

# More Electric Aircraft in the Aerospace Field

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**Abstract:** With the development of aircraft design toward more electricity, more electric aircraft effectively improving the fuel economy, reliability and maintainability of the aircraft, and has become an important direction of the aviation technology. This paper analyzes and compares the more electric aircraft and conventional aircraft, summarizes the key technologies supporting the development of more electric aircraft.

**Keywords:** More electric aircraft, Electric power system, Green aviation.

## 1. Introduction

The concept of more electric aircraft is that the electric power is provided for the utilization of all non-propulsive systems on the aircraft such as actuation system and anti-ice system, whose power is conventionally provided by a combination of various secondary power sources including, pneumatic, hydraulic, mechanical and electrical.

There are a variety of advantages of flying with MEAs compared with conventional aircraft. First, replacing the conventional powers sources such as gasoline whose emission of burning can be seriously harmful to the environment with electric power can make a great contribution to the solving of the greenhouse effect and global warming issue in recent years. For example, the flagship widebody applied on Boeing 787 is one of the largest implementations of more electric aircraft, which can save approximately 3% consumption of fuel by replacing conventional hydraulic and pneumatic components (Bailey 2021). Second, according to Bailey 2021, the application of electric power can increase the reliability and efficiency of the

aircraft system. In the past few years, most components in the conventional aircraft including environmental control systems, wing deicing systems, and flight control surfaces use bleed air as the power source. However, Todd Spierling, Senior Technical Fellow at Collins, mentioned that compressed air that a kind of traditional power source that may not efficient, and the implement of more electric can improve the efficiency of the use of aircraft fuselage. Furthermore, MEAs can provide passengers with a more comfortable traveling experience due to electric compressor equipment. It can simulate a low cabin altitude by continuously pulling the fresh air to the cabin to improve the air quality and reduce the “jet lag” effect on the passengers on a long-haul flight (Bailey 2021). In addition, Bailey 2021 mentioned that MEA releases less noise than conventional aircraft, which means that the airports for MEA can be opened in the city center for convention. As a result, people may not need to drive a long way to the airport to catch a flight in hurry. Last but not least, compared with conventional aircraft, MEAs can slash the cost. For instance, it has a lower cost and requirement on maintenance.

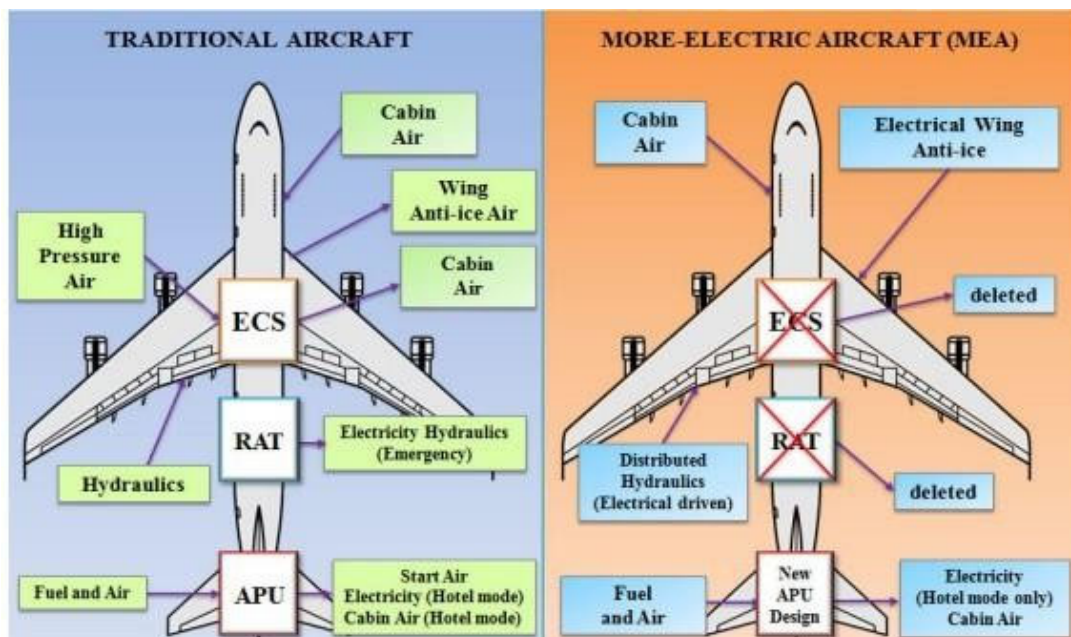


Figure 1. Difference between the conventional aircraft and MEA from Analysis and Simulation of Advanced Technology Solutions of Selected Components in Power Electronics Systems (PES) of More Electric Aircraft

In general, the biggest difference between the more-electric aircraft and the conventional aircraft is that the type of power source for no-propulsive systems, which is all-electric for MEA, and a combination of various secondary power sources for conventional aircraft. In addition, there are some differences between the sub-system of more electric aircraft and conventional. For example, the actuation system of conventional aircraft is hydraulic actuation but the MEA actuation systems consist of EHA and EMA systems. The following graph shows more differences between the traditional aircraft and more electric aircraft (As shown in figure 1).

## 2. What Is Happening Today in The Aerospace Field and Why the More Electric Aircraft

In the aerospace industry today, most companies are devoted to producing more efficient, environment-friendly, and low-cost aircraft. For instance, according to (Jaggi 2018), the Israel Aerospace industry have a plan to develop an all-electric aircraft. This kind of aircraft can have a flight at least 621 miles far on one charge and have a lower cost compared to other traditional aircraft because electricity is a kind of cheaper energy and the aircraft maintenance is not costly as the conventional aircraft. Moreover, it can fly almost as fast as the other kinds of aircraft without noise. Since the aircraft is all powered by electricity, it decreases the harmful emission and protects the environment to a large extent, which is the aim that whole aviation trying to reach in recent years.

The significant reason why the industry is being pushed towards greener aviation is that the environment has been seriously polluted during the last few years. As a result, meteorological disasters such as tsunami and typhoons are more frequent which have a harmful influence on human daily life. Additionally, the global temperature has been continuously increasing due to the greenhouse effect. It accelerates the process of the extinction of rare species on earth. Furthermore, according to shaw et al. 2012, oil prices is continuously increasing and the government published stricter legislation to govern fuel emissions released into the environment. Therefore, greener aviation can be necessary for creating a living-suitable environment for human beings and other kinds of species living on earth. In addition, with the increasing awareness of environmental protection of costumer, except for aviation, industries for other manufacturing fields are also trying to produce greener products to satisfy the demand and be more competitive in the market. Additionally, many countries have published policies that encourages industries to focus on the innovation of environment-friendly products. As a result, aviation is being pushed to a greener industry.

As the above paragraph mentioned, the near future targets of aviation are to produce more efficient, environment-friendly, and low-cost aircraft. For the aspect of improving efficiency, the industries should follow the philosophy that decreasing the all-up weight to the aircraft. The power resources and motor type of aircraft should be selected carefully to avoid releasing harmful emission to the environment. Therefore, replacing the conventional motor with the switched reluctance motor technologies to reduce the emission. Reducing the cost of aircraft can be significant to the development of aviation, which can be approached by using the aircraft systems and elements with long serving life.

For example, the EHA and EMA actuation systems can be a better choice compared to the conventional hydraulic actuation system.

The improvement of MEA technologies can be considered as great progress to reaching the targets of aviation near future. There are three kinds of typical successful more electric aircraft instance which are Airbus A380, Boeing 787, and F-35. Airbus A380 is a typical multifunctional commercial more electric aircraft which is entirely designed according to the MEA electric systems. The aircraft takes the technology of solid-state power distribution and most actuator systems are powered by electricity, which decreases the weight of the aircraft and increases the reliability and efficiency of the aircraft. Furthermore, the design of the structure of the aircraft can be simpler due to applied systems. Boeing 787 is closer to all-electric aircraft compared with the Airbus A380, which has more strong electric power system that is 1400 KVA (Gaynor 2015). The most advanced aircraft among the three types of aircraft mentioned above is the F-35. This kind of aircraft also applies the solid-state power distribution system. Moreover, the controlling system mainly consists of T/EMM and EHA systems, which contributes a better layout arrangement and utilization of energy for the aircraft, which is a quite meaningful achievement for reaching the targets that produce more efficient, greener, and low-cost aircraft.

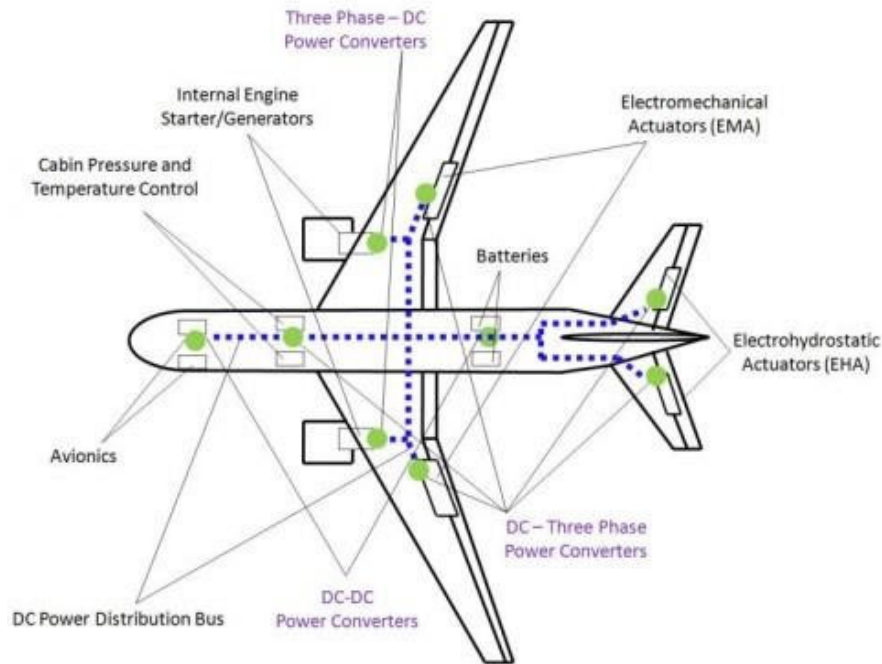
## 3. Conventional Technologies Compared with Technologies Being Used for the More Electric Aircraft

The specific systems of conventional aircraft can be aircraft hydraulic actuation systems. According to Setlak and Ruda 2015, the definition of hydraulic actuation systems in aircraft is that the system that provides a function to control and actuate flaps, landing gears, and brakes. The specific system on the traditional aircraft acts by pressurizing fluids to each section of vessels to create force and transmit pressure on every part to control the movement of aircraft. The system usually consists of four sub-systems which are pressure providing systems, execution systems, controlling systems, assisting systems. Pressure providing system performs a function to convert mechanical or electrical energy into hydraulic energy for the whole system. Execution systems take the responsibility to convert the pressure energy of oil to mechanical energy. The controlling system can control the direction, velocity, and volume of oil flow in the system. The assisting system commonly consists of the parts including oil box and piezometer that can display the system operating status.

For more electric aircraft, the conventional aircraft hydraulic systems are taken place by electro hydrostatic actuator (EHA) and electromechanical actuator (EMA). The working principle of an electro hydrostatic actuator is to convert electric energy into hydraulic power, and then the hydraulic power is converted into mechanical energy. The hydraulic actuator cylinder drives the corresponding pneumatic surface to deflect, which can be simply understood as power-by-Wire. For electromechanical actuator, it is a mechatronics device, the output command signal of the servo controller/driver into speed, displacement, load, and other mechanical quantities, in order to achieve the purpose of driving the speed, displacement and load of the control object. These two kinds of actuators are most widely used in more electric aircraft in recent years.

There are various advantages of using the EHA and EMA systems instead of conventional aircraft hydraulic actuation systems. First, the hydraulic system can occupy a large area and increase the total weight of the aircraft. EHA and EMA systems do not need to displace the hydraulic tubes on the aircraft. Therefore, they can decrease the weight and volume of the plane which improves the efficiency of the flight as lower utilization of fuel. Second, EHA and EMA systems can be more reliable because they can be easy to be check, fixed, and changed whose working principles are not as complex as the hydraulic systems. Third, the systems can be used for a long-time. The reason for that is the EHA and EMA systems

are not easily damaged and the area vulnerable to attack is small. Moreover, the systems do not need to consider the risk that the hydraulic oil can be easily burned during the flight. In addition, they can work in various environments such as rain, high temperatures, and dust. Therefore, the systems can be safer. Lastly, the EHA and EMA systems are lower in cost as they are firm, easy to assemble, and have long serving -life. Additionally, they have fewer requirements for maintenance. In conclusion, the EHA and EMA systems are better choices than the conventional hydraulic actuation system when applied on more electric aircraft (As shown in figure 2).



**Figure 2.** More electric aircraft from Analysis and Simulation of Advanced Technology Solutions of Selected Components in Power Electronics Systems (PES) of More Electric Aircraft

#### 4. Conclusion

In conclusion, aviation is moving forward to the target to produce more efficient, greener, and low-cost aircraft such as more electric aircraft. The recent MEAs introduced to the market have several advantages. For example, building the aircraft have a lower cost compared to the traditional aircraft as more efficient and cheaper systems such as EHA and EMA actuation systems are applied on the aircraft. In addition, MEAs can be more efficient as they lower total weight. Furthermore, MEAs are more reliable because the safer elements take the place of conventional elements such as electric wing anti-ice. However, there is still a large space to improve. Therefore, the industries should attempt to be creative and innovative to produce superior aircraft.

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