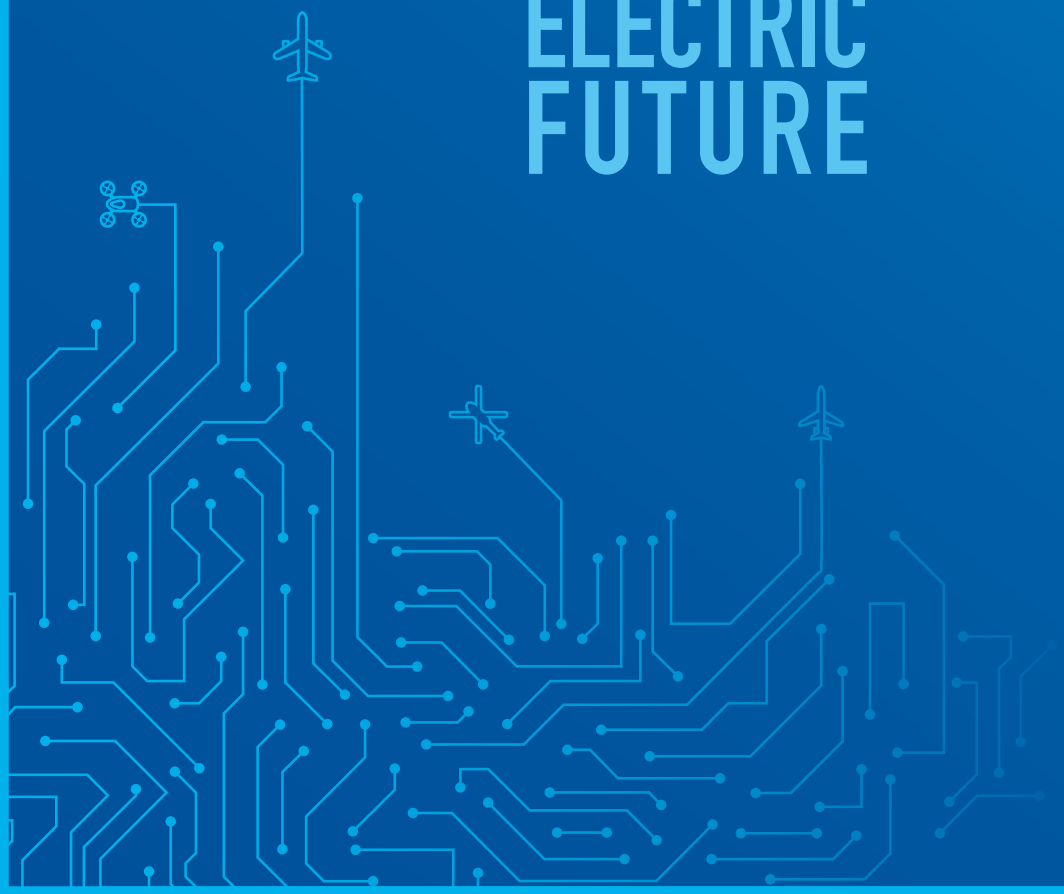
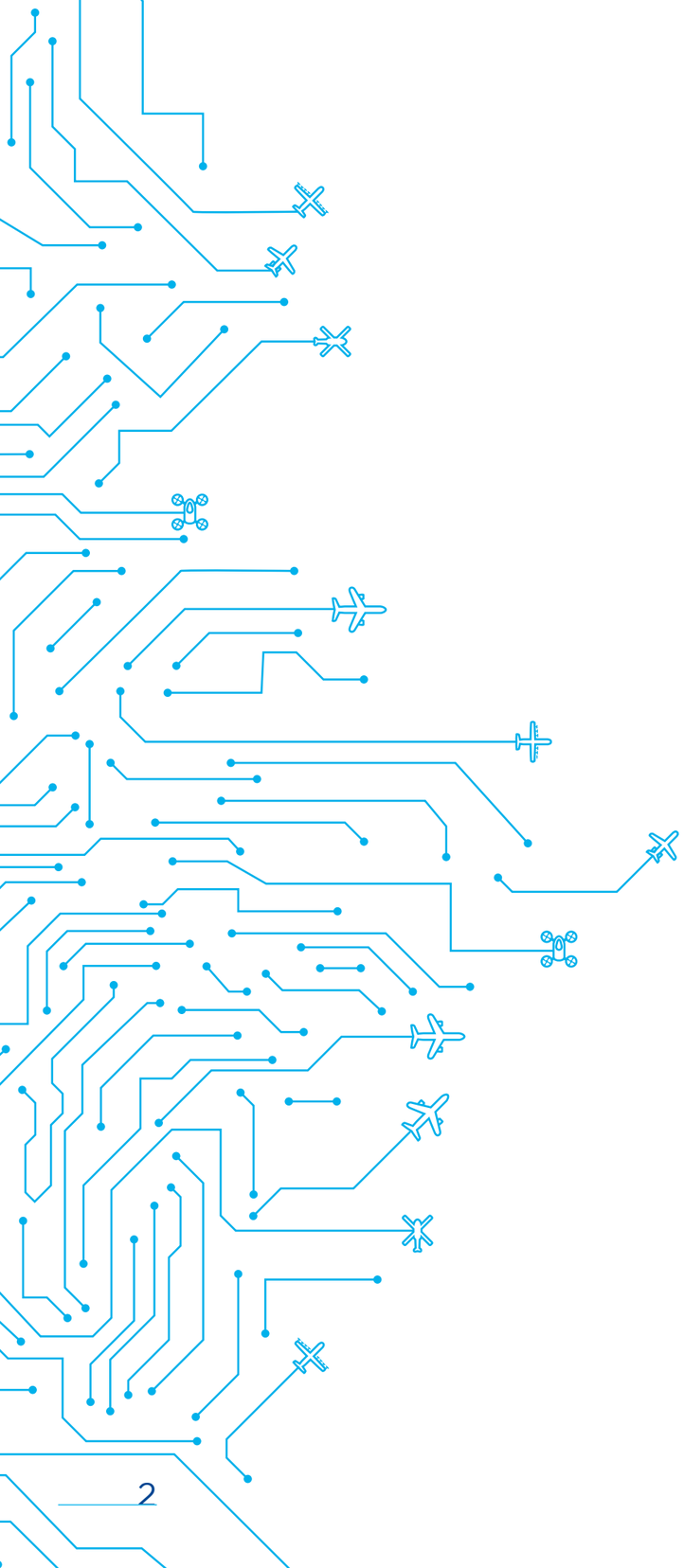
PRESS KIT
2019 PARIS AIR SHOW

SAFRAN AND AVIATION'S ELECTRIC FUTURE



ePower

SAFRAN



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S ELECTRIC THE LATEST TREND IN THE HISTORY OF AVIATION?

How the aviation industry develops in the 21st century will undoubtedly be very different from what we experienced in the 20th. It will certainly keep growing, since mobility requirements will continue to increase, meaning greater demand for air transport, especially in the emerging economies of Asia, Latin America and Africa.

But the factors driving this growth are changing, for several main reasons. First, because we have to meet the challenge of sustainability and make the growth in air traffic acceptable by decreasing its environmental impact. Secondly, to integrate the deep changes in technology already underway. These technologies will pave the way for new aircraft designs and business models, capable of providing innovative solutions to meet people's expectations for greater mobility, resolve congestion in urban centers and satisfy the need for transportation in regions lacking road and rail networks.

Both of these long-term trends favor the increasing electrification of new generations of airplanes. For non-propulsive functions, we're extending the efforts that began in recent decades, as we replace conventional hydraulic and pneumatic systems by their electric counterparts, which are more compact, reliable and flexible. When considering a transition to electric propulsion, however, we have to project ourselves several decades ahead to imagine the major technology breakthroughs needed to make large all-electric commercial airplanes feasible. But today we are already seeing the emergence of a market and technologies within our reach, based on electric and hybrid propulsion systems and a new class of light urban or suburban aircraft, even planes capable of flying regional routes.

Safran is more than ever a key player in this ineluctable trend, because of its expertise in the associated disciplines, unswerving commitment and constantly increasing investments in research and innovation.

Europe's ambitious goals

One of the main channels to meet the objectives defined in the European Commission's Flightpath 2050 vision is **Clean Sky,** a public-private research program launched in 2008 and extended in 2014. Safran is naturally a major partner in this program, designed to foster the development of clean, innovative and competitive technologies that could significantly reduce the environmental impact of air transport.

THE OBJECTIVES FOR 2050

in relation to a 2000 baseline, are as follows:

75%
reduction in CO_2 emissions

90%
reduction in NO_x (oxides of nitrogen) emissions

65%
reduction in aircraft noise

INNOVATION-FOCUSED EXPERTISE AND STRATEGY

SAFRAN: PROVEN EXPERTISE IN AIRCRAFT ENERGY SYSTEMS

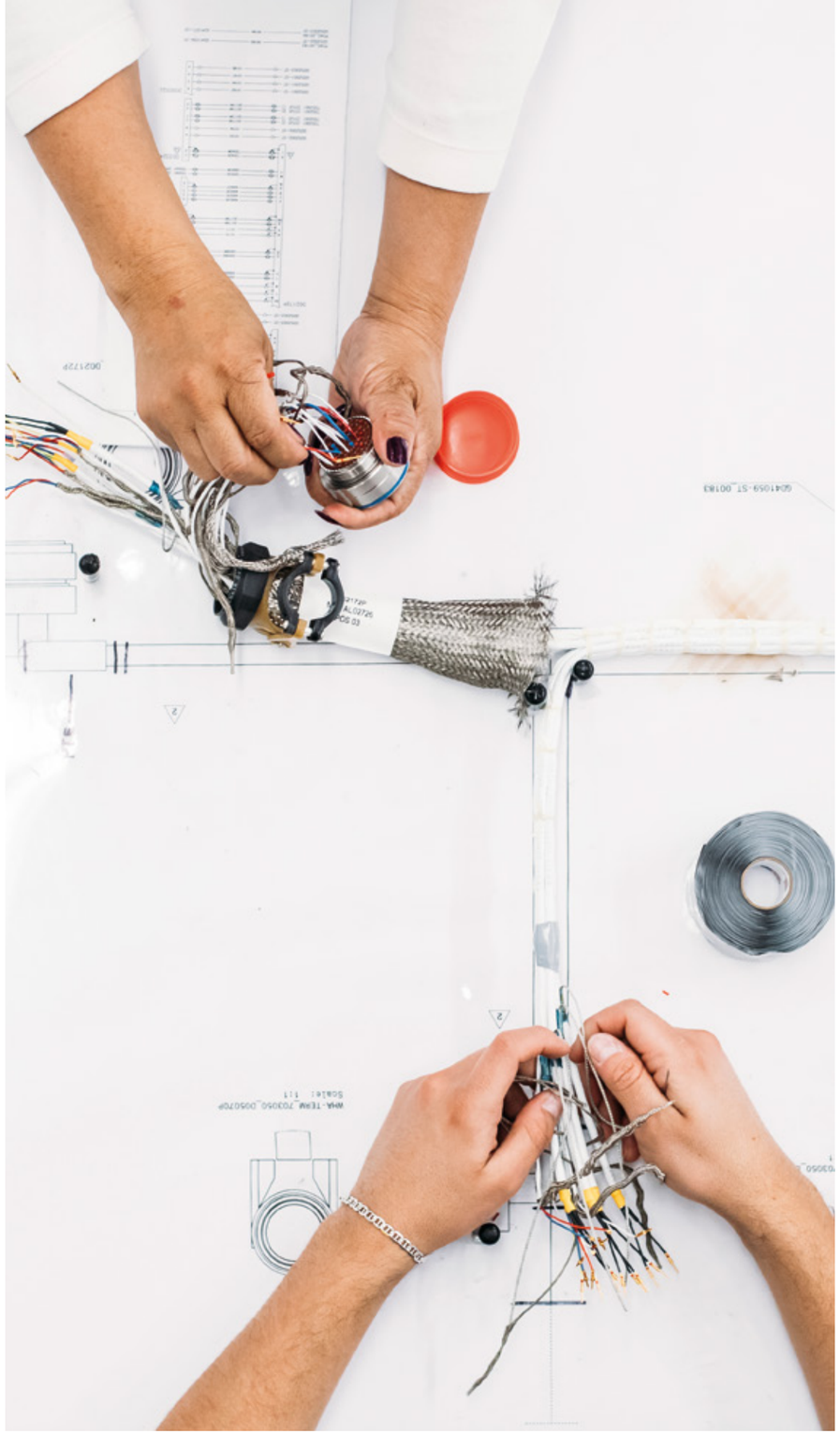
Electrification tends to blur the borders between different types of aircraft systems and equipment. It is therefore all the more critical for a supplier to span the widest range of onboard energy systems – and today only Safran can offer this comprehensive expertise.

As an international leader in aircraft propulsion and equipment, Safran is in prime position to address the challenges of aircraft electrification. The complementary areas of expertise offered by Safran companies means that the Group is involved in all aircraft energy systems, from power generation by jet engines and auxiliary power units (APU), to many different aircraft systems and equipment, from avionics and brakes to in-flight entertainment (IFE). Safran has built up confirmed leadership in aircraft electrical systems, including distribution hubs, power management units, generators, actuators, wiring and more. Because of this extensive expertise, Safran masters not only the specific challenges for each system, but also their overall integration within the aircraft, for both civil and military platforms, as well as space vehicles.

Safran is now capitalizing on its unrivaled holistic vision to build foundations for the future of aircraft energy systems. It identifies, develops and tests state-of-the-art technologies, while also developing advanced systems integration solutions. The Group can supply all or part of these systems to aircraft manufacturers to make sure their platforms combine higher performance and reliability with greater energy efficiency.

Over 100 years in the making…

The electrification of aircraft reaches back to… the 19th century! As early as 1883, the Tissandier brothers in France were flying the first balloon powered by an electric motor – but it wasn't powerful enough to make headway against the wind. The next entrants were Hungarian engineers, who developed the PKZ-1 helicopter in 1916, featuring an electric motor that developed 140 watts of power at 6,000 rpm. It did have a drawback, however… The PKZ-1 got its electricity from a cable connected to a generator on the ground… The world would have to wait until 1973 for a glider to be transformed into an electric airplane carrying its own energy source.

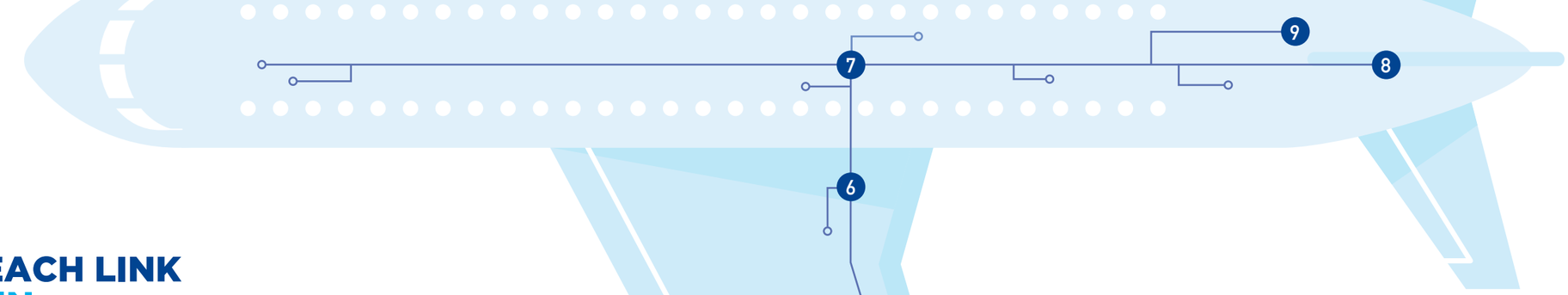


The right energy, when and where it's needed

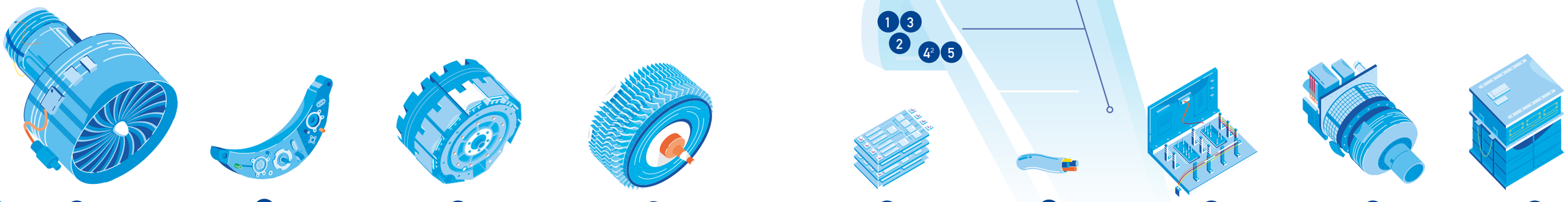
Aircraft electrification is not of course an end in itself. Like all technologies, electrical systems have both advantages and disadvantages. What we gain in flexibility and reliability may quickly be lost in weight, for instance, not to mention that the overall environmental budget of electrification is not necessarily more advantageous on airplanes. For all of these reasons, any replacement of hydraulic or pneumatic systems by their electrical counterparts has to be carefully studied in light of its impact on the aircraft's performance and cost-effectiveness throughout its life.

Safran is not trying to electrify all aircraft functions at any price, but rather to address real-world issues. For instance, how much energy does each system require at any given moment? And what is the best way to generate and transmit this energy? Over and above all these considerations, Safran is firmly convinced of one thing: **the largest part of energy efficiency improvements in next-generation aircraft will come from the energy management system… and that's a special area of expertise at Safran!** In particular, a balance must be sought between propulsive and non-propulsive energy.

For the moment, energy for the aircraft's non-propulsive systems is tapped from its engines. Tomorrow, based on the smart electrification of systems and the development of hybrid electric architectures, for example, we will be able to increase propulsion system performance, while also generating enough electricity to meet increasing energy needs in other areas, vital for passenger safety and comfort. Independent energy sources include batteries, fuel cells and turbogenerators.



SAFRAN ENHANCES EACH LINK IN THE ENERGY CHAIN



1 TURBOFAN OR GAS TURBINE ENGINES

Today
This is the main source of energy on aircraft, both for propulsion and to power their hydraulic, pneumatic and electrically-driven systems. Safran is a world leader in commercial airplane engines and No. 1 worldwide for helicopter engines.

Innovation challenge
While latest-generation engines such as the LEAP (developed by CFM International[1]) take off in the market, Safran is already working on concepts and technologies capable of delivering significant improvements in performance for tomorrow's aircraft – like the Open Rotor and Ultra High Bypass Ratio (UHBR) engines, or hybrid electric distributed propulsion systems for certain applications.

2 POWER TRANSMISSIONS

Today
Power transmission systems tap mechanical energy from engines to drive accessories such as fuel pumps, lubrication systems and starters, along with generators. Safran is the world leader in the market for mainline commercial jets (over 100 seats), with transmissions for all types of aircraft.

Innovation challenge
From materials and processes to system design, Safran keeps upgrading its systems and equipment to enhance integration with engines.

3 ELECTRIC GENERATORS

Today
These generators convert a small fraction of the mechanical energy from the main engines or APU into electricity to power all electrical systems on the airplane. Safran offers electric generators for all types of civil and military aircraft, including mainline, regional and business jets, as well as helicopters.

Innovation challenge
To meet the needs of more and all-electric aircraft, Safran is developing the most extensive and advanced range of "smart" generators on the market, with fully integrated control electronics.

4 ELECTRIC MOTORS

Today
Some actuation functions on today's aircraft are handled by electric motors, which could even totally or partially replace conventional hydraulics and pneumatics on flight controls, brakes, thrust reversers, etc.

Innovation challenge
Safran offers different families of compact yet powerful electric motors with integrated control electronics, tailored for various applications such as landing gear actuation. Other motors are purpose-designed to drive propellers on aircraft with all-electric or hybrid propulsion systems.

5 POWER MANAGEMENT

Today
These units control the electrical equipment on aircraft, including generators, motors and much more.

Innovation challenge
Power management is taking on an increasingly important role with the electrification of aircraft, to distribute this energy and ensure a stable and protected power supply.

6 WIRING

Today
World leader in aircraft wiring, Safran designs electrical wiring interconnect systems, comprising harnesses, cabinets, racks, etc., for all types of aircraft and systems, including operations in harsh environments.

Innovation challenge
With more and more functions going electric, aircraft need denser and more complex wiring systems. Safran is developing these systems with its advanced modeling system, and is also working on systems capable of handling the high voltages needed for electric propulsion.

7 ELECTRICAL DISTRIBUTION

Today
Safran offers complete electricity transmission and management solutions, from generators to loads via distribution hubs, including all components (switches, circuit breakers, etc.) and control electronics.

Innovation challenge
Because of the high power required by non-propulsive electrical functions and emerging propulsion needs especially propulsion, the aim is to develop smart distribution systems, capable of managing an increasing number of loads, and supporting high voltages without overheating, short circuits or arcing.

8 AUXILIARY POWER UNITS

Today
Safran supplies systems that generate electricity for non-propulsive functions, known as auxiliary power units (APU).

Innovation challenge
Emerging more and all-electric architectures are changing the traditional role of the APU, making it less and less "auxiliary"! Safran is therefore developing the eAPU to address the requirements of new more electric aircraft, and is already looking further ahead with fuel cells that could supplement or even replace APUs.

9 BATTERIES

Today
All aircraft are fitted with batteries used to start their engines. Safran is involved here as well, since we integrate the battery in the aircraft's electrical system. At the same time, we are developing our own battery pack technology by combining the best available chemicals and cell structures with advanced thermal, mechanical and electrical management devices.

Innovation challenge
Tomorrow's batteries will have to rise to the challenge of electric propulsion. Safran is naturally focused on significantly increasing battery power density and endurance, while keeping weight as low as possible.

[1] CFM International is a 50-50 joint company between Safran Aircraft Engines and GE.

[2] Here, an electric motor actuates the thrust reverser and is connected to a power management unit.

TRANSFORMING RELATIONSHIPS WITH CUSTOMERS AND PARTNERS

With the emergence of more and all-electric aircraft, the very design of the aircraft is changing. This in turn encourages companies to team up more closely and earlier in the process.

Tomorrow's aircraft will electrify more functions and use new propulsion layouts, which means that products from different companies will be more interdependent than ever. For instance, power management will have to be increasingly shared, since a single unit may be called on in turn for engine starting, landing gear, slat and flap actuators, compressors for cabin pressurization, wing deicing, thrust reversers, etc.

This type of evolutionary change is also transforming traditional industry relationships. Up to now, each equipment supplier tended to develop innovations in response to specifications from the aircraft manufacturer. Today, we have to start thinking "co-innovation". In these new architectures, the best overall system is not necessarily the sum of optimized subassemblies. Aircraft and equipment-makers will have to work together much more closely from the outset to develop the highest performance overall solutions.

A systems integrator like Safran will continue to offer aircraft manufacturers their choice of technology building blocks. But more than ever these basic units will have to be designed as part of a coherent whole, ensuring that they fit together seamlessly, deliver the requisite performance, and can be certified and used safely as part of the whole aircraft.

This is a major shift in industry culture, one that is reflected at Safran. Over the last few years Safran has multiplied gateways between its different professions, entities and companies in terms of R&D[1]. Experts from all horizons – propulsion, electrical generation and distribution, electronics and avionics, etc. – are teaming up on joint projects.

30 strategic partnerships in all areas of R&T, with:

- **Industry:** Valeo, Alstom, etc.
- **Universities and research organizations:** ONERA, CEA, CNRS, Georgia Tech, IRT Saint-Exupery, etc.
- **Innovative small businesses and startups:** Turbotech, OXIS, Prodways, SafetyLine, Kalray, Cailabs, Diota, etc.

Open innovation, a performance driver

More and all-electric aircraft are also at the heart of Safran's open innovation policy. For instance, Safran is a contributor to IRT Saint-Exupéry, a public-private technology research center which is working on more-electric aircraft as one of its three main areas of research. Safran also signed a technological collaboration agreement with Alstom in 2017, under which the two partners pool their skills and expertise in electric propulsion, in conjunction with academic institutions and innovative small businesses. Another example of industry partnerships is Safran's agreement with auto parts giant Valeo, enabling Safran to further expand its study of industrial facilities adapted to the production of electric motors. According to some studies, production rates for these motors would have to increase ten-fold versus the current delivery rate of jet engines.

Safran Corporate Ventures, the Group's corporate venture capital arm, is also contributing to this innovative aircraft electrification strategy. It has taken equity stakes in the U.K. company OXIS Energy, a leader in lithium-sulfur cells for batteries offering high energy density, and in Turbotech, a French startup founded by four former Safran employees, which is developing a range of innovative turboprop engines and electric turbogenerators for general aviation.

[1] Research & Development, which includes Research & Technology (R&T), technology developments for specific programs and innovation in general.

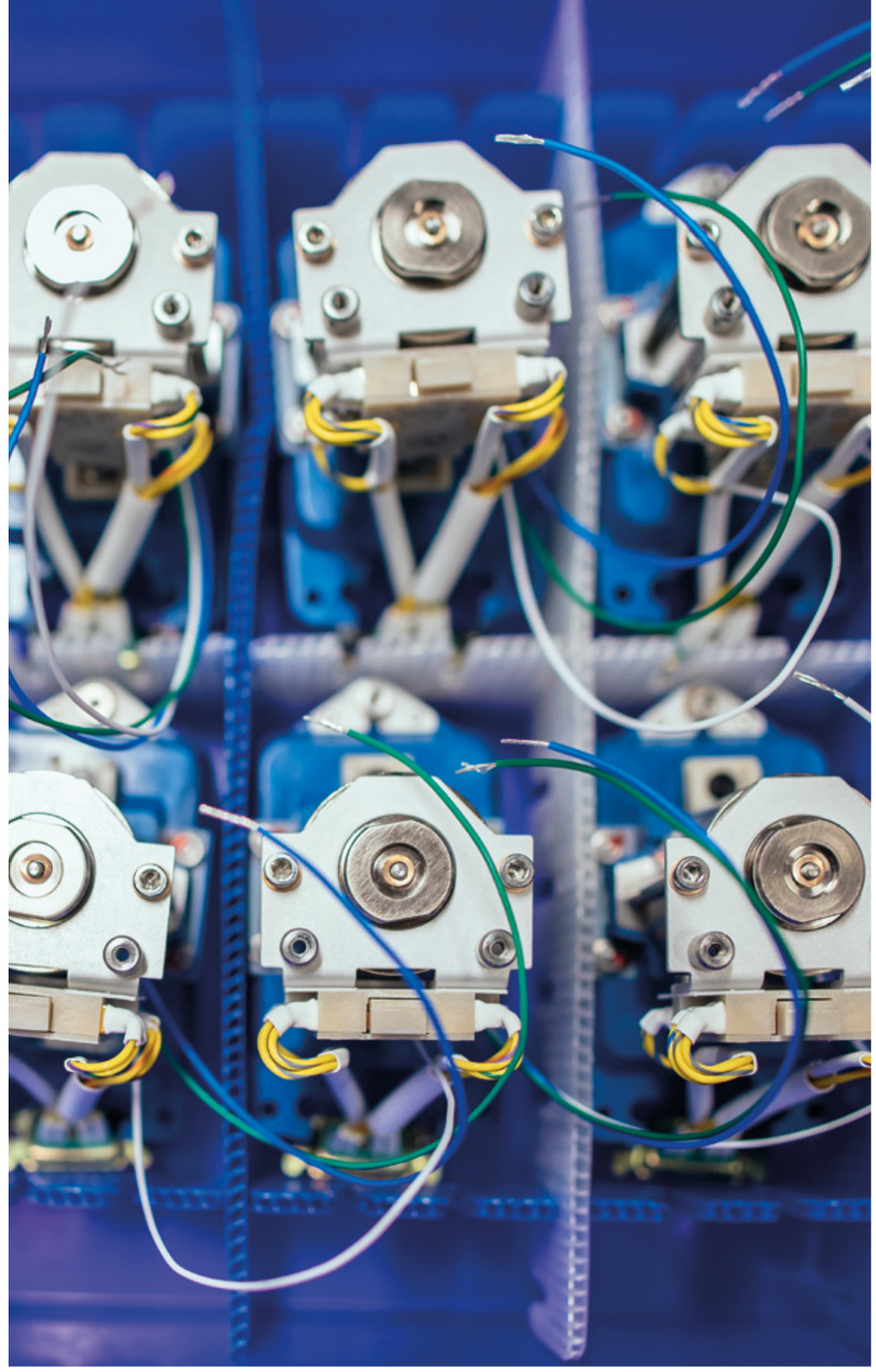
ENERGIZING INNOVATION AT SAFRAN

Safran invests a significant part of its revenue in R&D, using a state-of-the-art organization and processes to prepare the next major breakthroughs in aerospace.

Hybrid electric propulsion is one of the four main Group-wide R&T thrusts at Safran, along with digital technologies, autonomous systems and additive manufacturing. Its development is set out in a roadmap coordinated by Safran's Innovation department to pool our R&T expertise with partners from industry and academia. The overriding aim is to enable Safran and all of its companies to explore, with the support of Safran Tech, the Group's R&T center, the most promising paths in both electric propulsion and non-propulsive electric technologies.

Research and innovation in these areas applies **agile methods in a "test & iterate" approach.** These methods are designed to approve proofs of concept much faster than conventional methods for innovation in aeronautics. For instance, by using this approach, Safran teams needed just 18 months to design a complete distributed hybrid electric propulsion system – successfully tested in June 2018 by Safran Helicopter Engines.

16%
OF SAFRAN EMPLOYEES
are involved in R&D



1,000+
PATENTS FILED
in 2018

40,000+
PATENTS
in our portfolio

75%
of **R&T** allocated to **environmental efficiency**

An exceptional facility

Safran's plant in **Niort**, west-central France, features one of the world's most outstanding test facilities for electrical systems. Stretching over some 26,000 square meters (280,800 sq ft), this ultra-modern installation is used to test and certify electrical systems and equipment for today's leading aircraft (A350, 787, etc.), while also giving Safran's R&T teams an unrivaled resource to test out their future more and all electric solutions.

ELECTRIC AIRCRAFT PROPULSION

SAFRAN: POWERING THE NEXT CHAPTER OF AVIATION HISTORY

While the increasing electrification of non-propulsive functions has driven the evolution of airplanes and helicopters over the last few decades, the electrification of propulsion systems promises a revolution: a radically new way to design aircraft, including aerodynamics and even operating modes.

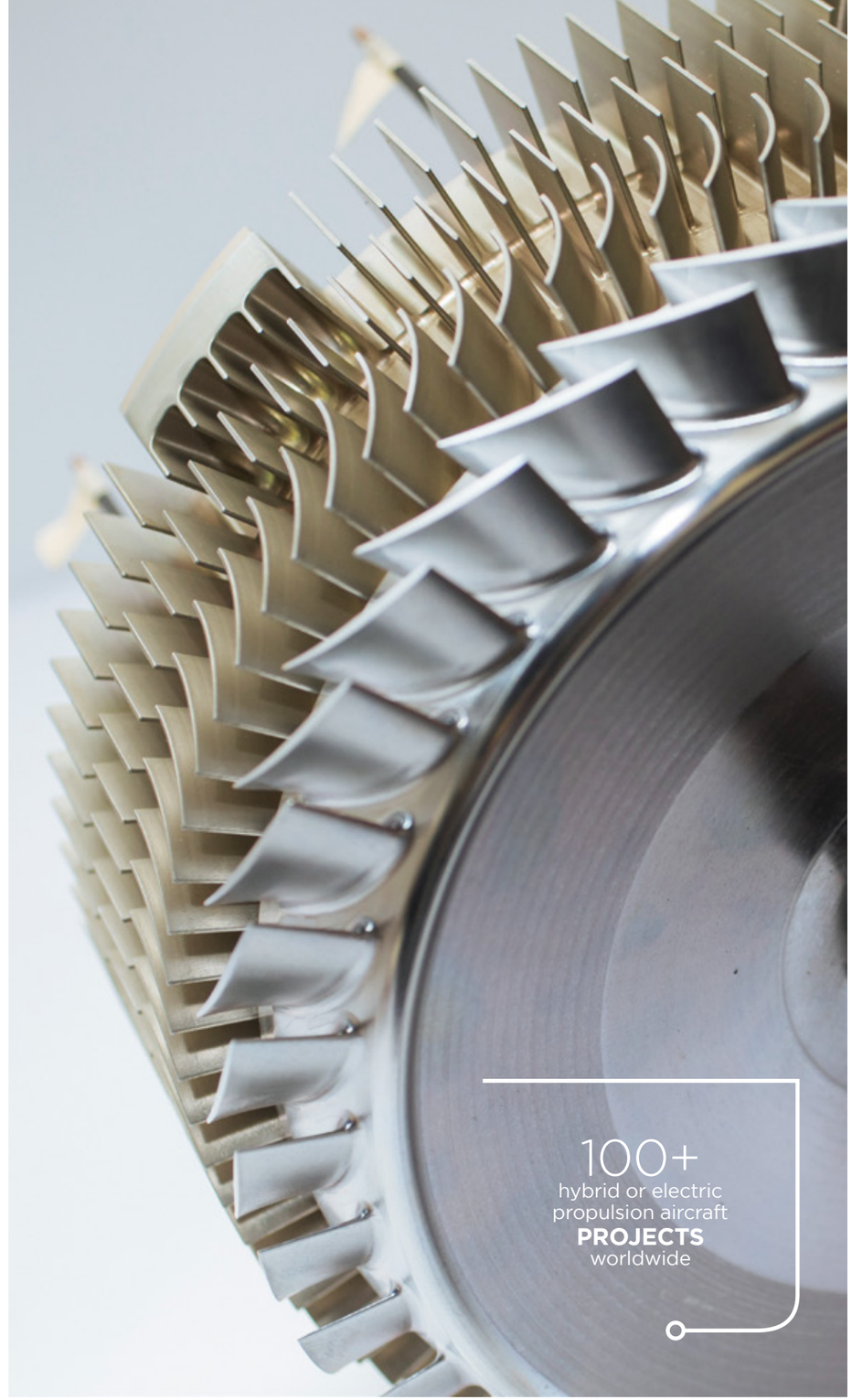
The innovation and research projects being conducted in electric propulsion herald a fundamental shift in the aerospace landscape in the decades ahead, including much greater diversity in what flying machines will look like and how they'll be used. This diversity will be largely determined by the extent to which electricity is the primary source of propulsive power.

Some aircraft will **use micro hybridization:** a combination of current combustion engines with small, smart electric motors, like the start-stop systems now common in automobiles. A similar system has been developed by Safran for the Airbus Helicopters Racer high-speed rotary-wing demonstrator. This technology allows the pilot to shut down one of the two engines during the cruise phases. Then, whenever necessary — when landing, for example, or if the pilot needs to gain airspeed or perform an emergency maneuver — the engine is restarted at full power by an electric motor.

Full hybridization will involve developing more powerful systems combining combustion engines and electric generators that will directly provide lift and forward thrust for the aircraft, as well as power its non-propulsive functions.

The final destination will be **all-electric propulsion,** where conventional combustion engines will be completely superseded by a purely electric power source.

A growing number of projects exploring the many possibilities are being conducted around the world, led by established industry players and startups alike. Amid the profusion of announcements and claims, Safran is pursuing a pragmatic approach to innovation. The company is developing and offering new needs-responsive solutions, from electrification of conventional aircraft to propulsion systems for new platform concepts, such as multi-rotors vertical takeoff and landing aircraft (VTOL).



The near-term objective is to test and refine these technologies so that we're ready in the longer term to deliver dependable, versatile, high-performance solutions for any type of commercial aircraft.

Why the shift to electric propulsion?

Hybrid or all-electric propulsion offers significant benefits:

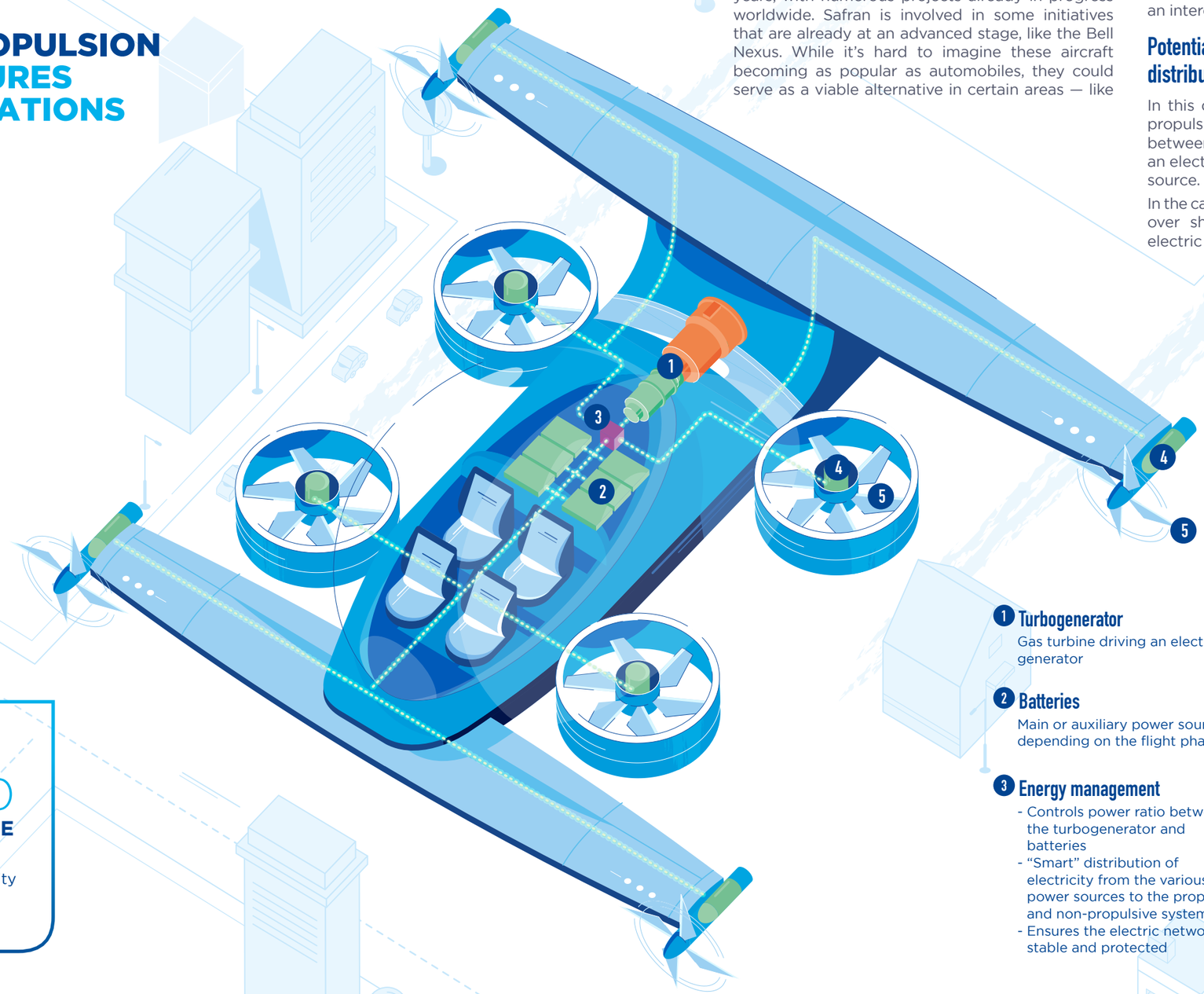
1. Enhanced performance
Huge technological progress has been made with latest-generation combustion engines, and further advances are possible by optimizing architectures, materials and coatings to boost performance. Hybrid layouts are another way to reduce weight, fuel burn and environmental impact, especially by avoiding the need to design the main combustion engine to meet maximum power requirements, for example at takeoff.

2. More reliable operation
More-electric architectures are more robust and require less maintenance. Smart electronic management makes them potentially more compatible with new digital technologies, allowing data to be collected and analyzed for greater automation, optimized flight and better failure prediction and management.

3. New markets
By increasing the number of electric motors, certain architectures such as multi-rotor VTOLs are inherently much safer and could open up a host of new uses in urban and suburban areas, as well as bringing this kind of flying to many more people, thanks to manually-assisted or fully-automated operation.

ELECTRIC PROPULSION ARCHITECTURES AND APPLICATIONS

Safran is developing electric propulsion technologies for numerous platform types – some of which herald a whole new approach to civil aviation. Using the same technological building blocks, the company is positioned to address wide-ranging needs and markets.



50,000 to 100,000
AIRCRAFT IN SERVICE WITHIN 20 YEARS
The market for new air mobility estimated by Safran

Air taxis

The age-old dream of the "flying car" is now within reach! Multi-rotor VTOLs able about to carry four passengers could become a reality in the next few years, with numerous projects already in progress worldwide. Safran is involved in some initiatives that are already at an advanced stage, like the Bell Nexus. While it's hard to imagine these aircraft becoming as popular as automobiles, they could serve as a viable alternative in certain areas — like air taxis in and around our congested cities, or air ambulance/medevac platforms, taking advantage of their speed, reliability and quieter operation. For the same reasons, the defense community is also taking an interest for logistics or special missions.

Potential architecture: distributed hybrid-electric propulsion

In this diagram, the amount of power needed for propulsion is optimally adjusted at each flight phase between the turbogenerator (turbine coupled to an electric generator) and a battery or other power source.

In the case of air taxis carrying one or two passengers over shorter distances, propulsion could be all-electric (see the architecture on page 22)

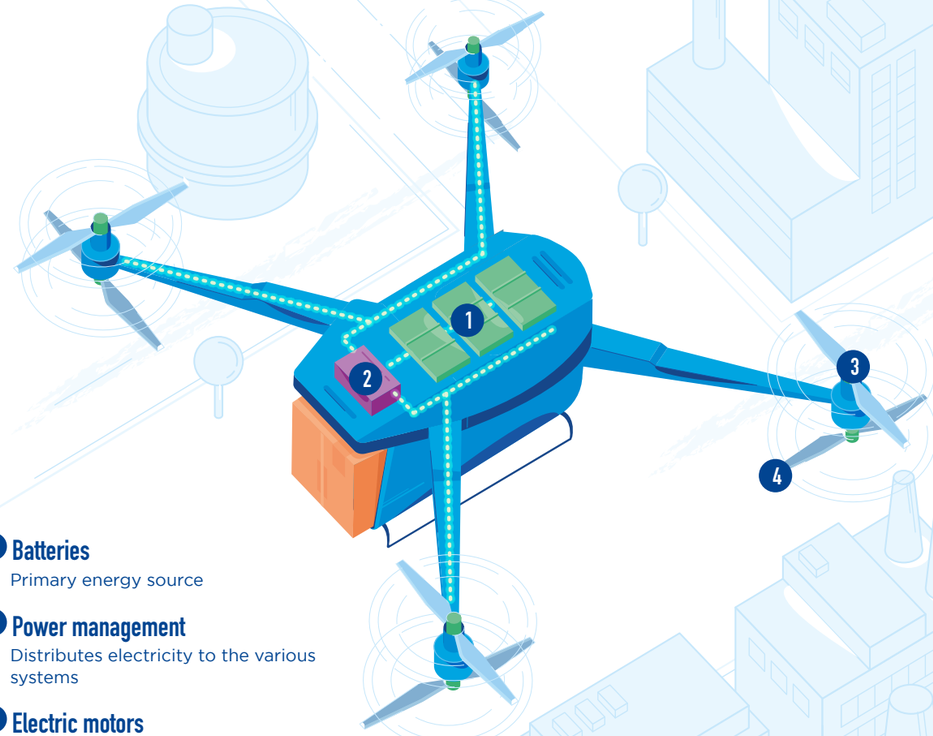
1 Turbogenerator
Gas turbine driving an electric generator

2 Batteries
Main or auxiliary power source, depending on the flight phase

3 Energy management
- Controls power ratio between the turbogenerator and batteries
- "Smart" distribution of electricity from the various power sources to the propulsive and non-propulsive systems
- Ensures the electric network is stable and protected

4 Electric motors
Powered by the turbogenerator, batteries or a combination of both

5 e-Propellers
- Each powered by an electric motor
- Provide lift, forward thrust and flight control



1 Batteries
Primary energy source

2 Power management
Distributes electricity to the various systems

3 Electric motors
Powered by batteries

4 e-Propellers
- Each powered by an electric motor
- Provide lift, forward thrust and flight control

Cargo Drones

Electric VTOLs could be used for short-distance parcel delivery. Current prototypes are already carrying payloads of several dozen kilograms. They could help delivery companies solve the logistics problem of the "last 10 miles", which is particularly inefficient due to growing congestion and increasingly restrictive CO_2 and particle emissions standards in our cities. These uses are especially promising since they could be coupled with autopilot or remote-controlled solutions, more readily accepted in the parcel transport market. With current technologies, an all-electric architecture wouldn't be capable of carrying cargo over long distances. However, the concept could be used with a hybrid architecture, giving it substantially greater power and range.

Potential architecture: all-electric propulsion

Propulsion solely by battery power.

1 Turbofan
Main engine for flight phases when a lot of power is needed

2 Generator
Converts part of the engine's mechanical power into electricity

3 Batteries
Main or auxiliary power source, depending on the flight phase

4 Energy management
- Controls power ratio between the turbogenerator and batteries
- "Smart" distribution of electricity from the various power sources to the propulsive and non-propulsive systems
- Ensures the electric network is stable and protected

5 Electric motors
Powered by the turbogenerator, batteries or a combination of both

6 e-Propellers
- Each powered by an electric motor
- Provide lift, forward thrust (for some phases) and flight control

Commuter aircraft

Safran is also interested in another application: small commuter aircraft in the 10-passenger class. Hybrid propulsion architectures could make these planes a competitive proposition for regular routes of a few hundred miles in certain parts of the world. The United States, for example, has more airports than any other country, yet an estimated 80% of them are underused or unused due to the difficulty of operating conventional airplanes profitably over short distances, and especially the overly restrictive noise regulations at these local airfields. While all-electric propulsion is unrealistic in the near term, a variety of hybrid designs is entirely conceivable.

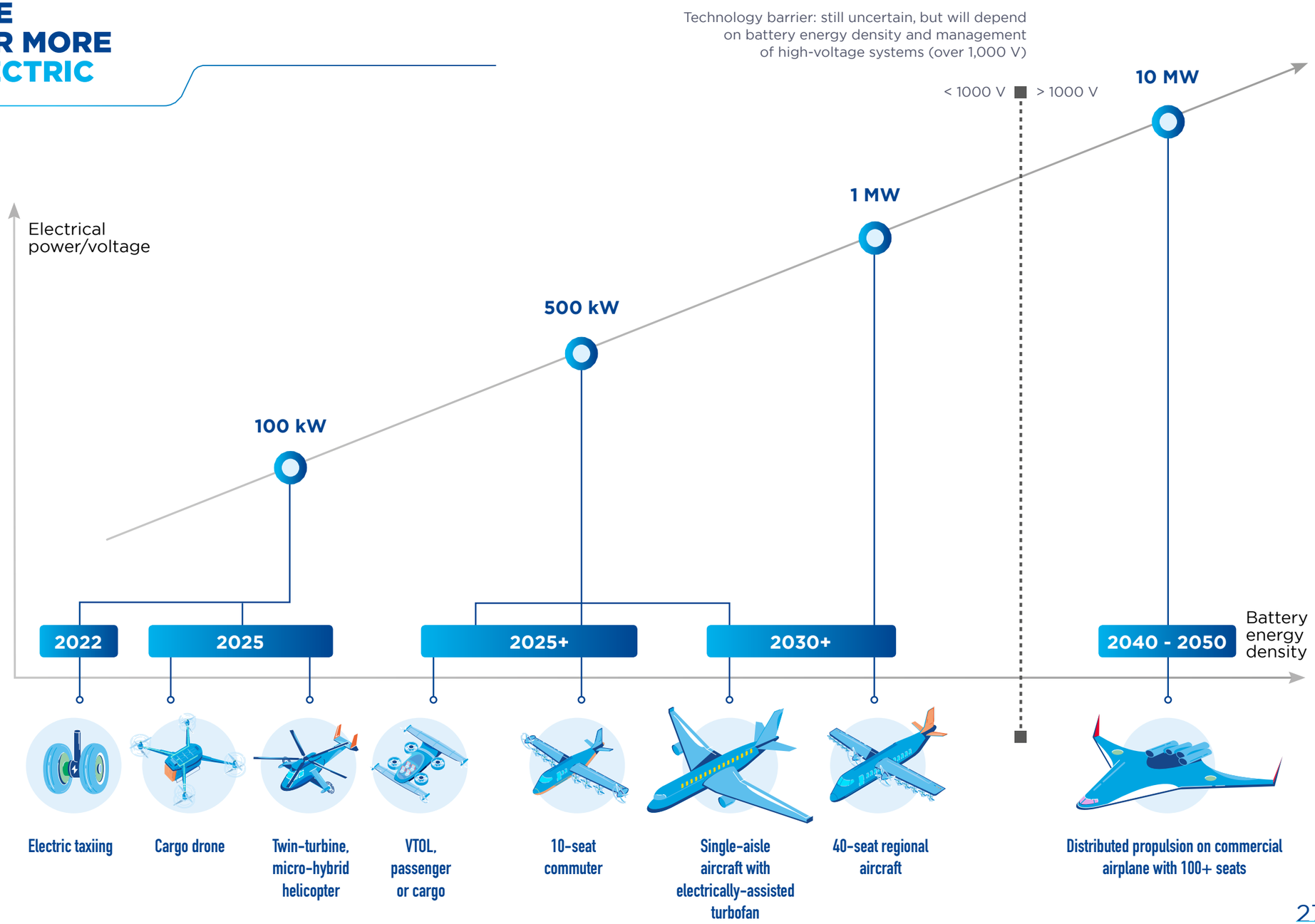
Potential architecture: series/parallel partial hybrid propulsion

Architectures combining conventional turbofan propulsion with electric propulsion (smart motors and e-propellers). These electric propulsors assist the turbofan and provide extra power when needed, or replace it completely during the cruise phase, for example, under battery power.

THE LONG ROAD TO ALL-ELECTRIC AIRCRAFT

WHAT'S ON THE HORIZON FOR MORE AND ALL-ELECTRIC AIRCRAFT?

The actual timetable for the entry into service of electric aircraft depends on multiple factors. Safran is planning ahead for these long-term step changes in the market, starting with shorter-range and more limited solutions, while awaiting technologies that are mature enough to store and deliver the electrical power needed for propulsion.



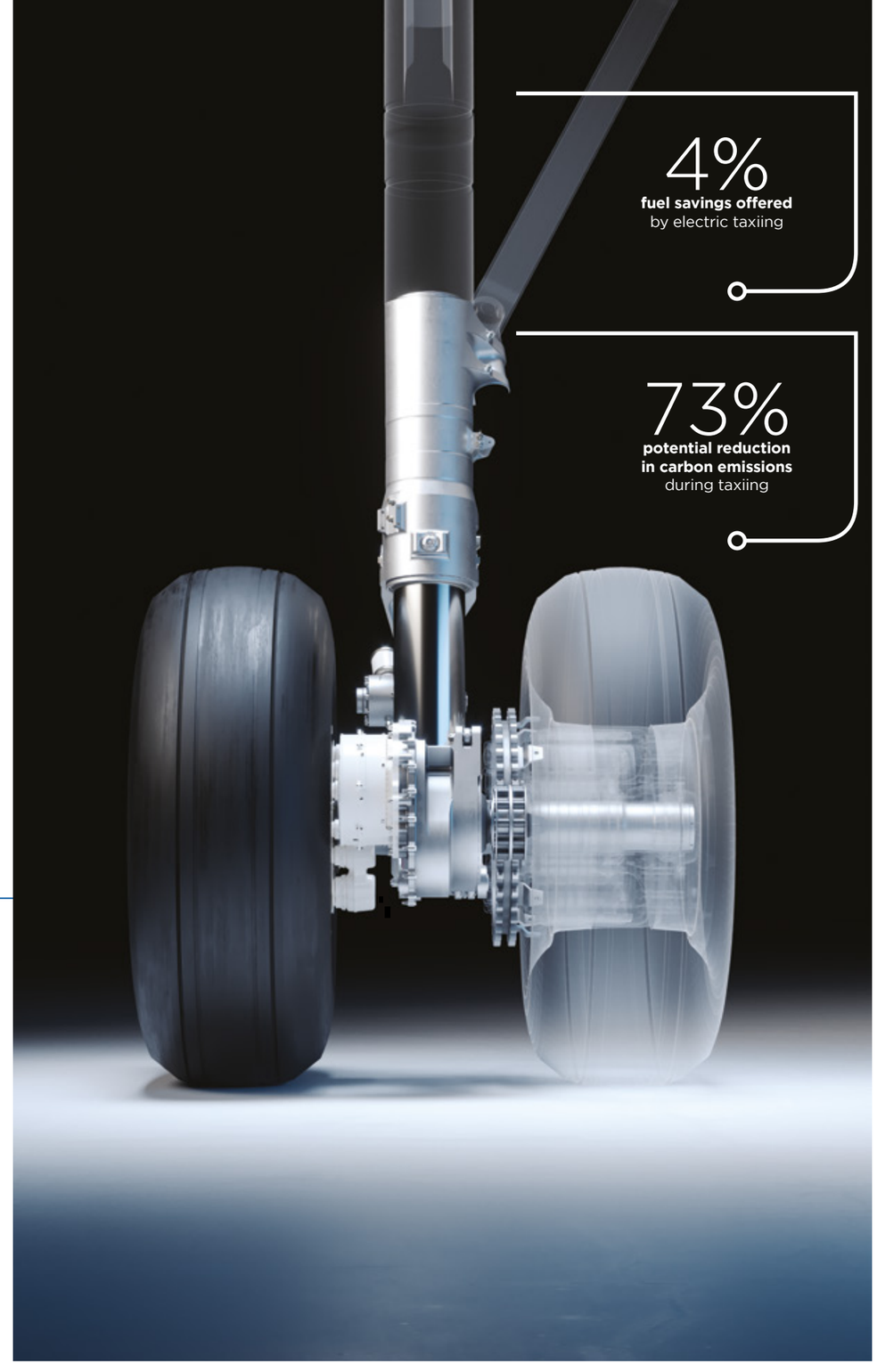
APPLICATIONS WITHIN OUR REACH

While all-electric aircraft remain a tantalizing but distant prospect, "more electric" aircraft are increasingly a reality. This progress is in part due to the systems and equipment developed by Safran to make upcoming aircraft even more reliable and economical, while improving their performance.

Safran is a pioneer in the trend towards "more electric" aircraft, and one of the most innovative players in the industry. It already supplies a wide range of electric systems to replace conventional pneumatic and hydraulic systems, including deicing, flight control actuators, thrust reversers and brakes. The aim is of course to electrify aircraft systems, which in turn simplifies the overall energy system, facilitates maintenance and enhances control. Safran will continue to devise innovative solutions for these strategic technologies and support a smooth transition to even more-electric airplanes and helicopters.

Increasingly electric aircraft

	Airbus A320	Airbus A380	Boeing 787	Next Generation
Deicing	Pneumatic	Pneumatic	Electric	Electric
Environmental control system				
Avionics	Electric	Electric		
Cabin systems				
Braking	Hydraulic	Partly electric		
Flight controls			Hydraulic	Partly electric
Landing gear, thrust reversers				
Total aircraft power	**< 200 kW**	**600 kW**	**1 000 kW**	**> 1 000 kW**



Electric taxiing on track for production

Safran has generated real industry buzz by offering the first electric taxiing solution, with an electric motor in the landing gear, powered by the APU, so that pilots no longer have to use their jet engines for taxiing. This innovative solution is now being developed with Airbus for the A320neo/ceo. The target date for entry into service is 2022. According to a study carried out with airlines, this system makes a lot of sense at busy airports with long taxiing times, as well as for carriers that operate a number of daily shuttle flights. With this new technology, they can reduce not only their operating costs, but also their environmental footprint.

PODS: power just where you need it

One of the main research thrusts at Safran is how to change the role of auxiliary power units (APU) to optimize aircraft's energy system and engine performance. Looking at propulsive and non-propulsive power management as a whole, APUs could take on a growing role by handling more functions during the different flight phases. Safran has already taken a first step in this direction with the eAPU. Today, the company is working on an even more advanced concept, namely PODS (power on demand system), a smart secondary generator that will be activated automatically when it's more advantageous for the aircraft to tap power from the APU instead of the jet engines.

A NUMBER OF HURDLES AHEAD FOR COMMERCIAL AIRPLANES

The electrification of aircraft propulsion would seem to be an inevitable trend. However, given the current state-of-the-art, all-electric propulsion of a large commercial airplane is impossible in either the short or medium term.

The main reason is that the power equation just doesn't compute! If we want to generate the dozens of megawatts needed to power a large airplane for flights of at least several hours, we will have to improve current battery technology at least 10-fold. Even with energy density five times greater than what current electric vehicles can offer, a long-distance flight (3,000 nautical miles) would require 170 metric tons of batteries (374,000 lb), compared with the 80 metric tons (176,000 lb) maximum takeoff weight (MTOW) of an Airbus A320 or Boeing 737 class jetliner.

Warning: high voltage!

In addition to this weighty issue, an electrical system for this type of aircraft would be in the high-voltage category, sending over 1,000 volts through the wires. This is routine on trains. But when you're talking about a plane flying at 35,000 feet, any difficulties are exacerbated because you have to include protective devices (insulation, heat dissipation, etc.), all of which add more weight. Not to mention that the physics underlying high voltages is not the same up in the troposphere as on the ground. Managing high-voltage systems in the sky is a brand-new discipline, and research is only just getting underway.

Regulatory challenges

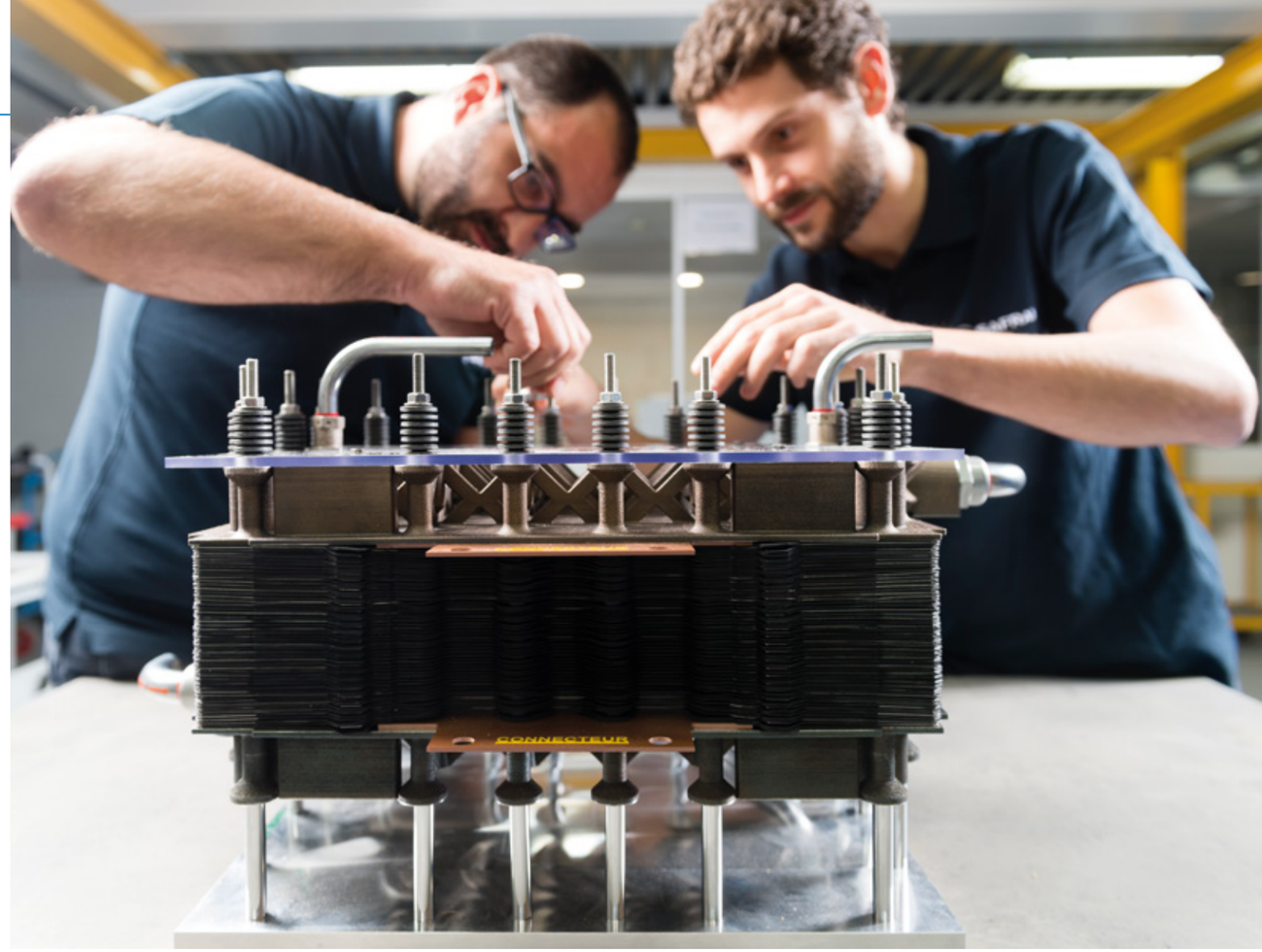
Over and above these technology obstacles, there are also a number of unknowns in terms of aviation regulations. No current legislation governs possible urban VTOL operations, for instance, and the whole certification process will have to be revamped to cover future distributed propulsion layouts.

Social challenges

There's a final roadblock to electric aircraft: will they be accepted by society in general? From the geopolitical standpoint, these technologies use rare earths (especially for batteries), which raises ethical issues, as well as sustainability issues for supply chains. From the environmental standpoint, the energy budget is undoubtedly better than current designs, but perhaps not everywhere and at all times: we can well imagine regions where electric VTOL aircraft would be a welcome alternative to congestion in big cities, but in others perhaps they would only extend noise and visual pollution vertically.

Fuels to generate electricity

It's a far from non-negligeable question, especially when you consider the different primary energy sources. For instance, Safran's R&T arm started looking into fuel cells several years ago as an alternative to storing energy in batteries. Fuel cells could be used in low-power propulsion systems, of course, but beyond a certain threshold they would run into the same weight problems as for batteries. Given the heady objectives for reducing the environmental impact of aviation, Safran is working on alternatives to jet fuel, which is still by far the most energetic power source. Safran is naturally studying both biofuels and "e-fuels", synthetic fuels with lower greenhouse gas emissions (hydrogen produced by electrolysis or synthetic methane).



Technological progress, meeting challenge after challenge, balancing risks and opportunities…
A new world is indeed dawning for the aviation industry and all its stakeholders, and Safran is of course at the forefront.

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About Safran

Safran is an international high-technology group, operating in the aircraft propulsion and equipment, space and defense markets. Safran has a global presence, with more than 92,000 employees and sales of 21 billion euros in 2018. Working alone or in partnership, Safran holds world or European leadership positions in its core markets. Safran undertakes Research & Development programs to meet fast-changing market requirements, with total R&D expenditures of around 1.5 billion euros in 2018. Safran is listed on the Euronext Paris stock exchange, and is part of the CAC 40 and Euro Stoxx 50 indices.

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