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Honeywell

electric green taxiing system

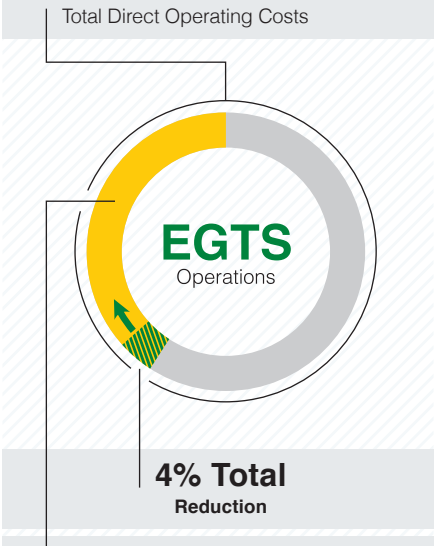
An assessment of the merits of an electric taxi solution and an introduction to the electric green taxiing system

Introduction – the need for a green taxi solution

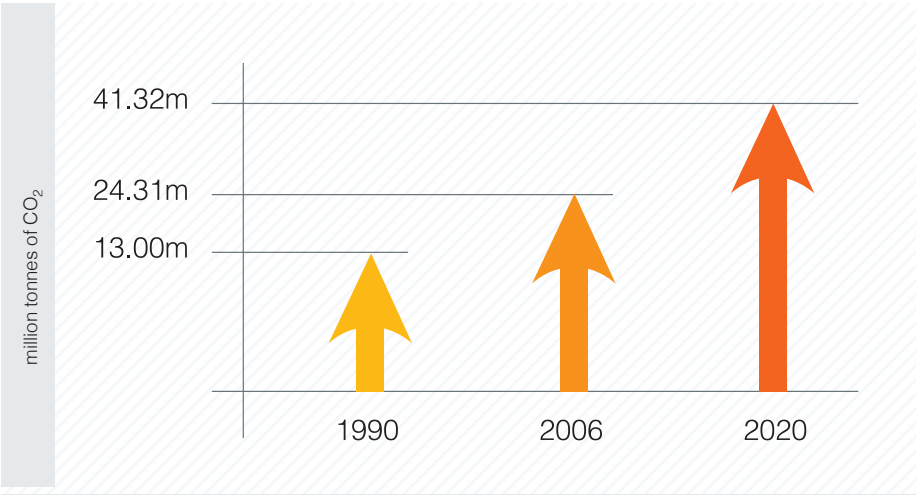
With oil prices expected to remain at record prices and with continued volatility in the market, airlines continue to look for new ways to save fuel and therefore money.

Fuel costs are an ever-increasing drain on airline revenues and profits – accounting for between 30-40% of Direct Operating Costs (DOCs), and up to 50% of airline DOCs in some regions of the world. With this in mind, taxi operations represent a significant portion of an airlines' fuel costs – up to 6% of fleet fuel consumption for short-haul fleets operating single-aisle aircraft from congested airports. A single-aisle aircraft operates an average 2.3 total hours on the ground during 8-10 daily rotations. In fact, the global family of short-haul aircraft burns as much as five million tonnes of fuel per year during taxi operations alone.

Reducing Fuel Costs



Aviation Greenhouse Gas Emissions in the EU



Up to 87% increase in emissions between 1990 & 2006

This also amounts to an output of around 13 million tonnes of CO_2 each year. There is an ongoing global drive to cut carbon and nitrogen oxide emissions. Despite the introduction of more fuel-efficient and less polluting turbofan and turboprop engines, the rapid growth of air travel in recent years has contributed to an increase in total pollution attributable to aviation.

According to the European Commission, greenhouse gas emissions from aviation increased by 87% in the region between 1990 and 2006. It says that by 2020, global international aviation emissions are projected to be around 70% higher than in 2005, even if fuel efficiency improves by 2% per year. ICAO forecasts that by 2050 they could grow by a further 300-700%.

As well as initiatives like the EU Emissions Trading System (EU ETS), the aviation industry continues to look at ways that emissions can be reduced.

Airports too have an ongoing need to reduce emissions in their environment. James Crites is Executive Vice President of Operations, Dallas/Fort Worth International (DFW) Airport. He says: "We have very strict limits on the emission of Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NOx), all of which are emitted by aircraft engines and the tugs using the airport. When planning development, such as a new runway or terminal, we are obligated to undertake a review under the US National Environmental Protection Act to look at what emissions would be created.

"So any new development work has to find ways of reducing existing emissions to 'make room' for new enterprises coming into the marketplace."

"We have done a whole host of things to reduce our emissions footprint, from energy-efficient buildings, to introducing buses that run on natural gas and electric baggage tractors.

Anything else that we can do to reduce emissions has to be looked at," he said.

Alain Chapgier, Corporate Strategy Manager at Aéroports de Paris, agreed and said that it too was under pressure to be more green. It is included in the top 100 companies worldwide showing the greatest commitment to sustainable development.

"We are now using solar energy and ground source heat pumps (geothermal) as part of our drive to sustainable energy production. Any initiative that helps us in our drive to become a more eco-friendly operation has to be taken seriously."

There are other environmental effects to be considered too. Noise in airport environments is regarded as intrusive and is likely to become more of an issue in future. And jet blast issues around gate areas remain an important safety concern.

The reliance on tugs for aircraft push back, can often result in delays. Milan Cornelsen, Director Fleet and Asset Management TUIfly, explained: "Electric taxiing would bring independence and fuel reduction to our fleet. Independence, because we would not need any push-back cart at any outstations and destinations.

"If the push-back cart is defective or occupied, or the driver is on strike, our passengers currently have to wait for their departure. With an electric taxi system we would just need the marshaller to help guide us."

Any solution that could eliminate the need for tugs is an added bonus and would make the dispatch process faster and more autonomous.

The benefits to passengers of a tug-less approach to aircraft dispatches would be faster turnarounds. And if the aircraft's engines were not running when the aircraft arrives at the gate, ground-handling staff would be able to access the aircraft faster and commence arrival tasks.

Passengers' bags could, in theory, be unloaded faster and arrive on the carousel much earlier. Passenger disembarkation could also be faster too.

The need for an alternative solution to traditional aircraft taxiing operations, which reduces fuel burn and delivers environmental benefits, is now greater than ever. As a result, a number of initiatives are under way to develop electric taxi solutions. Indeed the search for a viable electric taxiing solution has been going on ever since the oil crisis of the 1970s.

Currently both Boeing and Airbus are exploring the possibilities of electric taxiing or autonomous taxiing solutions and there are a number of potential solutions being brought to market.

The electric green taxiing solution

In 2011, Honeywell and Safran joined forces to develop an innovative new system that can significantly improve an airline's operational efficiency, reducing fuel and other taxi-related costs. It also provides environmental benefits by slashing carbon and other emissions created during taxi operations.

The **EGTS electric green taxiing system** combines Safran's extensive experience in integrated landing gear systems with Honeywell's heritage in APU innovation. Their combined experience gives airline customers an attractive proposition and represents a viable and credible solution when it becomes available in 2016.

The electric green taxiing system uses power from the aircraft's Auxiliary Power Unit (APU) generator to electrically power motors fitted to the main landing gear wheels. The system allows an aircraft to push back without tug assistance and then taxi towards the runway without the main engines running. Once near the runway the aircraft's main engines can be started. On landing, the aircraft can taxi off the main runway and then stop its engines. Then, using the APU power, it can engage the EGTS and taxi to the terminal and park at the gate. Again, all without using the main engines.

Today's turbofan engines are optimized for flying, not for powering aircraft on the ground. Every time an airliner taxis, it burns a disproportionate amount of fuel between gate and runway. This becomes even more of an issue for short and medium-haul aircraft, which spend a relatively long time taxiing between runway and gate, compared to the actual length of the flight. For an Airbus A320, for example, making a 500 nautical mile flight, it is estimated that EGTS will save up to 4% of block fuel costs, compared with standard taxiing procedures.

Operational Efficiency

EGTS can deliver up to 4% savings of total block Fuel consumption

The environmental benefits are also compelling. One single aircraft using EGTS is the equivalent of removing 400 cars from Europe's roads in terms of the fuel use and CO_2 emissions, or 300 if you consider NOx emissions.

Reducing Emissions

Removing 400 cars from Europe's roads in terms of fuel use and CO_2 emissions

Michel Laudy, Short and Medium Haul Fleet Director, Air France – KLM, says that electric taxiing could be a major boon. "Green taxiing could add some value to Air France. At Paris Charles De Gaulle (CDG) airport we typically have around 60-70 single aisle aircraft operating on routes less than 500 nautical miles every day (60% of these flying less than 300-400 nautical miles) and the taxi-out time per aircraft averages around 17 minutes. At Orly (ORY) it is around 10 minutes. The fuel savings using an electric solution would be significant. It would also give greater autonomy to the aircraft and cut down handling costs."

EGTS would also have a considerable impact on airport noise and emissions pollution, offering a reduction of up to 75% in carbon (CO_2/HC/CO) and up to 50% Nitrogen Oxide (NOx) emissions compared to current levels. Michel Laudy said that with both CDG and ORY being close to Paris any reduction in emissions and noise would be vitally important. "When considering the options list on a new Airbus aircraft a green taxi solution would certainly be worth considering."

Airbus A320 Captain, Uwe Leberl of Lufthansa AG agreed, saying that the benefits of an e-taxi solution are wide ranging in terms of fuel saving, drastically reduced push-back charges, reduced emissions and noise.

"This sends a signal out to the world that something is being done to reduce the impact of our industry on the environment," he said.

He added: "We have around 90 aircraft that fit the profile of potentially benefiting from an electric taxi solution. There are still a lot of details that I would like to know more about, such as the human-machine interface for operating such a system, but in principle I think it is a good idea. I think the time savings in what would have been the push-back phase are also worth considering – it would certainly accelerate the process.

"An e-taxi solution would require a significant change to the workflow required to dispatch an aircraft, including Air Traffic Control (ATC) procedures, and that needs to be carefully considered. In time I could see that an e-taxi solution could be commonplace in terms of new-build aircraft – you can design the airframe to accommodate such a solution from the outset. In the meantime I would like to look at the technical aspects of an after-market retrofit of such a solution."

Alain Chapgier, Corporate Strategy Manager at Aéroports de Paris, said that an autonomous e-taxi solution brought other benefits too. "Such a system would work at any airport, both during the dispatch and landing phases. It could also be used to move aircraft to maintenance facilities or parking stands as well. This saves time and money for both the airline and the airport handling teams.

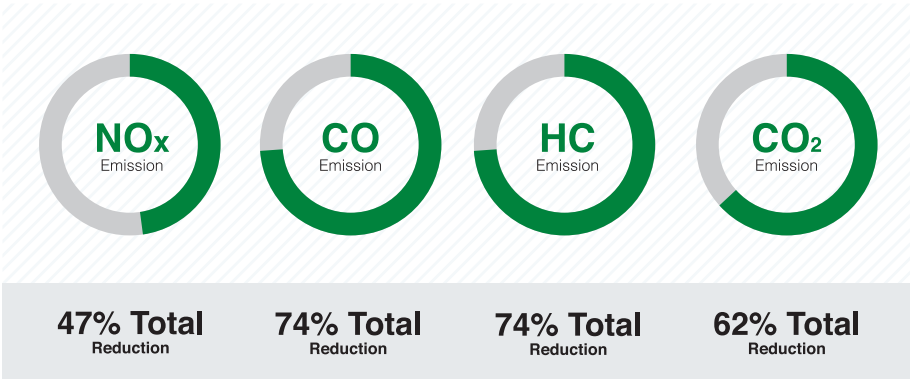
"As our average airport taxi-out time is around 25 minutes in total, we think that any solution must have certain minimum parameters, such as a taxi speed of at least 20 knots with good acceleration up to 10 knots. It must also be able to deal with slopes and have good integration with the aircraft's existing systems."

And there are other benefits too. Line maintenance time would be lowered because brake wear will be reduced and engine life extended – engines are prone to ingest large amounts of dust and debris when powering up on the ground at an airport. With EGTS the problem is reduced considerably.

The project has received a lot of interest from the aviation industry. James Crites, Executive VP of Operations at Dallas/Forth Worth Airport (featured earlier) said: "When I first saw the presentation on electric taxiing I thought this was potentially another tool that we could consider to address the emissions challenge that we all face.

"In addition to the environmental benefits it is also attractive in terms of reducing operating costs. Damage and injury caused by debris and equipment blown by engines being run up on the ramp would also be eliminated," he said.

Reductions in Emissions



Figures shown reflect reductions per cycle

So how does EGTS work?

The EGTS initiative was first announced at the Paris Airshow in June 2011, where Honeywell and Safran signed a memorandum of understanding to create a joint venture company called EGTS International to deliver innovative new electric green taxiing system solutions for new and existing aircraft. The joint venture encompasses joint system development, production, marketing and support.

The partnership provides systems expertise with a combined 8+ years of electric taxi research and development experience. This combines Honeywell's extensive knowledge of avionics and auxiliary power systems with Safran expertise in landing gear systems. Both bring complementary capabilities in terms of electric power products and systems integration, calling on the expertise of more than 200 engineers at 16 locations worldwide, from France, the US, Canada, UK, India and Mexico.

So how does it work? Using the Auxiliary Power Unit (APU) generator to power electric motors integrated into main landing gear, the EGTS system allows aircraft to pushback autonomously from the gate without the need for a tug and taxi between gate and runway without requiring the use of aircraft engines. Two of the main wheels are equipped with an electric motor, reduction gearbox and clutch assembly to drive the aircraft.

The main landing gear wheels were chosen for maximized performance, traction and agility.

EGTS Milestones

- **Q1 2012:** System architecture frozen
- **Q3 2012:** Manufacturing of first components
- **Q1 2013:** System integration testing begins
- **Q2 2013:** TRL4 targeted
- **Mid 2013:** Fully integrated prototype system test on A/C
- **Q4 2013:** TRL5 targeted
- **Q1 2014:** Expected full scale development program launch
- **End 2016:** Target EIS

Olivier Savin, EGTS Program Vice President at Safran, explained: “The primary driver for powering the main wheels rather than the nose wheel is traction. Less than 10 per cent of the aircraft weight is on the aircraft nose gear making it difficult to achieve the taxi performance required by airlines in all operating conditions. The EGTS will work on any type of taxiway condition – rain, ice or snow, where greater tire ground friction is required."

Each of the aircraft’s powered wheels is equipped with an electro-mechanical actuator, while power electronics and system controllers give pilots total control of the aircraft’s speed and direction during taxi operations. As mentioned earlier, the system is specifically aimed at single-aisle aircraft, like the Boeing 737 and Airbus A320, which operate many daily flight cycles and therefore many taxi operations each day. EGTS therefore offers the maximum fuel savings for these types of operations.

TUIfly's Milan Cornelsen added that "… there is a huge potential for fuel burn reduction savings each year."

The initial EGTS tests were completed in Montpellier, France, on an Airbus A320. The tests were to evaluate runway conditions and calculate the necessary loads needed for moving the aircraft on the ground.

Brian Wenig, EGTS Program Vice President at Honeywell, explained further: “What became clear was that the decision to power the main wheels and not the nose wheels was the right one. Under certain conditions (such as when the ground is icy, wet or there is an incline) poor adhesion (grip) can occur if the front wheels are driven. But when mounted on the main landing gear wheels, closer to the aircraft's centre of gravity, the problem is eliminated.”

The big benefit of EGTS is that it is a fully-integrated solution, including the cockpit interface, controls, APU integration, wheel mounted motors, actuators and much more. As Christophe Hesters, EGTS Program Director at Messier-Bugatti-Dowty (Safran), is keen to point out.

"This is unique in the market," he said. "No-one else is working on such a fully-integrated method of offering electric taxiing. EGTS is an Air Transport Association (ATA) modification, comprising four different ATA chapters – electrical power (chapter 24), landing gear (chapter 32), indicating/recording systems (chapter 31) and airborne auxiliary power (chapter 49).

"As a result there is extensive sub system and full system integration that needs to be undertaken, along with an exhaustive testing campaign," Hesters said.

The testing has been undertaken by both Honeywell and Safran at sites across Europe, the US and Canada. The full system integration is being tested and validated in Toulouse on an Airbus A320.

More than 3,000 lab hours have now been spent on electrical and landing gear sub-system integration. Other qualification testing has been under way on the wheels and brakes used on the EGTS aircraft – a total of 2,200 miles in both normal and loaded conditions. More than 160km of ground testing has also been undertaken with the Airbus A320 over a period of 300 hours. The fully-integrated EGTS "package" has been designed for single aisle aircraft, with both the forward fit and retrofit markets in mind. Honeywell and Safran plan to make EGTS available for new aircraft in 2016, to be followed shortly thereafter by a retrofit option for aircraft already in service.

Key Performance Attributes

- ≈20 knots speed in 90 seconds (≈18 knots @ MTOW)
- ≈10 knots speed in 20 seconds for active runway crossing
- Breakaway torque @ 1.5% slope at MTOW
- No reduction in reliability or dispatch performance

The Benefits

The expected benefits of the Honeywell/Safran system include:

- **Lower Fuel Burn**

As taxi operations burn a significant amount of fuel (as much as five million tonnes of fuel per year for the global short-haul fleet) the electric green taxiing system can result in savings of up to 4% of total block fuel consumption. For airlines that operate high-cycle, single-aisle aircraft, the EGTS is expected to generate a projected savings of more than USD $200,000 per aircraft per year.

- **Improved "On Time" Performance**

Aircraft equipped with the system are able to “push back and go” more quickly, thus reducing both gate and tarmac congestion, improving on-time departure performance and saving valuable time on the ground. This innovative electric taxiing system also offers significant advantages for airports, including up to a two-minute improvement on each dispatch, optimized aircraft ground traffic, reduced gate and apron congestion, as well as greater gate availability. Personnel can get to work sooner after the aircraft arrives at the gate, resulting in reduced turnaround times, faster passenger disembarkation and earlier luggage delivery.

- **Greener Operation**

In addition to reducing noise in the airport environment, the electric green taxiing system offers a reduction of up to 75% in carbon (CO_2/HC/CO) and up to 50% Nitrogen Oxide (NOx) emissions.

- **Added Value**

The EGTS operation eliminates the need for aircraft push back and repositioning via a tug tractor, while also reducing brake wear, extending main engine life and enhancing ground crew health and safety. EGTS also decreases engine maintenance by limiting foreign object debris (FOD) damage caused by material being ingested into the engines while taxiing.

electric green taxiing system

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All estimates on performance, operational benefits and cost savings provided within this document are based on Honeywell and Safran data.

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