

helix

# Advancing the future of aerospace electrification



Powertrain Advantage





# The aviation industry is taking significant strides toward electrification as the world seeks greener, more sustainable mobility options.

The shift from traditional internal combustion and turbine powerplants to electric propulsion is gaining momentum, promising a future of cleaner, more efficient flight. Helix is leading the way among the pioneering electric powertrain manufacturers.

As part of Middle Ground Capital, Helix combines cutting-edge motor and inverter technology with aerospace transmission expertise (Zoerkler) and advanced control software (New Eagle), further strengthening our capability in the aerospace electrification arena.

Aviation is perhaps the most difficult industry of all to decarbonise. Yet there is an indomitable determination among OEMs, operators and technology developers to achieve net-zero. Electric propulsion will play a critical role within a portfolio of solutions, and Helix, through its lightweight, power-dense motors and advanced inverter technology, is a leader in the field.



# Key questions

Why should aviation adopt electric propulsion?

Electric propulsion promises to reduce aviation emissions and noise pollution, making it a compelling choice for general, commercial and advanced air mobility applications. The power behind the emergence of eVTOL aircraft, electric propulsion, is already driving a new generation of training aircraft and is set to revolutionise short-haul flying with airliners up to around 19-seat capacity.

Is electric aviation practical?

Electric propulsion technology in aircraft shares commonalities with electric drives used in high-performance cars. Helix's experience in high-end automotive and motorsport applications therefore places it at the forefront of this burgeoning requirement. Electric light aircraft are already operational and training the next generation of pilots.

Are electric propulsion systems reliant upon heavy batteries?

Electric propulsion units are energy agnostic. This means that while power may be supplied by batteries, other sources of electrical power, including hydrogen fuel cells and turbogenerators, are also compatible with Helix electric power units. Airframes can be designed for drop-in replacement of power sources without disrupting the powertrain, futureproofing them as electrical generation/storage solutions evolve. A nine-seat commercial aircraft mission can be delivered for 10% of the conventional fuel burn by using Helix EPU's and current turbo-generator and battery technology.

What is an electric propulsion system?

Aircraft electric propulsion systems include electric motors, power electronics and associated control systems, supplied with electricity by an energy storage system. Energy may be stored in batteries, or derived from hydrogen fuel cells, a turbogenerator or other device.

## Conclusion

The International Civil Aviation Organisation (ICAO) has called for net-zero commercial aircraft operations by 2050. Electrification is critical to aviation achieving this goal. The performance demands of high-end automotive and motorsport electrification have provided Helix with a solid foundation from which to introduce its unique electric propulsion technology to the aerospace sector. Helix recognizes the stringent requirements of aerospace products and is conducting rigorous fault analyses to bring our high-performance powertrains to production.

# Aviation electrification

Helix's core technology centres around a radial flux, concentrated winding, surface permanent magnet motor. This design places magnets on the surface of the rotor, offering a high-performing, low air-gap solution. The concentrated wound stators provide flexibility in designing tailor-made motor windings.

Helix's technology is also engineered for easy scalability. Increasing the length of the motor proportionally increases torque, providing a solution easily optimised to customer needs. It is a clear advantage Helix technology has over axial-flux architectures, which are less efficient in scaling power and operating at high speeds.

In addition to motor development, Helix is exploring high-speed generator technology, which enables hybrid propulsion systems to help close the technology gap for electric powered product introduction. This work is being conducted under an eVTOL technology demonstration contract.

## X-Division

Helix's X-Division was created to take premium customers on a journey beyond Scalable Core Technology, towards exclusive, advanced electric powertrain solutions for tomorrow's most challenging opportunities. Evolving Helix DNA to provide future powertrain advantage.

At X-Division, today's impossible becomes tomorrow's reality, a process recently proven with the Direct Drive Scalable Aerospace Electric Propulsion Demonstrator – designed, built and tested in partnership with the Midlands Aerospace Alliance and supported by the University of Nottingham's Unlocking Potential aerospace funding.

Aerospace applications require high continuous power. Helix excels at designing and manufacturing motors suitable for high continuous output, arguably from the world's most power-dense machines.



Helix through shaft motor with integrated coolant pump for tandem drives

# Advanced inverter technology

Sitting between the energy store and motor, the inverter is an essential component in any electric propulsion unit. Helix has developed its own high efficiency inverters.

With high-performance water cooling and proprietary control software, they deliver optimised output. Combined, Helix motor and inverter technology delivers reliability, dynamic performance and extended real world battery range.

For commercial aerospace applications Helix has a strategic partnership with a world leading aerospace systems provider. This partnership provides aerospace pedigree to deliver certification ready powertrain solutions to meet your programme timing.

Helix are actively engaged with customers to define the requirements for the next generation of aerospace inverter technology.

## Features

- 1200V Silicon Carbide power stage
- Proprietary inverter & motor control algorithm
- High velocity direct water cooling
- Aluminium housing

## Benefits

- Continuous maximum performance
- Maximum efficiency
- Long battery range
- Light weight
- Robust, reliable



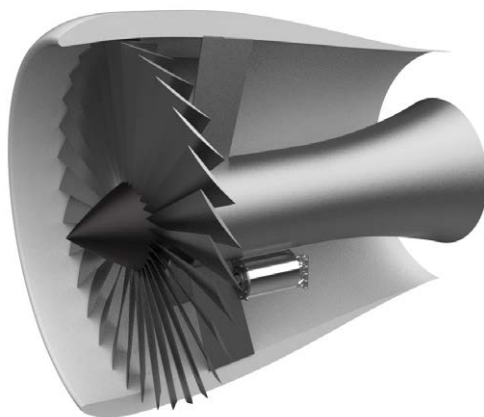
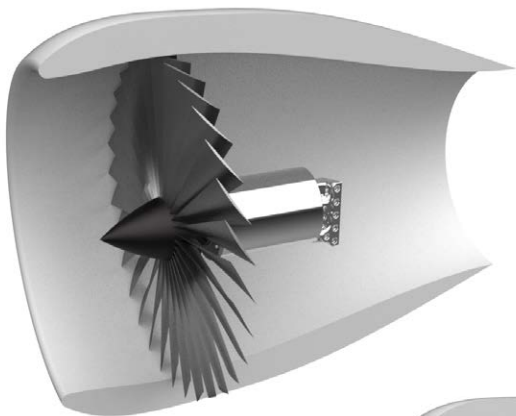
# Propulsion architecture

Helix electric motor technology can deliver multiple megawatt continuous power delivery for significantly lower mass than a conventional gas turbine power unit. Combining these motors with efficient ducted fan propulsion technology also delivers significantly more thrust per kW of shaft power than open propellers.

Conventionally, efficient ducted fans (high-bypass-ratio gas turbines) are reserved for high cruise speed aircraft because the combustion process benefits from stagnation pressure created at the duct inlet. For this reason, lower speed aircraft tend to use open propellers. Electric propulsion breaks this convention, enabling efficient ducted fans to be used on lower speed aircraft.

However, current energy storage solutions for large commercial flights are limiting the adoption of electric propulsion above the Megawatt power level. This is because the increased power to cruise with the added mass of the energy store onboard limits the break-even range of such flights to an impractical level.

An excellent application of these high-power motors on large commercial flights is to augment the traditional gas turbine power during the take-off and climb phases of the flight mission. In this way the overall fuel burn for the mission is reduced and the gas turbine can be further optimized for the cruise phase.



Helix Motor Platform

Max Power kW

Max Torque Nm

Mass kg

Speed rpm

Max Power Density kW/kg

SPM236e

3,000

1,658

62.7

22,000

47.85

# Advanced air mobility EPUs

Helix geared electric power units deliver the same power and high prop-shaft torque as our direct-drive motors, but at a lower mass, approximately half the diameter and with higher overall efficiency.

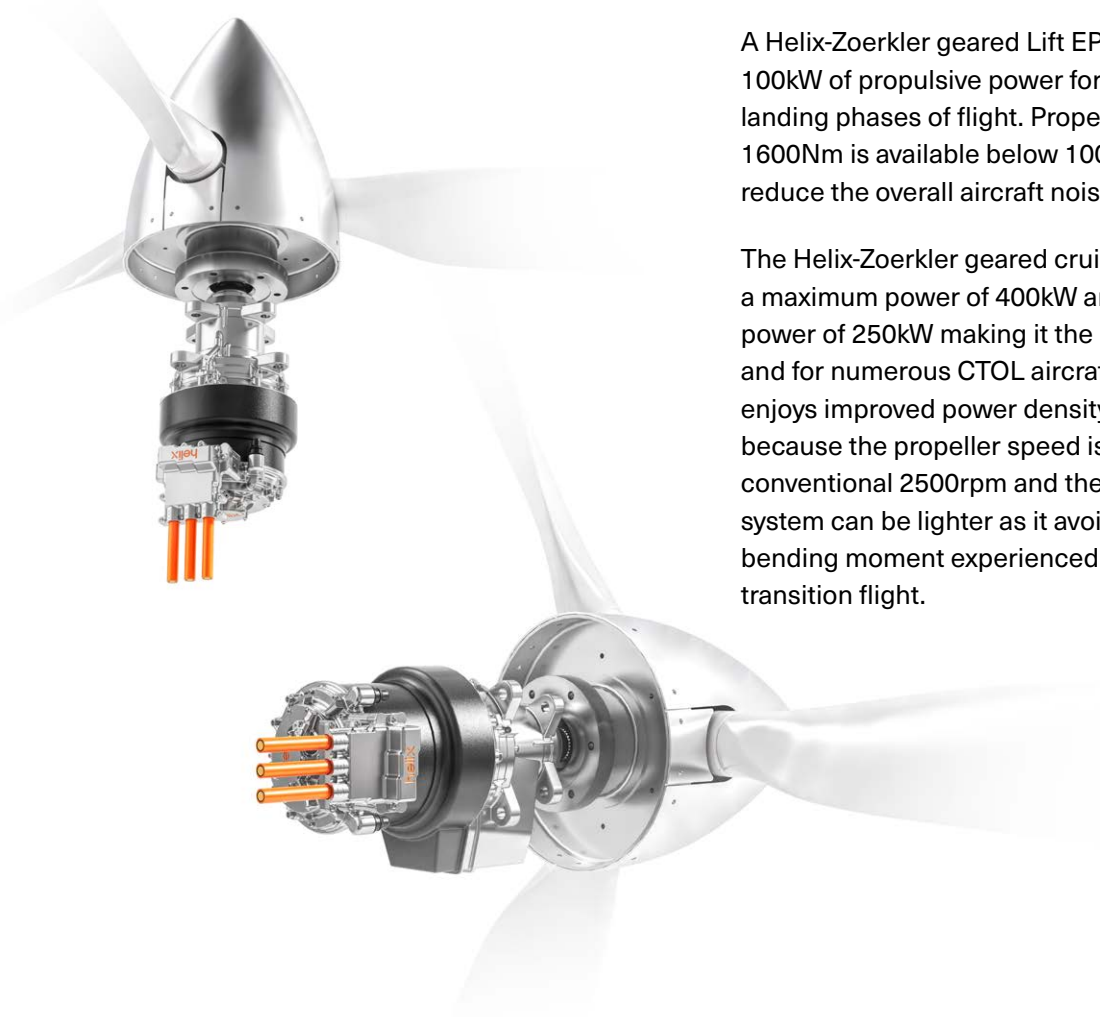
This mass saving directly improves mission range by enabling an increased capacity energy store to be carried on the aircraft. The smaller diameter improves range by reducing the drag force during cruise and provides a compounded mass saving on the airframe because the nacelles can also reduce in diameter.

Helix can deliver lift, cruise or tiltrotor geared power unit options with a transmission efficiency greater than 98% due to our oil-jet lubrication design. In fact, Helix geared electric power units boast improved overall efficiency over our direct-drive power units because motor efficiency at high-speed (low-torque) is so much better than the direct-drive option, it more than pays for the modest transmission losses. Improved EPU efficiency uses less energy during cruise and so further increases mission range.

Zoerkler designed eVTOL power unit transmissions enable the integration of oil pumps and cooling systems within the motor design. This approach provides the lightest, most compact, and airframe-friendly power unit possible.

A Helix-Zoerkler geared Lift EPU can deliver over 100kW of propulsive power for the take-off and landing phases of flight. Propeller torque up to 1600Nm is available below 1000rpm which helps to reduce the overall aircraft noise signature.

The Helix-Zoerkler geared cruise EPU can deliver a maximum power of 400kW and steady-state power of 250kW making it the ideal choice for AAM and for numerous CTOL aircraft. The cruise EPU enjoys improved power density over the Lift EPU because the propeller speed is increased to a more conventional 2500rpm and the propeller bearing system can be lighter as it avoids the huge prop-shaft bending moment experienced by the lift units in transition flight.



Helix Motor Platform	Peak Power kW	Continuous Power kW	EPU Assembly Mass kg	Peak Power Density kW/kg	Continuous Power Density kW/kg
Lift EPU	200	140	32	6.3	4.4
Cruise EPU	400	250	40	10	6.3

# High power starter generator unit

Helix-developed automotive traction motors are also finding their place in aerospace applications as high-continuous-power generator units (with engine start functionality).

These Motor Generator Units (MGUs) can supply continuous power up to 650kW @20,000rpm depending on vehicle DC bus voltage. These are amongst the highest power density motors produced by Helix boasting 25kW/kg.

These motors are also finding application in the space sector as oxidizer pumps for larger rocket motors. Hardware demonstrator units will be tested later this year.



Helix Motor Platform	Max Power kW	Continuous Power kW	Mass kg	Speed rpm	Max Power Density kW/kg
SPX177	711	660	28.3	25,000	25.12

# 100kW high-speed motor

Using high-performance electric motors to power oxidizer and fuel pumps on the next generation of space vehicles provides significant operational and performance benefits.

Traditional turbine pumps are complex, heavy and difficult to control during the critical start-up sequence. Thrust control during the flight is also more difficult than with electrically powered pumps.

Battery mass is minimal due to the very short mission duration, enabling current battery technology to support new vehicle introduction.

Running the oxidizer or fuel pumps at higher speeds can offer further mass savings for the same pumping power.

Helix has been delivering high-power 130,000rpm electric motors in volume turbine applications for over a decade.

These light-weight high-speed motors provide the perfect drive for air compressors for secondary flight systems such as cabin air or blown wind drag reduction without the need to bleed air from the engine compressor.



Helix Motor Platform	Max Power kW	Max Torque Nm	Mass kg	Speed rpm	Max Power Density kW/kg
SPX84	100	15	4.6	125,000	22

Helix: Engineering the Future of Flight.

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