One of the most familiar sounds on an aircraft – one that disconcerts many a nervous flyer – is the whirr and clunk as the hydraulic system retracts the wheels after take-off or extends them on the approach to landing.

However in years to come, that sound could be a thing of the past as hydraulic systems and other parts of the aircraft that have traditionally been powered by diverting power from the engines – in a process known as bleed-air power – move to running on electricity.

While there is little prospect of aircraft actually being propelled by electric motors any time soon, there is a move within the industry to run all other power systems on electricity.

“The main purpose is to reduce the overall weight of the plane and therefore fuel consumption,” says Rainer Von Wrede, director of environmental affairs at Airbus – the parent of which, EADS, has shown its commitment by pursuing the VoltAir concept and, with Aero Composites Saintonge and the Green Cri-Cri Association, the all-electric Cri-Cri.

As things stand, a small proportion of power generated by an aircraft’s engines is diverted to central hydraulic pumps and other mechanically driven subsystems, and also to the main electrical generator for non-propulsive power, the auxiliary power unit (APU).

The APU provides electrical power to the aircraft’s avionics systems, to cabin and aircraft lighting, to the galleys, and other uses such as the entertainment systems. It also provides power when the aircraft is on the ground. The hydraulic pumps transfer hydraulic power to the actuation systems for primary and secondary flight control, to landing gear and to a number of ancillary systems.

“We don’t know exactly what the savings will be but electric cables are far, far lighter than hydraulic tubes – the weight savings will be in the order of a number of tonnes,” Von Wrede adds.

Clean Sky, the joint venture between the European Union and Europe’s aviation industry, is working on making future aircraft more environmentally friendly. It says: “Conventional equipment systems on civil aircraft are a product of decades of development by the systems

**CURRENT THINKING**

Use of electricity as a replacement for bleed-air power for hydraulic systems offers a novel means of reducing an aircraft’s weight – and therefore its fuel consumption
suppliers. Each system has become more complex, resulting in an architecture that is far from being optimal. Designers have striven to overcome the myriad of interactions between equipment by increasing the efficiency of each system in an evolutionary way.”

“We are still largely in the research phase but we are well on the way to more electric aircraft”

Rainer von Wrede
Director of environmental affairs, Airbus

Such an improvisational approach is reaching the limits of its possibilities with the latest generation of aircraft, which use far more electricity than their predecessors. In addition, there is much more focus now on the need to reduce fuel consumption for cost and environmental reasons. “One reason we have not focused on the electrics is that in many cases these are new technologies,” says Pascal Thalin, vice-president of research and technology at Thales, which is co-leading Clean Sky’s work on all-electric aircraft. “But it is also because deriving power from the engines was not a bad solution and relatively cheap. It is only now that we are faced with environmental constraints and the need to improve engine efficiency because of fuel costs that we have to look again at this area.”

Engine Bleed

The Airbus A380 uses 1.2MW of electricity, while the Boeing 787 uses 1.5MW, Thalin says, “This is a huge increase and there are limits to how much extra power you can off-take from the engines.” Improving the architecture by, for example, removing the gearbox, reducing engine bleed, and introducing local hydraulic sources and more electrical power, could substantially reduce the level of power diverted from the engines and therefore improve fuel efficiency. “Removing the need to divert high-compressed air from the engine will also give engine manufacturers more freedom in the design of their products when it comes to speed and efficiency,” adds Thalin.

Bleed-air systems create constant speed power generation, explains Sebastian Ziehm, research and technology project manager at Liebherr, the other co-lead of the Clean Sky Systems for Green Operations strand. This means excess power is sometimes generated but not used, which is a waste of fuel.

Use of electric power for all non-propulsion requirements on an aircraft will enable power to be used only when it is needed, while getting rid of the hydraulics will reduce weight and pollution because there will no longer be any hydraulic fluid to dispose of.

Boeing’s new 787 Dreamliner is the most advanced aircraft when it comes to electric systems, using bleed-air power only for the engine inlets’ anti-ice system. The transition to an electric architecture has drastically reduced the aircraft’s mechanical complexity, says the airframe: “Overall, the 787 will reduce mechanical systems complexity by more than 50%, compared with a 767.”

The 787 “reflects a completely new approach to onboard systems,” the company says. “Virtually everything that has traditionally been powered by bleed-air from the engines has been transitioned to an electric architecture.” The affected systems include engine start; APU start; wing ice protection; cabin pressurisation and hydraulic pumps.

The no-bleed architecture does not only improve the efficiency of the engines, it also improves reliability and cuts maintenance costs, Boeing claims. By eliminating the pneumatic systems from the aircraft, the 787 will realise a notable reduction in the mechanical complexity of aircraft systems. However, if the electricity is no longer being generated by the aircraft’s engines, where does it come from? In the near term, the APU can be powered by kerosene but also by less expensive fuels such as gas or diesel, while in the future fuel cells are likely to play a major role in powering onboard systems, says Ziehm.

Last year, Airbus linked up with Parker Aerospace to explore the possibilities of replacing APUs with fuel cell systems, which could cut fuel consumption by 10-15% on short-haul flights. The APU gets more use in short-haul flights because aircraft spend more time on the ground than on long-distance routes.

The fuel cell is a proven technology that has demonstrated its effectiveness in other applications, notably the Apollo space programme, notes Ziehm. “The main issues are cost and safety around the hydrogen that fuel cells need to produce power.” There is a lot of research into how hydrogen can be stored on board, Von Wrede adds. “At the moment, the system is not sufficiently weight-efficient to be used on board, but we are not far away. I would imagine that within a decade or so, it will be mature enough to use.”

The only waste products from fuel cells are water, heat and oxygen-depleted air, which can all be reused on the aircraft – the oxygen-depleted air in flight safety systems – further reducing weight and fuel consumption.

Decentralised units

While the first fuel cells on aircraft will be single, large centralised units, as the technology evolves there are likely to be a number of smaller, decentralised units deployed to those areas that use the most power, such as the kitchens and air-conditioning.

One challenge is that at the same time as this transformation, fuselages are being built with increasing amounts of composite materials. These do an excellent job of making aircraft lighter, but they do not have the conductivity of traditional metal fuselages so a lot more wiring will be needed.

Further into the future, Airbus envisions aircraft that harvest energy from a range of sources to reduce the amount of fuel they need – including solar power and the heat from passengers’ bodies, from the galley and air-conditioning system.

“We are still largely in the research phase,” says Von Wrede, “but we are well on the way to more electric aircraft.”

For more on the Cri-Cri aircraft developed by EADS Innovation Works and partners, visit flightglobal.com/cri-cri

Via its VoltAir project EADS developed a new concept for an all-electric aircraft