection, goods and passenger drones and supporting services is projected to be ca. US$ 74 bn worth with passenger drones accounting for ca. half of it
- The market for urban passenger drones is estimated to reach US$ 32 bn by 2035, with intracity mobility accounting for ca. US$ 21 bn (base case)
- In the value chain for the passenger drone market, hardware will account for c.25%, whilst services (mainly on-demand transportation) will have the lion's share

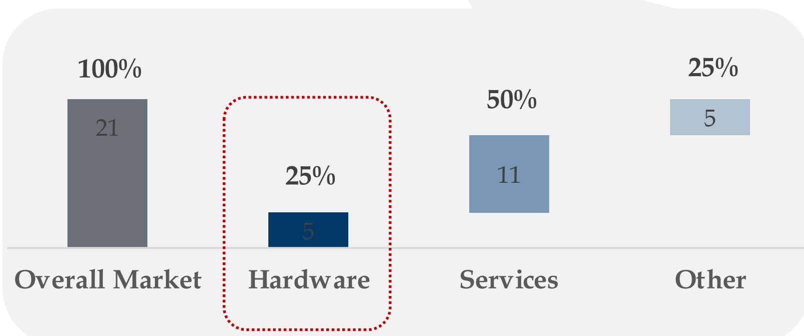
UAM Market size (2035E) – base case

Inspection: US$ 34 bn

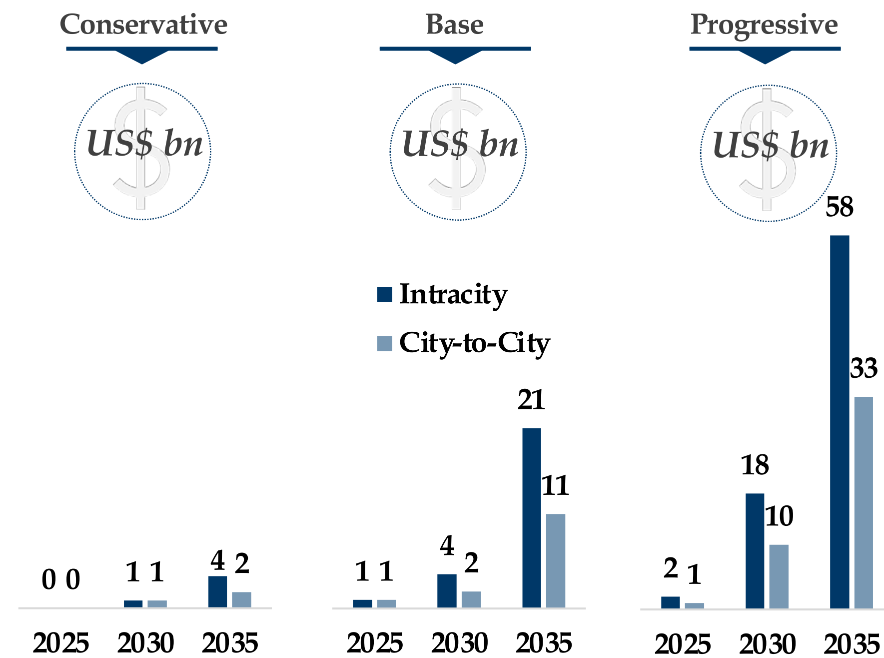
Goods: US$ 4 bn

Passenger: US$ 21 bn Intracity; US$ 11 bn City-to-city

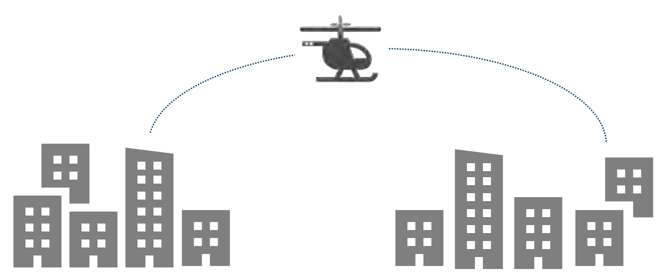
Supporting services: US$ 4 bn



Market growth according to different scenarios[1]



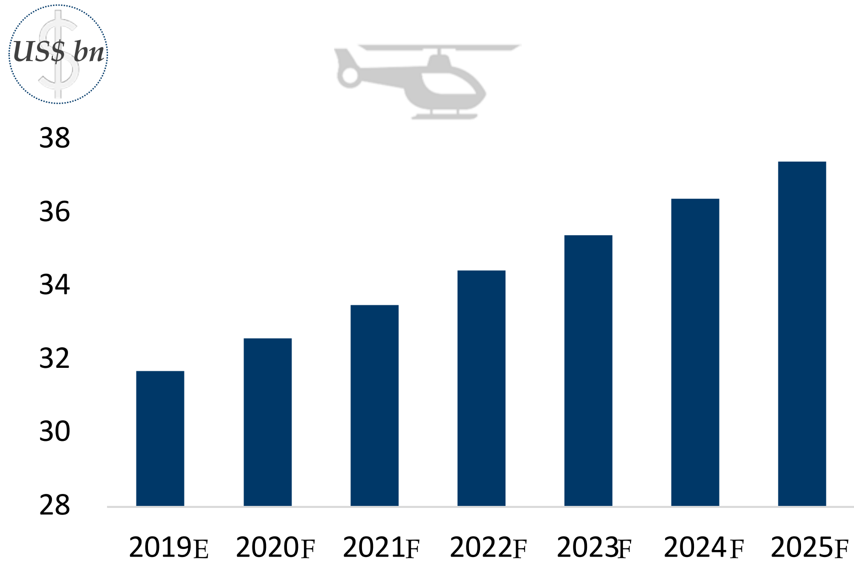
VTOL Units	Conservative 2025	Conservative 2030	Conservative 2035	Base 2025	Base 2030	Base 2035	Progressive 2025	Progressive 2030	Progressive 2035
	0	1,000	3,000	500	2,000	15,000	1,000	12,000	43,000



Source: The future of vertical mobility, Porsche Consulting, 2018
Global perspective and solutions, Citi GPS, September 2019
Notes: (1) overall market, including related services; F-Helix's focus

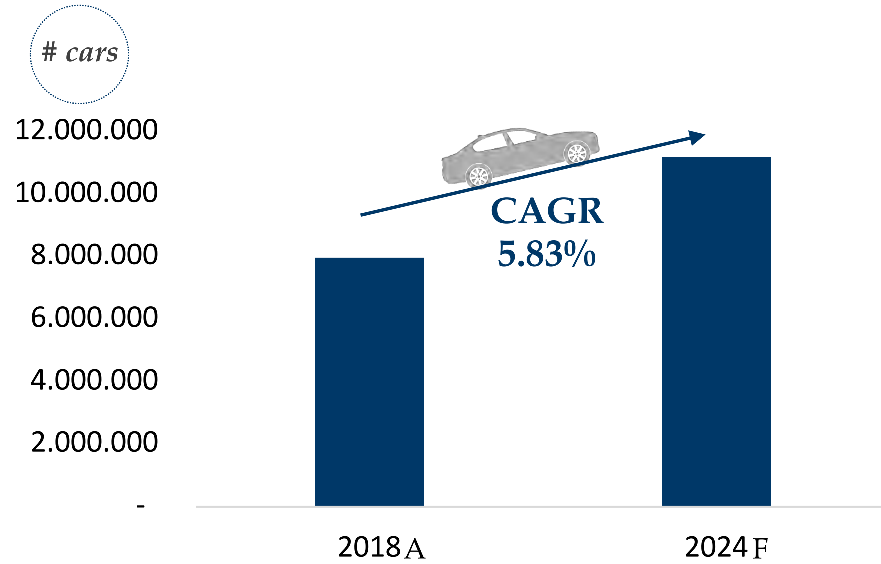
UAM – Sizing up the market

Helicopter market to grow at 2.8% CAGR between 2019 and 2025



- One of the main drivers of growth will be the increased demand for lightweight helicopters, typically bought by private individuals for civil applications
- Traditional monoturbine helicopter prices range between US$ 250,000 – 1,700,000 and they are not allowed to fly above cities
- Biturbine helicopters can fly above cities, but the prices are ranging on average between US$ 3,000,000 - 4,000,000

Increasing disposable incomes driving demand for luxury cars



- 7,956,543 cars sold in 2018 by top-6 luxury brands[1]
- Market for luxury cars forecasted to register a CAGR of about 5.8% from 2019 and 2024
- Extreme urban growth, the emergence of the megalopolis and growing environmental concerns are driving demand for alternative mobility
- Those who can afford it, will consider private aerial transportation for short urban commutes

eVTOL will cannibalize market shares which are currently domain of light helicopters and luxury cars

Source: Helicopters market - global forecast to 2025, Markets and Markets, 2019
Luxury car market – growth, trends, and forecast (2019 - 2024), Mordor intelligence, 2019
Selected luxury car brands: global sales in 2018 (in units), Statista, 2019

Notes: (1) Mercedes – Benz, BMW/ Rolls Royce, Audi, Lexus, Jaguar Land Rover, Volvo

3

Competitive landscape

Competitive landscape (1)

None of the currently existing projects has obtained Type Certification, pre-requisite for mass production and commercialisation

Project	Parties	Technology	Autorotation	Comparison to F-Helix 👍	Comparison to F-Helix 👎
Tier One Modified Robinson 	USA. Tier 1 Engineering	• All electric • Brammo Lithium Polymer batteries	✓	• Prototype available • Farthest distance travelled by electric helicopter	• Lower performance • Lower efficiency • New platform • Timing issue
Volocopter 2x 	Germany, Volocopter GmbH; supported by Intel and DG Flugzeugbau GmbH	• Completely electric • 6 Y shaped struts emanating from its axle 18 propellers and 3-phase PM synchronous brushless DC electric motors • 9 batteries	✗	• Easy to control • Simple configuration • Low development costs • Obtained Design Organisation Approval (2019)	• Inefficient in forward flight compared to eVTOLs with wings • New platform
VRCO NeoCCraft 	UK; Vehicle Redesign Company	• Electric ducted propellers fore and aft on each side • The ducts and propellers can go from vertical lift to horizontal flight mode	✗	• Probable high efficiency at low-mid horizontal speeds	• Safety • Significant development costs • New platform • Timing issue

Source: IEROM SA; eVtol.news, 2019; Volocopter GmbH website, 2019; Reuters, 2019

Competitive landscape (2)

Project	Parties	Technology	Autorotation	Comparison to F-Helix	
Karem Butterfly 	California; USA; Karem Aircraft	• Electric quad tiltrotor aircraft • Larger slow turning rotor propellers for more efficient lift, safer flight and quieter acoustics	✗	• Proven feasible tilt rotors	• Weight issue • Possible limited forward speed • New platform • Timing issue
Aurora PAV 	Virginia USA; Aurora Flight Sciences, a Boeing Company	• Eight propellers for vertical flight • A tail mounted pusher-prop for forward flight and a three-surface wing configuration for cruising • 9.14 m long, 8.53 m wide • Max. range of 80 km, carries a load of 225 kg • Max. speed180 kmh	✗	• High success chance • Fully autonomous • The aircraft crashed during the unmanned flight test in June 2019	• 1 seat • New platform • Timing issue
Ehang 216 	Guangzhou, China; EHang company	• The EHang 216 is based on the EHang 184, yet it has eight arms instead of four. This allows for the vehicle to be seat two passengers instead of just one	✗	• In 2018, made more than 1,000 manned flights	• Lower efficiency • Longest single trip: 8.8 km • New platform • Timing issue

Source: IEROM SA; eVtol.news, 2019; Volocopter GmbH website, 2019; Reuters, 2019; aviationweek.com for the Aurora PAV news

Competitive landscape (3)

Project	Parties	Technology	Autorotation	Comparison to F-Helix (pros)	Comparison to F-Helix (cons)
Vertical Aerospace Seraph 	UK; Vertical Aerospace Ltd.	• Top speed at 80 kmh • Passive cooling system • Customizable design • Can land on water	✗	• First eVTOL aircraft able to carry 250 kg	• Lower efficiency • Lower performance • New platform • Timing issue
Baykar Cezeri 	Turkey; Baykar	• Quad-copter eVTOL • Single passenger • Electric aircraft	✗	*N/A*	• 4 rotors do not provide safety • Lower efficiency • Lower performance • 1 seat • New platform • Timing issue
Lilium Jet 	DE; Lilium GmbH	• 36 all-electric ducted fans	✗	• Company know-how and experience • Completed a 240 US$ m financing round	• High-disk loading: inefficient in hover • New platform

Source: IEROM SA; eVtol.news, 2019; Volocopter GmbH website, 2019; Reuters, 2019; Lilium website, 2019

Competitive landscape (4)

Project	Parties	Technology	Autorotation	Comparison to F-Helix: 👍	Comparison to F-Helix: 👎
A3 by Airbus 	California, USA; Airbus	• Self-piloting • Fully electric • 8-prop tilt wing	✗	• Fully autonomous • Preexistent advanced algorithms for software development	• 1 seat • New platform • Timing issue
Embraer X 	Florida, USA; Dream Maker	• One high-wing with booms on the ends of the wing • Each boom has three propellers for VTOL flight • Forward flight is by a ducted fan mounted on the rear of the aircraft	✗	N/A	• Probably disk loading too low: performance not guaranteed • New platform • Timing issue
Hyundai S-A1 	South Korea, Hyundai and Uber	• 4 tiltrotor propellers for forward and vertical lift and 4 sets of stacked co-rotating propellers used only for vertical flight • One high wing • Distributed electric propulsion • Emergency parachute	✗	• Part of a US$ 1.5 bl UAV plan launched by Hyundai in Jan 2020 • Presented a purpose vehicle at CES 2020	

Source: IEROM SA; eVtol.news, 2019; Airbus website, 2020; Reuters, 2019

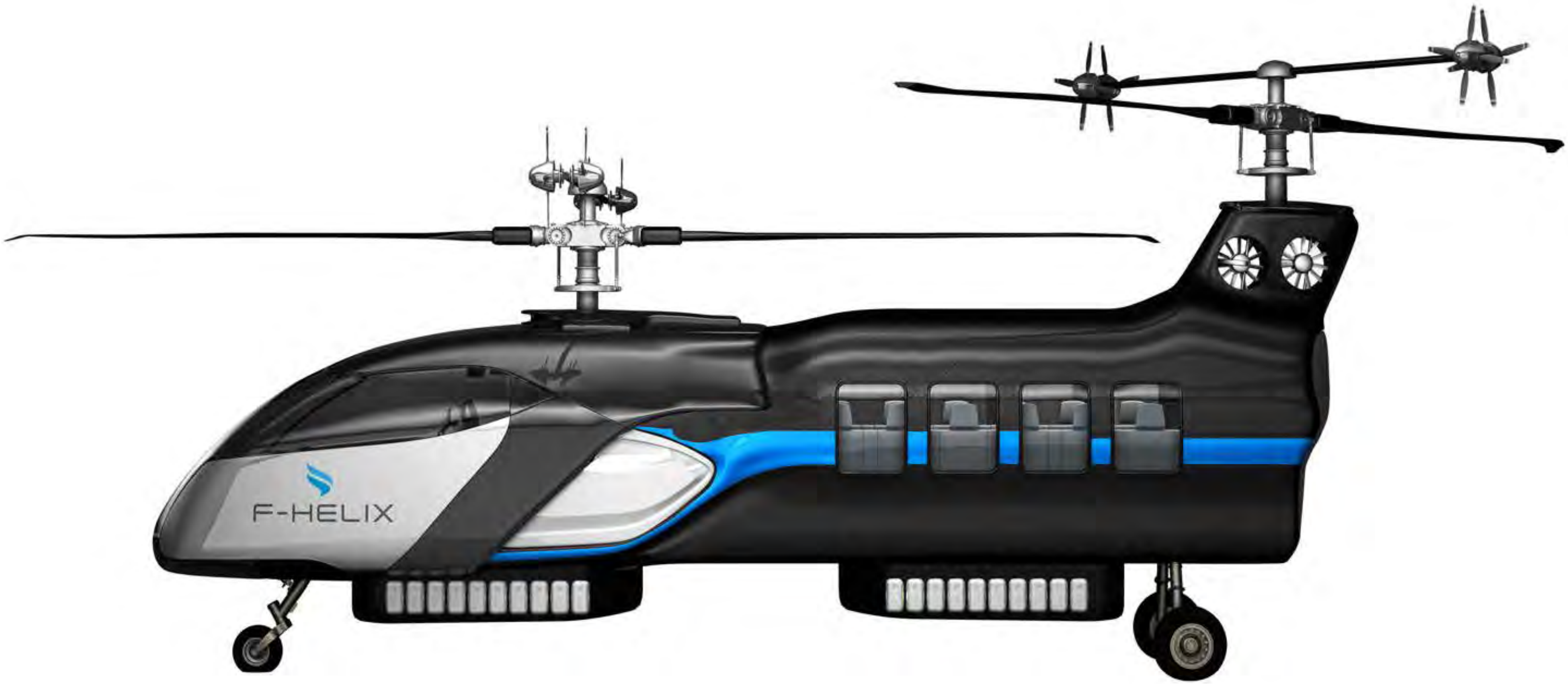
Competitive landscape (5)

Project	Parties	Technology	Autorotation	Comparison to F-Helix	
Joby S4 	California, USA; Joby Aviation	• Vectored-thrust aircraft with six tilting propellers • Distributed Electric Propulsion (DEP) System • Lithium-nickel-cobalt-manganese-oxide batteries	✗	• Successfully flown sub-scale and full scale demonstrators	• Not autonomous

Source: IEROM SA; eVtol.news, 2019; Joby Aviation website, 2019

4

Regulatory Environment



Overview

Relevant agencies and governmental authorities

Since 2003, the **European Union Aviation Safety Agency (EASA)** is an agency of the European Union (EU) with responsibility for civil aviation safety. It carries out certification, regulation, and standardisation, and also performs investigation and monitoring. It collects and analyses safety data, drafts and advises on safety legislation, and coordinates with similar organisations in other parts of the world

Created in August 1958, the **Federal Aviation Administration** (FAA) is a governmental body of the United states with powers to regulate all aspects of civil aviation in the country as well as over its surrounding international waters. Its powers include the construction and operation of airports, air traffic management, the certification of personnel and aircraft, and the protection of U.S. assets during the launch or re-entry of commercial space vehicles

Approval from one agency implies a light process for the other, because of a mutual recognition principle[1]

Source: EASA website, FAA website

Notes: (1) Bilateral Agreement between the European Union and a Third Country in accordance with Article 12 of Regulation (EC) No 216/2008

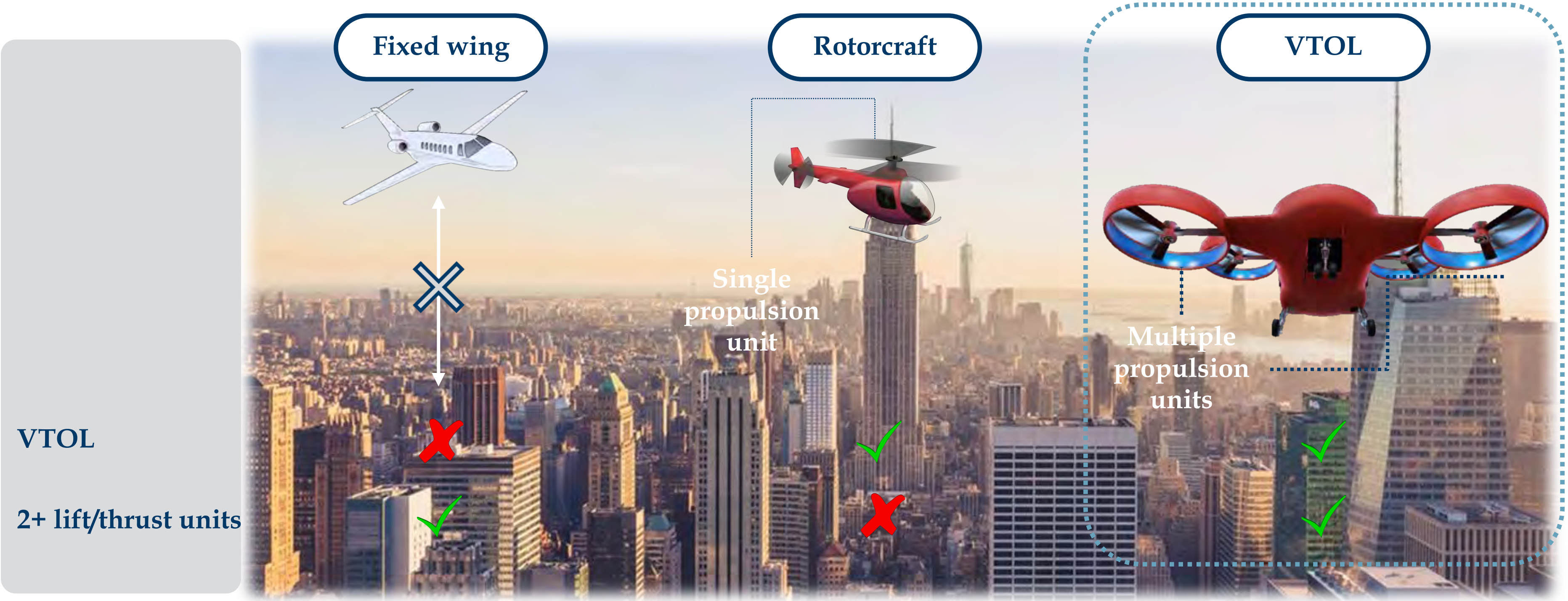
Multi-propeller VTOL special regulation

Special condition for small-category VTOL aircrafts – SC-VTOL-01

A "special condition" is applicable to Vertical take-off and landing (VTOL) aircrafts as they differ from conventional fixed-wing aircrafts or rotorcrafts because of two features:

1. Ability to **take-off and land vertically**
2. Use of **distributed propulsion**, specifically when more than two lift/thrust units are used to provide lift during vertical take-off/landing

The "special condition" – yet to be defined – will apply to VTOLs. This implies a more strict and complicated process



F-Helix is categorised as regular rotorcraft. Will have to run a simpler and faster clearance process, resulting in an abridged go-to market time

Source: EASA website; Doc. No: SC-VTOL-01, Issue: 1, Date: 2 July 2019
Notes: (1) Acceptable Means for demonstrating Compliance

Regulation for VTOL aircraft

Certifications overview

1 Design Organisation Approval (DOA)

Certifies that an organisation is compliant with the basic rulebook requirements for any aircraft certification – Part 21

2 Type Certificate

A certification applicable to a specific single aircraft concept

The DOA approval is a prerequisite to obtain a Type Certificate. Prototyping is required for the Type Certificate application under the supervision of EASA

The two above mandatory certification processes can be run in parallel

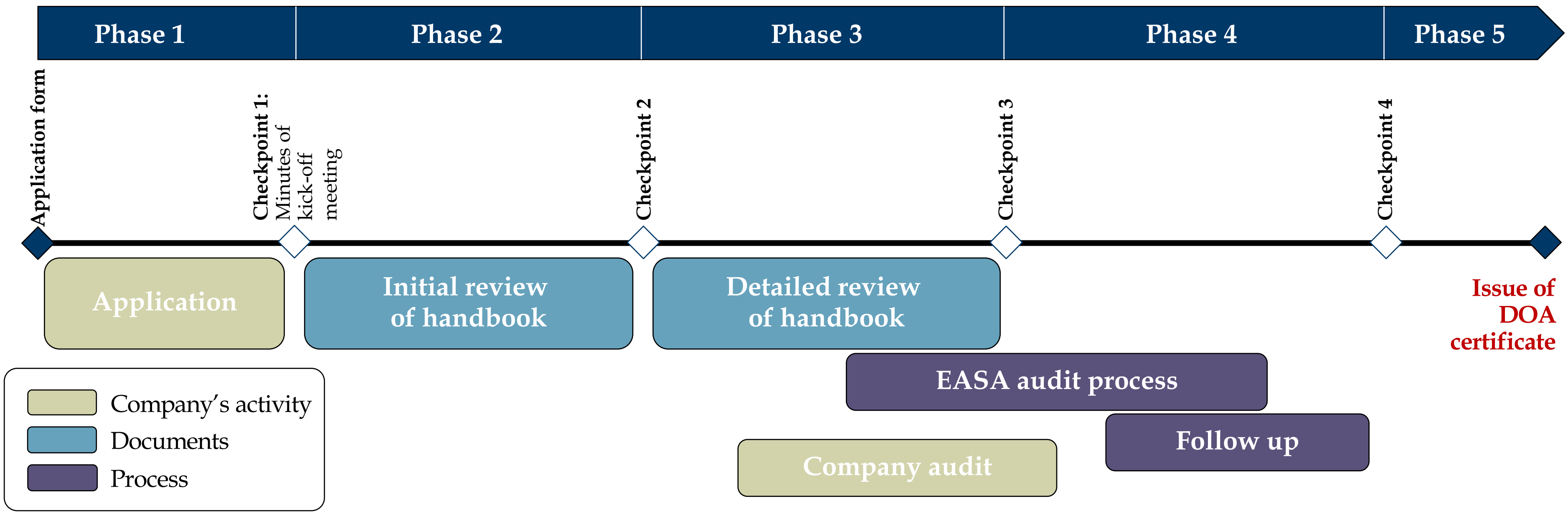
Source: EASA website; direct exchange with EASA project managers

Regulation for VTOL aircraft

Design Organisation - Process

A **Design Organisation Approval** is the recognition that a Design Organisation complies with the requirements of Part 21 Subpart J. The approval includes terms of approval defining:

- **Scope of approval:** The type of design activities including fields of expertise
- **Categories of products:** The applicable products such as large aeroplanes, engines, small rotorcraft, sailplanes, etc.
- **List of products:** The list of products for which the DOA holder is Type Certificate applicant or holder (if applicable)
- **Privileges:** A DOA holder can
  - Perform design activities within the scope of approval
  - Have compliance documents accepted by the Agency without further verification
  - Perform activities independently from the Agency
- **Limitations:** Any limitations on the above



Source: EASA website; direct exchange with EASA project managers

Regulation for VTOL aircraft

Type Certificate - Steps

1 — Technical familiarisation and Certification Basis

Project presentation to EASA. Establishment of set of rules applicable to specific aircraft type ***(Certification Basis)***

2 — Establishment of the Certification Programme

Definition of means to demonstrate compliance

3 — Compliance Demonstration

Both ground and air testing. ***Engines, Control systems, electrical systems, flight performance etc.***

Longest phase - Focus of whole process

4 — Technical closure and Issue of Approval

If technically satisfied, EASA closes investigation and **issues certificate**. EASA issues primary certification for European aircraft models which are also being validated in parallel by foreign authorities[1] *(and vice versa)*

The full process for a medium / small aircraft is expected to be fully executed within 3 years

Source: EASA website, FAA website

Notes: (1) Bilateral Agreement between the European Union and a Third Country in accordance with Article 12 of Regulation (EC) No 216/2008

International Electric Rotorcraft Manufacturers

5

F-Helix eVTOL concept

Background – the road so far

BACKGROUND

- Mr. Vinati bought the SILVERCRAFT aeronautical factory in 1990 and resumed the production of the Silvercraft SH-04, a lightweight class two bladed helicopter with a maximum take-off weight of 862 Kg and a 3 seats capacity
- F-Helix is the natural evolution of the Silvercraft SH-04
- Research agreement with the Penn State Vertical Lift Research Center of Excellence to validate the F-Helix concept and optimize the performance

6 OBJECTIVES

1. To create an eVTOL that can autorotate
2. To abate the initial cost by simplifying assembling and number of parts
3. To improve the flight characteristics
4. To reduce maintenance costs
5. To reduce noise
6. To create conditions for a green flight

F-HELIX

- A 1-6 seat, two bladed fly-by-wire electric helicopter with a maximum take-off weight of 862 kg and fewer moving parts

Source: elaboration on info. provided by IEROM SA; Performance and design optimisation of the F-Helix eVTOL concept, Penn State 2019

Specifications – CryoHelix 18 kg

DIMENSIONS	
Length	26,63 ft. / 9030 mm
Width	8,62 ft. / 3300 mm
Height	11,32 ft. / 3450 mm
Rotor Diameter	29.63' / 9.03 Mt
Rotor Disc Area	689 Sq.ft. / 64 Mq
Max Disc Loading	2.76 Lb/sq.ft. / 1.25kg/mq

WEIGHT	
Empty Fuel Cells and Tank included	992 lb / 450 Kg
Max Gross Wieght	1900 lb / 862Kg
Payload	*886 lb / 402Kg*

ENGINE	
Engine	N. 4 E-fan
Total Power E-fan	220 Kw
Max Thrust	1000 N / 212 Lbf
Yaw Fan (Directional Fan)	N. 2 Kw. 0,5+0,5

PERFORMANCE	
Max Speed At Sea Lelvel	106 Mph / 170 Kmh
Cruising Speed	87 Mph / 140 Kmh
Economic Cruising Speed	80 Mph / 128 Kmh
Max Rate Of Climb At Sea Level	1.140 Fpm
service Ceiling	13115 Ft. / 4.000 Mt
Hovering Ceiling In Ground Effect	7850 Ft. / 2.392 Mt
Hovering Ceiling Out Of In Ground Effect	5550 Ft. / 1.691 Mt

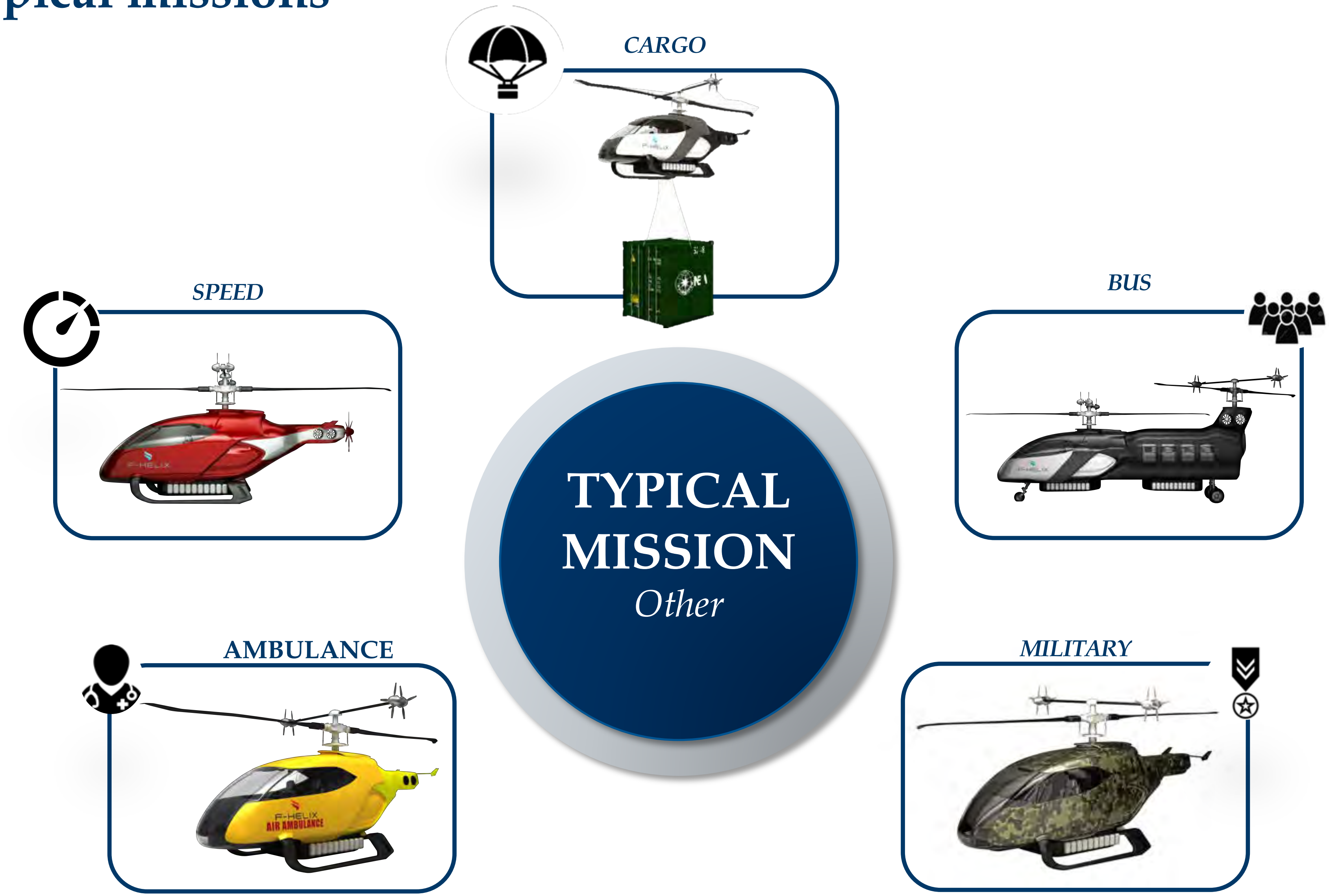
LIQUID HYDROGEN FUEL CELL BATTERY (18 Kg H)	
MAX RANGE	*609 Mi / 990 Km*
Total Power	*600 kwh*
Time for recharge	*3 min*
Flight duration	*7 hours*

Intellectual property

REF.	LP0289	LP0324	LP0351
NAME	«PROPULSION APPARATUS FOR A ROTOR WING AIRCRAFT AND TORQUE MULTIPLIER»	«PROPULSION APPARATUS FOR A ROTOR WING AIRCRAFT AND TORQUE MULTIPLIER»	«ROTATING WING AIRCRAFT EQUIPPED WITH IMPROVED PROPULSIVE EQUIPMENT»
STATUS	GRANTED	PENDING	PENDING
DURATION	20 YEARS	20 YEARS	20 YEARS
APPLICATION DATE	28.09.2017	28.09.2017	07.05.2019
ISSUE DATE	13.12.2019	N/A	N/A
COUNTRIES	ITALY	INTERNATIONAL PCT: EUROPE, USA, CHINA, JAPAN, RUSSIA, CANADA, INDIA	ITALY
DESCRIPTION	▪ Patent concerning a propulsion apparatus for a rotary wing aircraft ▪ The same apparatus may also be used in fields other than aeronautics, in particular in the field of power generation	▪ Extension of LP0289	▪ Two-bladed rotary wing aircraft ▪ Improved thrust efficiency ▪ Avoidance of undesired gyroscopic effects
PURPOSE	▪ Weight reduction by applying propulsion systems to the end of the blades ▪ To create a rotary wing aircraft that allows reduced costs compared to existing aircrafts		

Source: elaboration on info. provided by IEROM SA
Notes: all patents belong to VINATI srl

Typical missions



Source: IEROM SA

Typical Missions – CryoHelix 18 kg

UTILITY (4 seats)	Liquid Hydrogen	
Battery Pack max weight	210 kg	463 lb
Battery	600 Kwh	
Operative empty Weight	250 kg	550 lb
Gross weight	862 kg	1900 lb
Payload	402 kg	887 lb
Endurance	7 hours	
Range	980 km	609 mi

AMBULANCE	Liquid Hydrogen	
Battery Pack max weight	210 kg	463 lb
Battery	600 Kwh	
Operative empty Weight	250 kg	550 lb
Litter installation	82 kg	181 lb
Patient (one)/ (two)	160 kg	353 lb
Pilot+Assistant	160 kg	353 lb
Operative empty Weight	250 kg	550 lb
Gross weight	862 kg	1900 lb
Endurance	7 hours	
Range	980 km	609 mi

EXTERNAL CARGO	Liquid Hydrogen	
Battery Pack max weight	210 kg	463 lb
Battery	600 Kwh	
Operative empty Weight	250 kg	550lb
Pilot	80 kg	177 lb
Underslung load or spraying eq.	322 kg	710 lb
Gross weight	862 lb	1900 lb
Endurance	7 hours	
Range	980 km	609 mi

EXTERNAL CARGO DRONE MODE	Liquid Hydrogen	
Battery Pack max weight	210 kg	463 lb
Battery	600 Kwh	
Operative empty Weight	250 kg	550 lb
Automatic system	40 kg	88 lb
Underslung load or spraying eq.	362 kg	799 lb
Gross weight	862 lb	1900 lb
Endurance	7 hours	
Range	980 km	609 mi

Source: IEROM

6

iEROM
International Electric Rotorcraft Manufacturers

F-HeliX

Unique features

Unique feature 1 – Power Mast

Concept

Power mast connected to the rotor hub with 2 sets of co-axial counter-rotating propellers (e-Fans)

Features

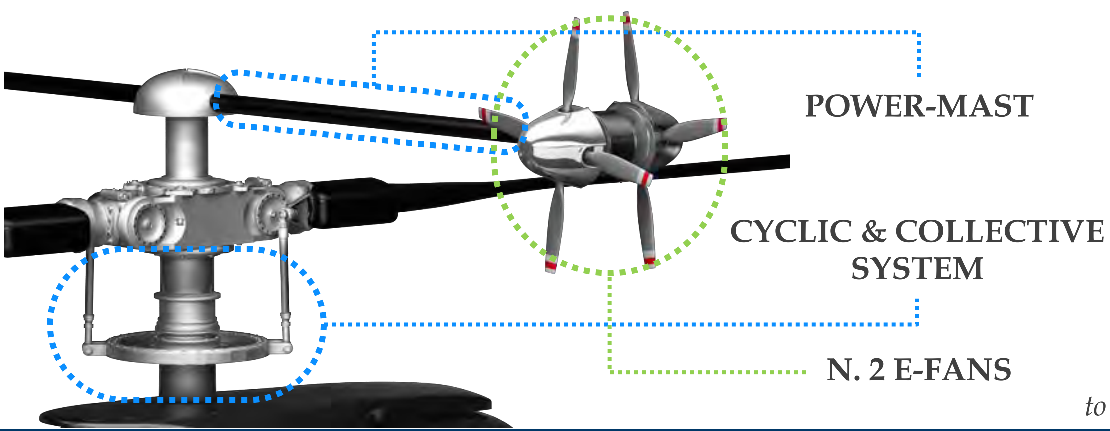
- Lift entirely generated by the two-bladed rotors
- Mounting the electric propellers on the main rotor leads to no torque exchange between main rotor and fuselage → No tail boom required reducing weight and drag
- Main transmission is eliminated → Lower airframe weight and reduced maintenance costs

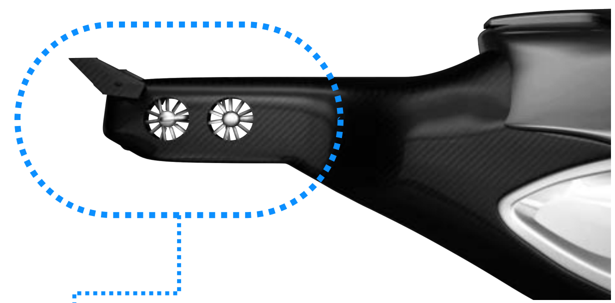
Result

- ~~Fuel Engine~~
- ~~Main Rotor~~
- ~~Tank~~
- ~~Fuel~~
- ~~Free Wheel~~
- ~~Tail Beam~~
- ~~Oil Pump~~
- ~~Oil Tank~~
- ~~Lubrification System~~
- ~~Engine Shroud~~

=

- Low Maintenance
- Low Noise
- Low Cost
- Easy to Pilot
- Green Flight
- Less Weight
- More Load Capacity
- Long Flight Duration





Electric ducted fans
to provide control and directional stability

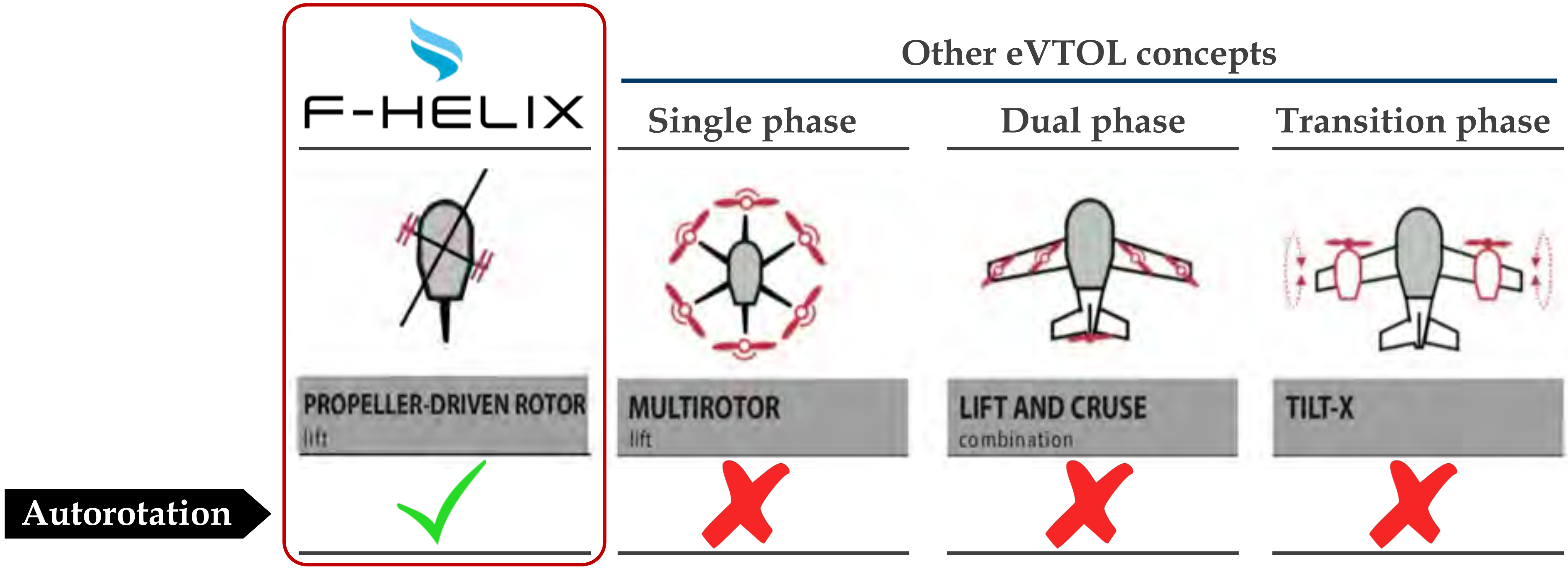
Source: elaboration on info. provided by IEROM SA; Performance and design optimisation of the F-Helix eVTOL concept, Penn State 2019

Unique feature 2 – Autorotation

Safety

Autorotation is a state of flight in which the main rotor system of a helicopter or similar aircraft turns by the action of air moving up through the rotor, as with an autogyro, rather than engine power driving the rotor

It is the means by which a helicopter can land safely in the event of a complete engine failure



Unlike most of the other eVTOL concepts, F-Helix uses a single large rotor for providing thrust, allowing it to autorotate (i.e. descend at a vertical rate that allows for the safe recovery of the aircraft in case of a loss of power)

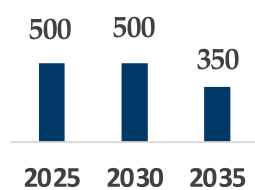
Source: The future of vertical mobility, Porsche Consulting, 2018

Unique feature 3 – Existing platform

- F-Helix is based on the existing Silvercraft SH-4 platform thus reducing initial set-up costs. Ca. 90% of previous aircraft reusable
- The data and the experience collected with SH4 allow Mr. Vinati to have a close overview of mass production details and target price for his aircraft
- The initial design has been optimized to produce the least power required while still meeting the structural and physical constraints of its components and to enhance performance

Expected VTOL unit prices[1]

US$ k



F-Helix target price[2]

ca. **260,000** *US$*

> *"With the current state of the art of liquid batteries, mission performance is in line with, if not superior to, NASA's concept vehicles for VTOL air taxi operation"*

PennState
Vertical Lift Research
Center of Excellence

Source: elaboration on info. provided by IEROM SA; Performance and design optimisation of the F-Helix eVTOL concept, Penn State 2019 ; The future of vertical mobility, Porsche Consulting, 2018
Notes: (1) according to base case scenario (see pg. 10); (2) as of start of mass production

Unique feature 5 – iTOWER and WITP Cables app

Problem

- Visual flight applications limited to the cartography of overflight areas / display of the route set by the pilot

Solution

- **iTOWER**[1]
  - The system that establishes the flight plan and warns the pilot of potential collisions or hazards with other aircrafts in flight
  - Not only allows the aircraft to be seen and to see other aircrafts but also indicates the flight altitude, ground level, speed, course and estimated time of approach to the aircraft
  - Includes a system for aircraft traffic control, able to create a real-time map of aircraft traffic and to verify on that basis the possibility of collision and, if this verification is successful, to alert aircrafts of a potential collision

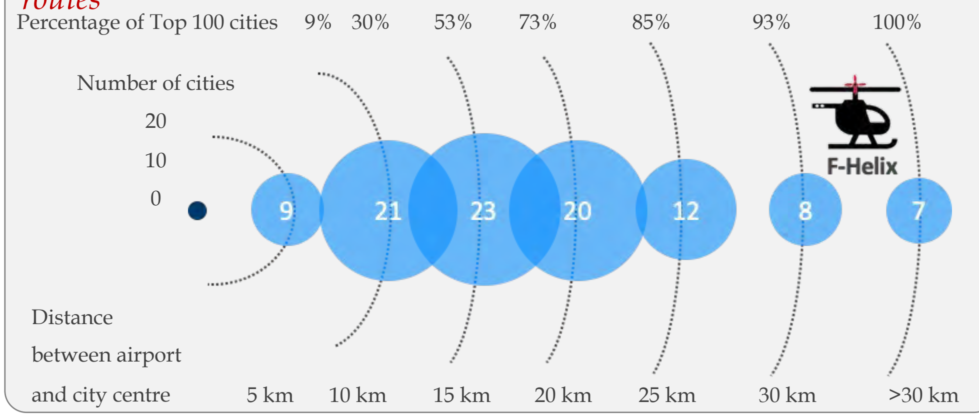
Source: IEROM SA

Notes: (1) Control aircrafts outside of VFR regulatory boundaries (Visual Flight Rules). Method implemented through RTS server (Real Time Server)

F-Helix's response to major needs for urban air mobility

Requirements		F-Helix response
Safety	VTOL needs to be as safe as any other commercial aircraft	• Four e-fan ensure redundancy • Autorotation guarantees safe recovery of the aircraft in case of a loss of power
Noise emissions	Compliance with demanding noise restrictions to achieve public acceptance and fly over urban areas	• Adoption of power mast connected to the rotor hubs and use of Blue Edge[1]- like blades result in lower noise emissions
Range & speed	Ability to cover the most populous high – traffic routes at a reasonably high speed to save time vs. alternative transport means	• Larger UAM market expected for intra-city market and airport shuttle than for intercity service i.e. for cruises of c.30 km • F-Helix can achieve economic cruising speeds of 140 km/h, well above e.g. Volocopter

F-Helix can serve the majority of airport to city centre as well as intra-city routes



Notes: (1) Blue Edge is an Eurocopter trade mark

F-Helix's response to major needs for air mobility

Requirements		F-Helix response
Operating costs	Low operating costs to offer competitively priced, scalable transportation services	Use of existing SH4 platform ▪ Less amortisation costs due to manufacturing scalability ▪ Less maintenance costs
Payload	Number of seats to achieve maximum payload	F-Helix seating (2-6 in the base configuration) allows optimisation of payload
Design for usability	Comfortable and safe onboarding, travelling and descending	Designed to provide practicability and comfort
Recharge	Fast recharge of the aircraft/ battery substitution	Completely refill the fuel cell hydrogen batteries in under seven minutes, allowing connecting flights to reach longer distances

iEROM International Electric Rotorcraft Manufacturers

F-HeliX

Promoters

7

Felice Vinati – CEO - Project ManagerInventore F-Helix
1979: Graduates with honours in Economics and Commerce at the University of Parma
1979-1988; 1995-2000; 2007-current: CEO of Vinati's family company specialized in industrial machinery
1990-1994: Producer of the Silvercraft SH4 helicopter
2014: Launches the F-Helix project as the natural evolution of the SH4
2018: After 4 years of internal development, reaches a deal with Penn State University to develop the F-Helix in a partnership with the Aerospace Engineering department
2019: Successfully presents the F-Helix project at Forum75 in Philadelphia

Giacomo Vinati – Inventore F-Helix
Computer Engineering Politecnico di Milano

Mariachiara Vinati - Inventore F-Helix
Architect and designer in Milan – Designed the F-Helix

Samuele Vinati– F-Helix Inventor
Passionate of aeronautics and coming from a long experience in the technology and software field since 2014 is managing director and member of the board at VINATI srl.

Matteo Vinati– F-Helix Inventor
Born in 1979 Matteo has a degree in economics and a 12 years experience in managing manufacturing companies.

Umberto Saetti, PhD – Member of the board of directors
Postdoctoral Fellow at Georgia Institue of Technology – Incoming Assistant Professor at Auburn University (Alabama)
Experience : Rotorcraft Flight Dynamics and Controls, Handling Qualities, System Identification - Postdoctoral Fellow, School of Aerospace Engineering, Georgia Institute of Technology (Atlanta, GA) – Penn State University

Felice Vinati

"F-Helix to become the Ford Model T of the skies"

Ruggero von Wedel - Advisor
Twenty years of international corporate finance experience with leading financial institutions providing financial advice to entrepreneurs, their companies and their families on acquisitions & divestments, capital raisings, strategic partnerships and succession management.

Fonte: IEROM SA

The enlarged team

Tech savvy and experienced team contracted

	Swiss Safety Research SA Advanced Technologies for Safety	PennState Vertical Lift Research Center of Excellence	

Presentation	• Swiss company, owned by Mr. Vinati, specialized in R&D for safety instruments
	• Able to provide unique magnetic resistant instruments that will further enhance F-Helix safety
	• Develops algorithms for safety light flight
		• Public college of the State of Pennsylvania (USA)
		• Triple function:
		  • Educational
		  • Research centre
		  • Public service
		• In charge of the research and patent development
		• Author of the Concept Project Paper (2019)
			

Contribution	• Developing iTower navigation software	• Designed and optimized F-Helix model • Developed simulation model • Ran performance simulations	Arco FC • Leading in Hydrogen Fuell Cell
Role	• Continuous scientific support	• Continuous scientific support • Acoustic simulations/ optimization	ROSSO CARBON • Engineering sCarboin Fiber

iEROM
International Electric Rotorcraft Manufacturers

F-HeliX

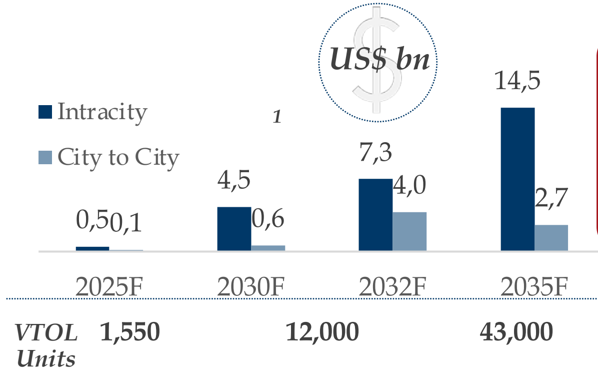
8

Next Steps

The goal

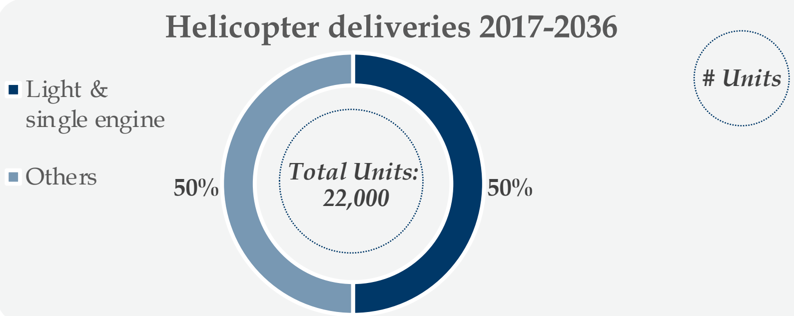
Addressable market– Three segments

Passenger eVTOL

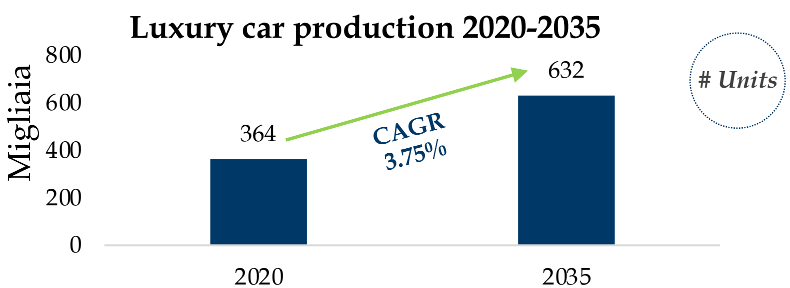


In an unconstrained scenario[2], a **US $ 57.5 bn** total market, with **200k VTOL units**, is conceivable by 2035

Helicopters



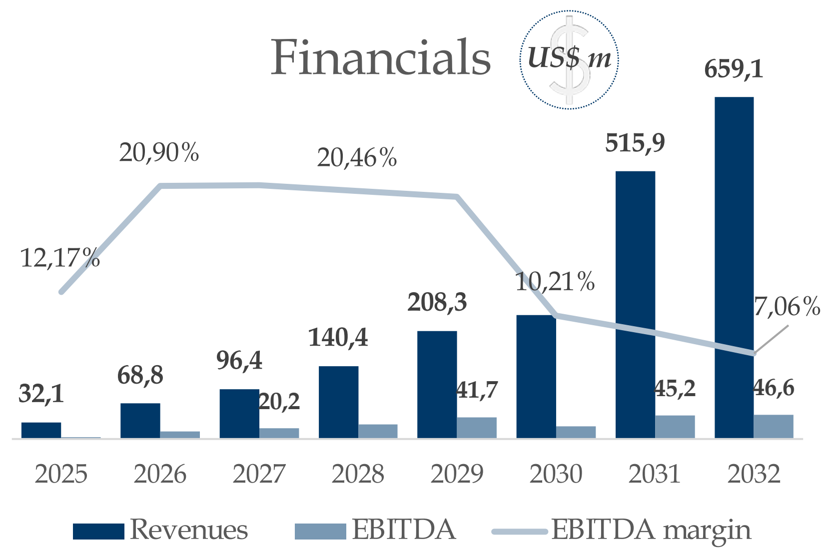
Luxury Cars



F-Helix's goal – Progressive case

2032 UAM – VTOL aircraft market[3]

UAM intracity and **City-to-city** are expected to be the **dominant segments** for F-Helix. There are also additional market shares to be won from light and single engine **helicopters** and **luxury cars**



Sources: elaboration on The future of vertical mobility, Porsche Consulting, 2018; best-selling-cars.com; global helicopter forecast, Airbus 2017
Notes: (1) the VTOL aircraft market is computed as 25% of the total UAM market (considering hardware only, see pg. 10); (2) no infrastructural problems, nor capital intensive investments to be made for the product to work properly; (3) reference to passenger UAM - Intracity and city-to-city see pg. 10

Progress to date

Milestone **1**
2018

Finalisation of initial F-Helix concept

- Acquisition of SH4 data
- Development team of 6 people
- 33k hours of development work

Investment: ***US$ 6.7m***

Milestone **2**
2019

Validation and optimisation of F-Helix concept

- Involvement of Penn State to integrate initial development team
- Successful completion of flight simulations
- 5k hours of development work
- Incorporation of IEROM SA and incubation at USI
- Scaled prototype under construction

Investment: ***US$ 1. 8m***

Seed funding[1]:	**US$ 1,282,350**
+ Not expensed development working hours & Silvercraft know-how transfer:	**US$ 7,233,360**

Source: IEROM SA
Notes: (1) CHF/US$: 1.03 (source: Morningstar 05.02.2020); includes payment to Penn State University and exhibitions

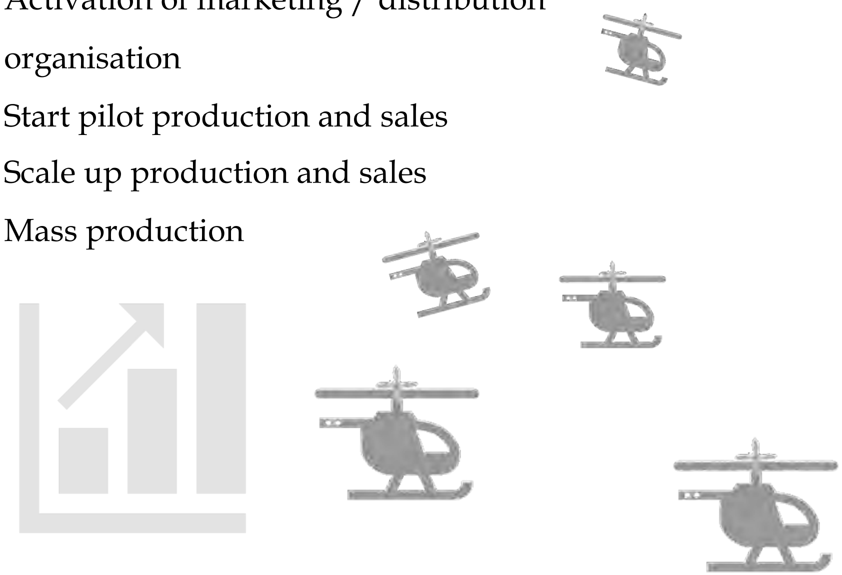
Go-to-Market

1 Prototyping / Certification
2020 - 2022

- Prototyping
- Flight tests
- EASA / FAA certification
- Identification / onboarding of manufacturing partners
- Set up of marketing / distribution organisation

2 Market entry
2022/2023

- Set up of manufacturing / assembly capabilities
- Activation of marketing / distribution organisation
- Start pilot production and sales
- Scale up production and sales
- Mass production

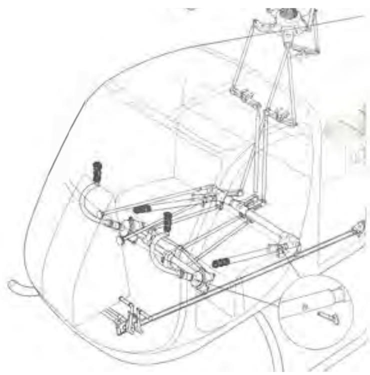


We are seeking US$ 8.0 m to complete the prototyping and certification phase

Source: IEROM SA

1 Prototyping – use of original platform

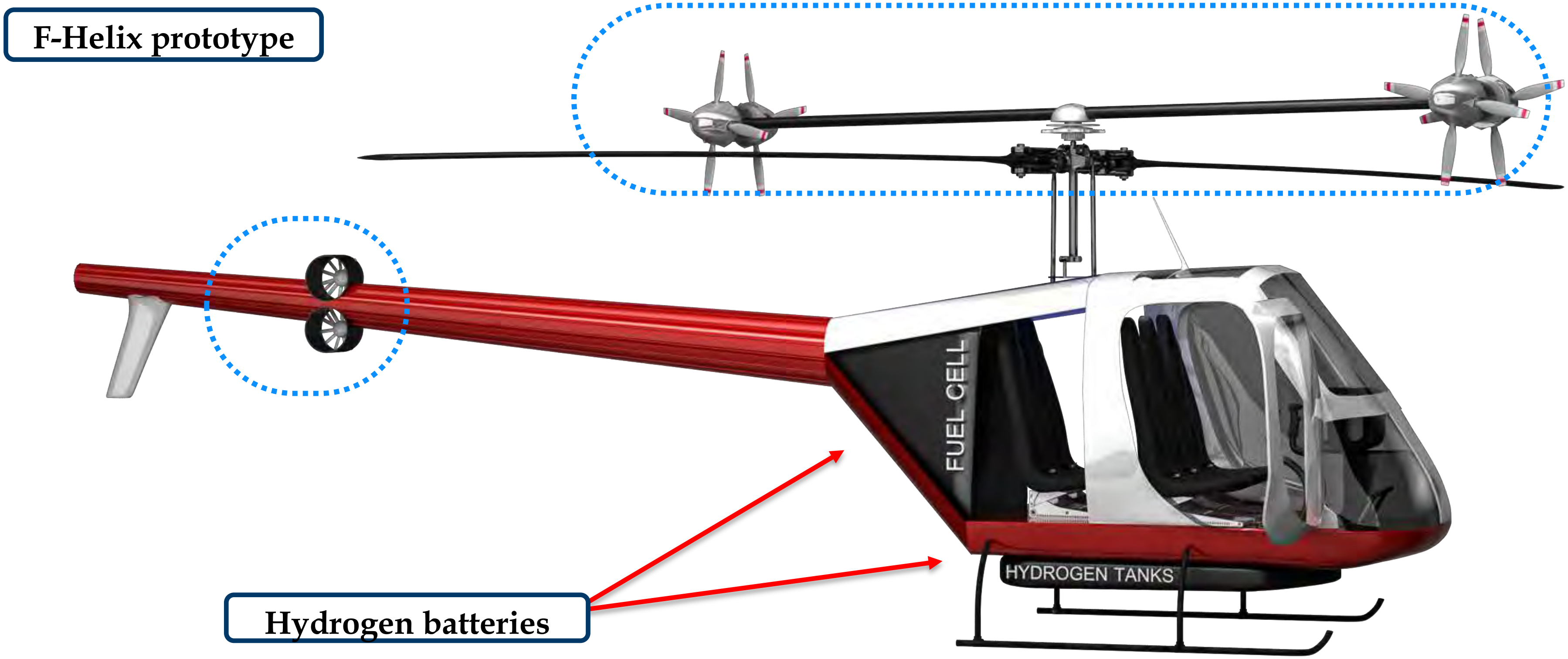
Silvercraft SH4



Maintain the original chassis, the blades, and the command box

Source: IEROM SRL

Prototyping – changes to implement



Substitute the engine, the fuel tank, and the tail rotor with the electric motor, the hydrogen batteries, and the electric deducted fans
Implement the new power mast, the e-fans, and the cyclic collective system alongside with the Penn State's control and navigation system

Source: IEROM SRL

Market entry – assumptions *1/2*

Business model

- Assumptions
  - Market driven model (mainly UAM and intercity mobility)
  - Cost assumptions provided by sponsor
  - Prototyping and Type Certification attained between 2H 2021 and 1H 2022
  - Start of production in 2H 2022 / 1H 2023
- Revenue streams
  - F-Helix units sold
  - Extraordinary maintenance: this service is due after approx. 2,000 flight hours and accounts for 60% of the purchase price of F-Helix[1]. This revenue stream kicks in starting from 2024
  - Other revenues: 2% of core revenues (customisations, discounts and rebates)

Production plant

- 3,000 sqm plant
- 705 €/sqm (759 USD/sqm)
- Investment to be faced in 2022
- Total sum: **USD 2,504,025**
- Assembly and quality control only
- Plant acquisition financed through a mortgage (80% leverage)

Equipment

- Ahead of the take-off of UAM market, the light aircraft industry's production process will be closer to the automotive industry
- Assembly equipment: **robots**
  - Costs of robots: **USD 150,000 p. u.**
  - Number of robots in facility: **10**
  - TOT: investment: **USD 1,500,000**
- Tooling: included under direct costs of production
  - **15% of total direct costs[2]**
- Acquisition financed through leasing

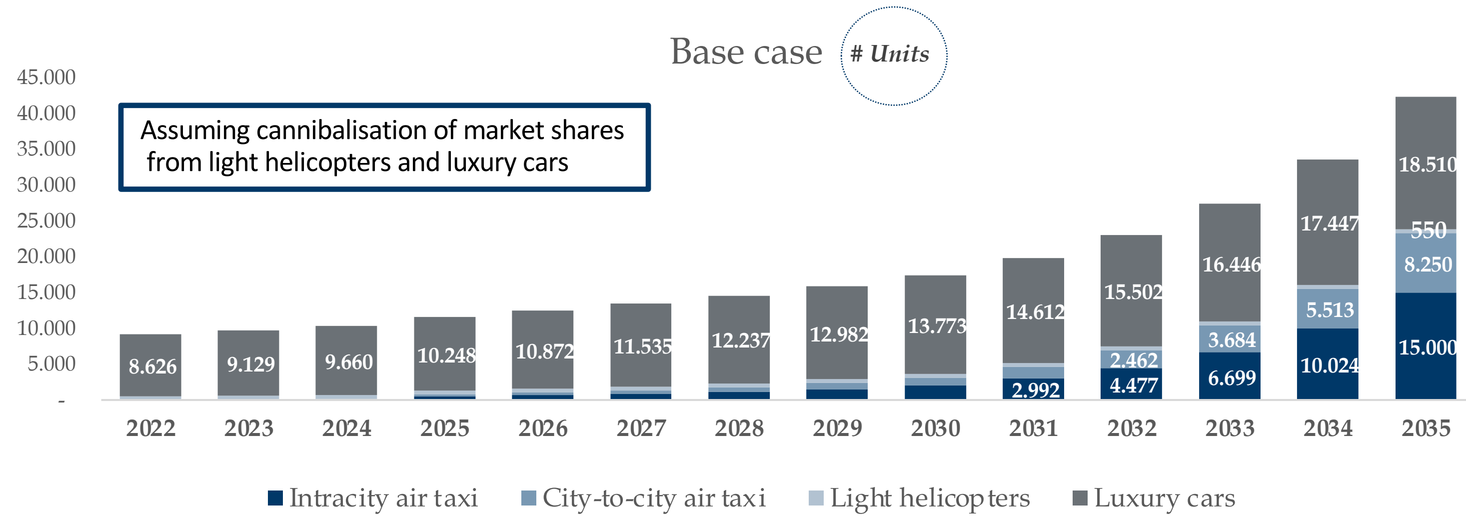
Labour

- 2022:
  - 10 employees to kick start the production
  - 1 engineer for quality control and test
- 2023:
  - 20 employees in production facility
  - 1 engineer for quality control and tests

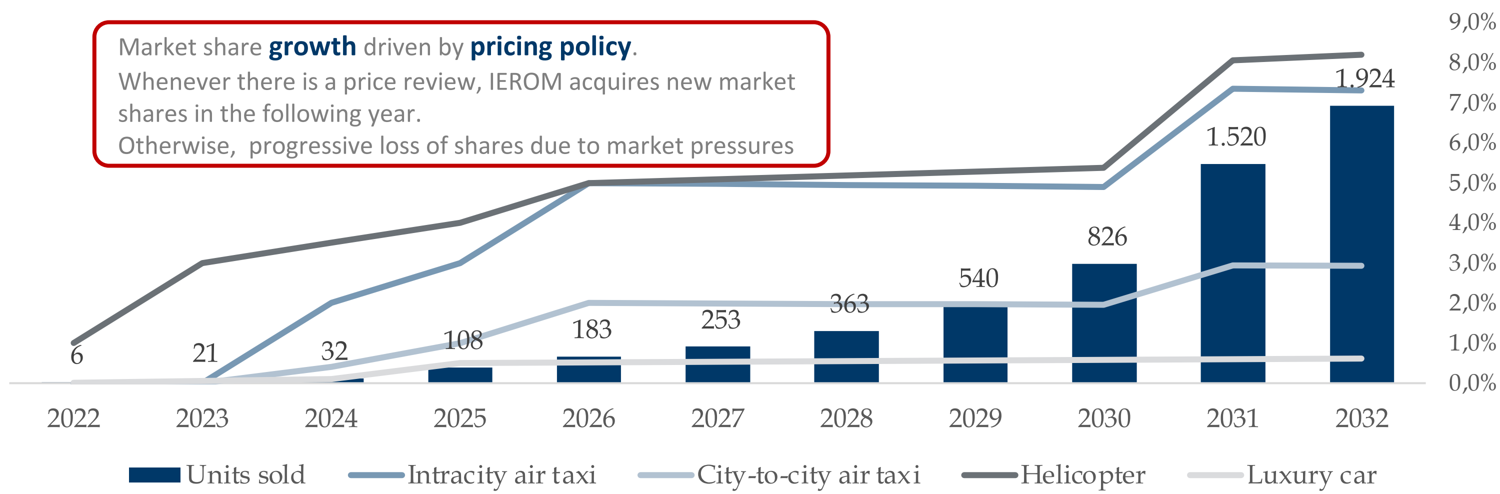
Source: elaboration on The future of vertical mobility, Porsche Consulting, 2018; IEROM SA
Notes: (1) For simplicity, this service is accounted as an increase of units sold and maintains the same gross margin as the aircraft itself; (2) excluding direct labour costs

Market entry – assumptions *2/2*

Market



Market share[1]
Base case

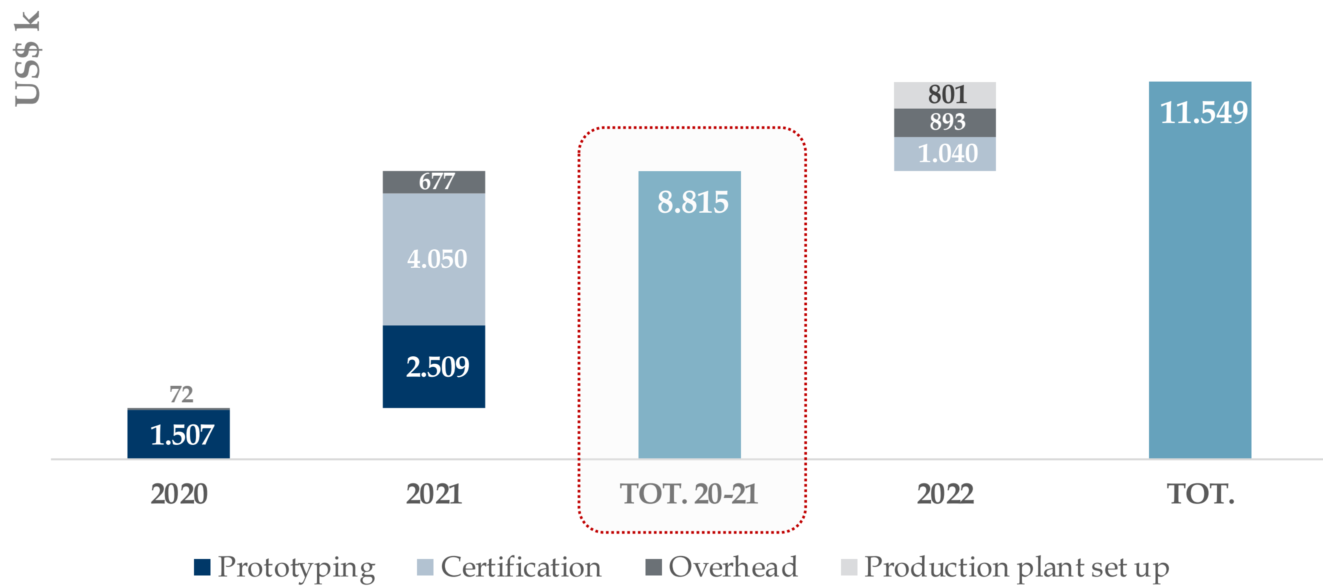


Source: elaboration on The future of vertical mobility, Porsche Consulting, 2018; IEROM SA
Notes: (1) Units sold are only new aircrafts sold, not including extraordinary maintenance service

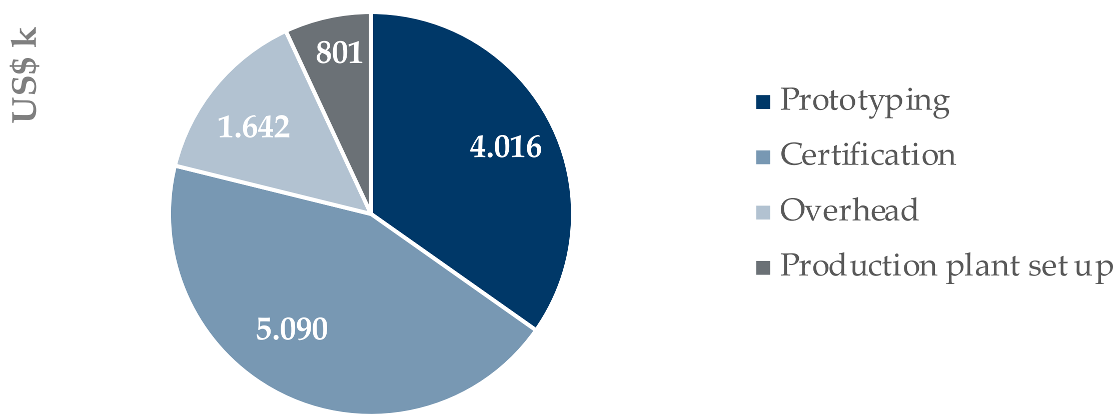
Market entry – Financial request

2

Cash burn rate[1] *USD*



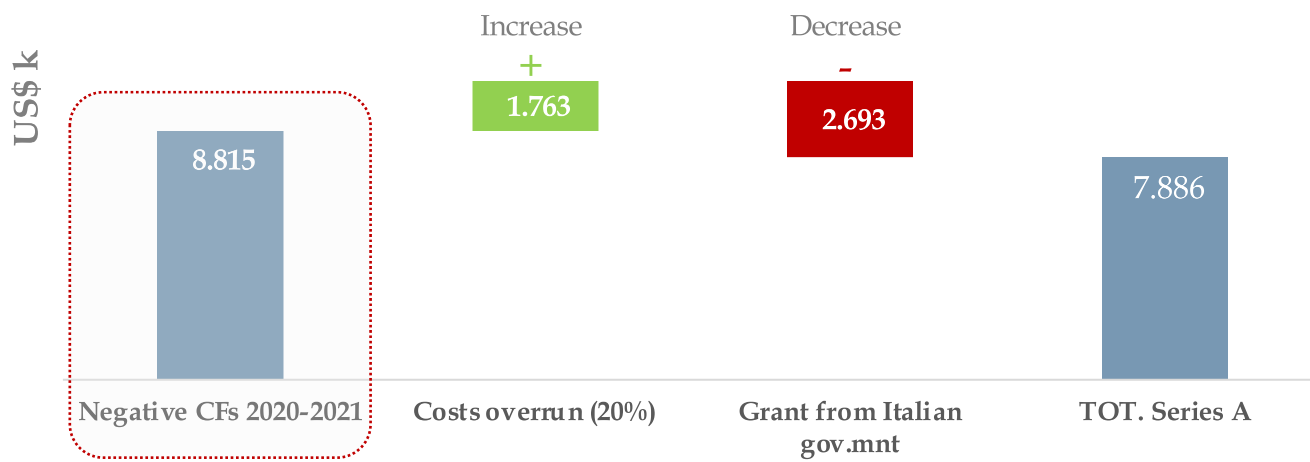
Aggregated Cash BR *2020-21*



Notes: (1) overhead include costs such as SG&A

Market entry – Financial request

Series A[1]



Valuation
USD$

Valuation methodology:

- the principle of substitution – or reproduction of the project – was used to evaluate IEROM

• Patents value:	77,250
• Penn State algorithms:	1,050,600
• Other[2]	155,000
Tot. other intangibles:	**1,282,350**

\+

• Technical design:	9,597,000
• Silvercraft data:	2,884,000
Tot. Goodwill:	**12,481,000**

=

IEROM intangibles valuation:
13,763,350
\+
IEROM cash position:
100,000

IEROM Pre-money valuation
13,863,350

Series A
7,886,000

IEROM After-money valuation

21,749,250
with a 36.3% stake investor

Notes: (1) financing round includes the possibility of receiving a grant from the Italian government for innovative start-ups in 2021 for EUR 2.5 mln. Request for 20% on top of actual cash need budgeted, this compensates for other risks, including that of receiving the US$ 2.7 mln grant. Recall: prototyping itself already includes 10% premium for costs overrun; (2) marketing material: brochures, depliant, road shows etc.

9

SWOT and Risk analisys

SWOT Analysis

STRENGTHS

- Technological innovations:
  - Use of propeller-driven rotor
  - Decoupled dynamics
  - Counter-rotating small fans providing yaw axis control
  - Hydrogen-based power units
- Autorotation capability - safety
- Initially piloted
- Existing platform
- Low cost, low price
- Shorter certification process

WEAKNESSES

- Prototyping, flight testing and certification to do
- Limited financial resources
- Limited human resources

OPPORTUNITIES

- Urbanization
- Traffic congestion
- Pollution
- Flaws of current eVTOL projects
- Improvement in battery storage capacities
- Improvement in air traffic management
- Development of supporting infrastructure

THREATS

- Competing eVTOL projects
- Emerging technologies and concepts in ground transportation
- Public perception
- Changes in social mobility
- Laws and regulations

Risks mitigants

Category	Risks	Mitigants
Relating to our business	1. Proof of technology	▪ Modular project with stop-loss milestones ▪ Experienced research and implementation partners ▪ Prototyping and flight testing
	2. Type Certification (delay refusal)	▪ Development of existing, certified platform ▪ Definition as rotorcraft to reduce timing/obstacles of certification
	3. Cost overrun	▪ Modular project with stop-loss milestones ▪ Hiring of experienced engineering project manager
	4. Time-to-market	▪ Development of existing platform ▪ Inclusion of experienced implementation partners ▪ Short certification process ▪ Cost and capex advantages
	5. Customers' acceptance and demand	▪ Safety features (initially piloted, autorotation) ▪ Development of existing platform ▪ Promotion efforts (fairs etc.)
	6. Timely production and distribution	▪ Inclusion of experienced implementation strategic partners ▪ Multi-sourcing platform ▪ Limited production depth ▪ Rifle approach
Relating to our industry	1. Approval processes for commercial use in different jurisdictions	▪ Existing platform ▪ Initially piloted ▪ Rifle approach
	2. Market reception and adoption	▪ Safety features ▪ Existing platform
	3. Development of supporting infrastructure	▪ Use of existing infrastructure initially sufficient
	4. Competition	▪ Advantage in safety features ▪ Pricing advantage ▪ Lean structure

51

Appendices

Intellectual property

Patent N.102017000108804.
International Patent Application N. PCT/EP2018/071196.
Patent Application N. 102019000006604.
Patent Application N. 102017000121411.

Altre info sul team

Intellectual property

REF.	LP0289	LP0324	LP0351	LP0326
NAME	«PROPULSION APPARATUS FOR A ROTOR WING AIRCRAFT AND TORQUE MULTIPLIER»	«PROPULSION APPARATUS FOR A ROTOR WING AIRCRAFT AND TORQUE MULTIPLIER»	«ROTATING WING AIRCRAFT EQUIPPED WITH IMPROVED PROPULSIVE EQUIPMENT»	«AIR TRAFFIC CONTROL METHOD» iTOWER
STATUS	GRANTED	PENDING	PENDING	GRANTED
DURATION	20 YEARS	20 YEARS	20 YEARS	20 YEARS
APPLICATION	28.09.2017	28.09.2017	07.05.2019	25.10.2017
ISSUE DATE	13.12.2019	N/A	N/A	22.01.2020
COUNTRIES	ITALY	INTERNATIONAL PCT: EUROPE, USA, CHINA, JAPAN, RUSSIA, CANADA, INDIA	ITALY	ITALY
DESCRIPTION	▪ Patent concerning a propulsion apparatus for a rotary wing aircraft ▪ The same apparatus may also be used in fields other than aeronautics, in particular in the field of power generation	▪ Extension of LP0289	▪ Two-bladed rotary wing aircraft ▪ Improved thrust efficiency ▪ Avoidance of undesired gyroscopic effects	▪ Application mapping all aircrafts within the area ▪ 3D mapping (also altitude) and forecast of route
PURPOSE	▪ Weight reduction by applying propulsion systems to the end of the blades ▪ To create a rotary wing aircraft that allows reduced costs compared to existing aircrafts			▪ Allow the operators to be fully aware of nearby aircrafts ▪ Notify the operators in case of possible collision routes

Source: IEROM SA
Notes: all patents belong to VINATI srl

Team – Swiss Safety Research (SSR)

SSR – Mr. Vinati's R&D hub

- Research Centre in Switzerland that develops the algorithms necessary for inertial flight platform systems
- Activity: the development of flight systems and navigation software called I-Tower

Swiss Safety Research SA
Advanced Technologies for Safety

Projects

F-Helix

Acubo

The only patented system in the world of inertial platform for the safety of transverse loads

Virtual Hook

Field of lifting system: a device based on LASER light beams. It allows the operator to always have a perpendicular reference point between the position of the hook and the load

Inertial push-button panel

Antimagnetic algorithm that generates stability inertial systems even in the presence of strong magnetic fields

Source: ssrswis.com

Team - Pennsylvania State University (PSU)

Pennsylvania State University (PSU) at a glance

- Public college of the State of Pennsylvania (USA)
- Founded in 1855 as an agricultural science college
- Triple function:
  - Educational
  - Research centre
  - Public service
- Around 44,000 students enrolled each year
- Top 1% of Universities world wide

PennState
Vertical Lift Research Center of Excellence
http://www.vlrcoe.psu.edu

PSU – Research centre of excellence

- $968 million in annual research expenditures
- Top 25 U.S. research universities

158 INVENTION DISCLOSURES RECEIVED

64 U.S. PATENTS ISSUED

8 START-UP COMPANIES FORMED

31 LICENSES AND OPTIONS EXECUTED

Sampling of major awards

- BOVINE TUBERCOLOSIS
  Bill and Melinda Gates Foundation awarded $5.55M
- BRAIN DISORDERS
  National Institute of Mental Health and the National Institute of Neurological Disorders and Stroke awarded $6M
- SEA-LEVEL RISE
  $2.3M award from the National Science Foundation
- LUNG CANCER DIAGNOSIS
  The National Cancer Institute awarded $1.98M
- **X-RAY ROCKETS**
  The National Aeronautics and Space Administration provided $ 4.12M to support studies on the use of rockets for extended source soft X-ray spectroscopy to provide information about the evolution of large-scale structures in the universe
- SAFER FUEL RODS
  $2.5M award from the US Department of Energy

Summary of major proposals and awards

$2.79B TOTAL AMOUNT OF PROPOSALS

$730M TOTAL AMOUNT OF AWARDS

4,799 PROPOSALS SUBMITTED

3,346 AWARDS RECEIVED

1,885 NEW & COMPETING CONTINUATION AWARDS RECEIVED

1,994 INVESTIGATORS RECEIVING AWARDS

967 SPONSORS

Source: Penn State annual report, 2018; psu.edu

Team – M4 Engineering

M4 Engineering - Overview

- Mechanical components
- Composite design

- Test execution & support
- Material testing and allowable developments
- Test correlation

- Aeroelastic analysis
- Structural analysis
- CFD/Flow

- Composites manufacturing
- Metallic fabrication
- Fixtures & tooling

- Multi disciplinary optimisation
- Weight reduction topology optimisation
- Composites (optimisation)

M4 Engineering - Partners and projects

BOEING
JACOBS
GE Aviation
U.S. AIR FORCE
NASA
NAVY
Uber
NORTHROP GRUMMAN

Source: m4-engineering.com

UAM – Use Case *Air Taxi*

	Characteristics	Comments
Vehicle	2- to -5-passenge autonomous (unpiloted) VTOLs[1]	▪ High investment costs will make a wide spread air taxi market with ubiquitous vertiports unlikely before 2030 ▪ Opportunities: concentrated areas of HNWI / Business corporate users
Payload	~402 kg	
Distance	~15-500 km per trip	
Scheduling and routes	Routes are unscheduled and unplanned and are likely to be different each time	
Infrastructure	Very large density of vertistops on or near buildings to create a "door-to-door" service; charging stations; service stations; UTM[3]	
Technology	Requires improved battery technology, autonomous flight, detect-and-avoid (e.g., LiDAR[4], camera vision), electric propulsion, and GPS-denied technology	
Potential regulatory UTM[3], **requirements**[2] restrictions, operator restrictions	Significant OEM[5] requirements for air worthiness, BVLOS[6], flight above people, weight and altitude certification, identification, environmental	
Competing technology	Human-driven cars (personal vehicle, ride-hail/taxi, rideshare), driverless cars (personal vehicle, ride-hail, rideshare), commuter rail, subway, bus	

Source: Nasa Urban Air Mobility report, 2018

Notes: (1) Vertical Take-off and Landing; (2) Regulatory requirements are likely to range across use cases depending on risks (for example, delivery case may have less stringent airworthiness requirements than air taxis); (3) unmanned traffic management; (4) Light Detection and Ranging, (5) Original Equipment Manufacturers; (6) Beyond Visual Line of Sight

UAM – Use Case *Air Metro*

	Characteristics
Vehicle	2-5 passengers autonomous (unipiloted) VTOLs
Payload	~402 kg
Distance	~15-900 km per trip
Scheduling and routes	Routes are predetermined and scheduled well in advance of flight time
Infrastructure	~100-300 vertiports per MSA[1] located in high-traffic areas capable and of handling ~3-6 VTOLs at once (on average); charging stations; service stations; UTM
Technology	Improvements in battery technology, autonomous flight technology, detect-and- avoid (e.g., LiDAR, camera vision), electric propulsion, GPS-denied technology
Potential regulatory requirements[2]	Development of air worthiness standards, UTM, flight above people, weight and altitude restrictions, BVLOS, operator certification, identification, environmental restrictions
Competing technology	Subway, bus, bike, rideshare, driverless cars (personal vehicle, ride-hail, or rideshare)

Comments

- Expected to be profitable by 2030, assuming regulations in place
- Larger scale “entry into service” may occur previously
- Piloted services may be a stepping stone to large scale autonomous operations

Source: Nasa Urban Air Mobility report, 2018
Notes: (1) Metropolitan Statistical Areas

UAM – Use Case *Private Individuals*

	Characteristics	Comments
Vehicle	2-5 passengers autonomous (unipiloted) VTOLs	▪ Potential entry point with HNWI / businesses in densely populated areas ▪ Novelty factor
Payload	~402 Kg	
Distance	~15-900 Km per trip	
Scheduling and routes	Routes are unscheduled and unplanned and are likely different each time	
Infrastructure	In addition to the public infrastructures (vertiports, charging stations, service stations, UTM); HNWI[1] could use private or premium facilities	
Technology	Improvements in battery technology, autonomous flight technology, detect-and- avoid (e.g., LiDAR, camera vision), electric propulsion, GPS-denied technology	
Potential regulatory requirements	Development of air worthiness standards, UTM, flight above people, weight and altitude restrictions, BVLOS, operator certification, identification, environmental restrictions	
Competing technology	Human-driven transportation (luxury car; chauffeur; helicopter); driverless cars (personal vehicle)	

Source: Nasa Urban Air Mobility report, 2018
Notes: (1) High Net Worth Individuals

Last-mile delivery

	Characteristics
Vehicle	Small UAS
Payload	402 Kg
Distance	Within – 15 Km roundtrip
Scheduling and routes	Deliveries are unscheduled and routes are determined as orders are received
Infrastructure	Receiving vessels, distribution hubs, docking/charging station UTM
Technology	Improvements in battery technology, autonomous flight technology, detect-and-avoid (e.g. LiDAR, camera vision), electric propulsion, GPS-denied technology - WITP Cables iTower
Potential regulatory Requirements[1]	BVLOS (Beyond Visual Line of Sight), air worthiness, UTM, flight above people, altitude restrictions, operator certification, identification, environmental restrictions
Competing technology	Autonomous and human driven ground delivery services (e.g., FedEx, UPS, Amazon Prime), courier services, AGV lockers, droids

Last-mile delivery is rapid package delivery from local distribution hubs to a receiving vessel. Deliveries are unscheduled and flight times are determined as orders are placed

Source: Nasa Urban Air Mobility report, 2018

[1] Regulatory requirements are likely to range across use cases depending on risks (for example, delivery case may have less stringent airworthiness requirements than air taxis

International Electric Rotorcraft Manufacturers

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Headquarters:
Via la Santa, 1
6962 Lugano – Viganello TI Svizzera
c/o Centro Promozione Start-Up
Azione dell'Università della Svizzera Italiana,
Campus EST Lugano
Registry Number: CHE-170.065.040
Phone: (+41) 764832537

CEO:
fv@ierom.com
Member of Board:
sv@ierom.com
Member of Board:
mv@ierom.com
Advisor:
rvw@ierom.com