

electric green taxiing system

Presentation to Arts et Métiers – June 2013



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electric green taxiing system – Meeting Agenda

- Introduce **electric green taxiing system (EGTS)** concept and Provide overview
 - **General Introduction to EGTS and Safran/Honeywell JV**
 - **Technical Overview**
 - **Benefits/Value**
 - Operational benefits
 - Present Airline Value Model
 - **Focus on ground operations**
 - **Summary**

Informing on EGTS Program and Airline Benefits

electric green taxiing system

general introduction



Why an **electric green** taxiing system ?

Current impact of global single aisle fleet in airport ground operations



~13 Million tonnes CO₂

Fuel is now ~ 40% - 50% of Airlines' costs

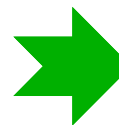


Up to 6% of total fuel burnt on ground

**EGTS
will save
50%**

- Aircraft engines not optimized for ground operations
 - Technology now available to offer a more efficient alternative

**One single EGTS aircraft equivalent to removing from European roads:
~ 400 Cars (Fuel + CO₂ emissions)**



**~ 3,000 EGTS single aisles
=
~ 1 Million+ cars**

Basic Concept of the EGTS

- The **EGTS** will allow the aircraft to push-back and taxi under APU generated electrical power *without the main engines running*
 - APU generator powered motors allow aircraft to “taxi”
 - Motors housed in main landing gear wheels for maximized performance, traction and agility
- High value offering to Single Aisle Airline Customers with significant savings and “Green” Benefits, *reducing:*
 - Fuel Use
 - Airport Emissions
 - Need for Ground Tug
 - Other Direct Operation Costs



Target Savings: ~3% block fuel reduction depending on mission

A 50/50 JV combining the strength of two market leaders



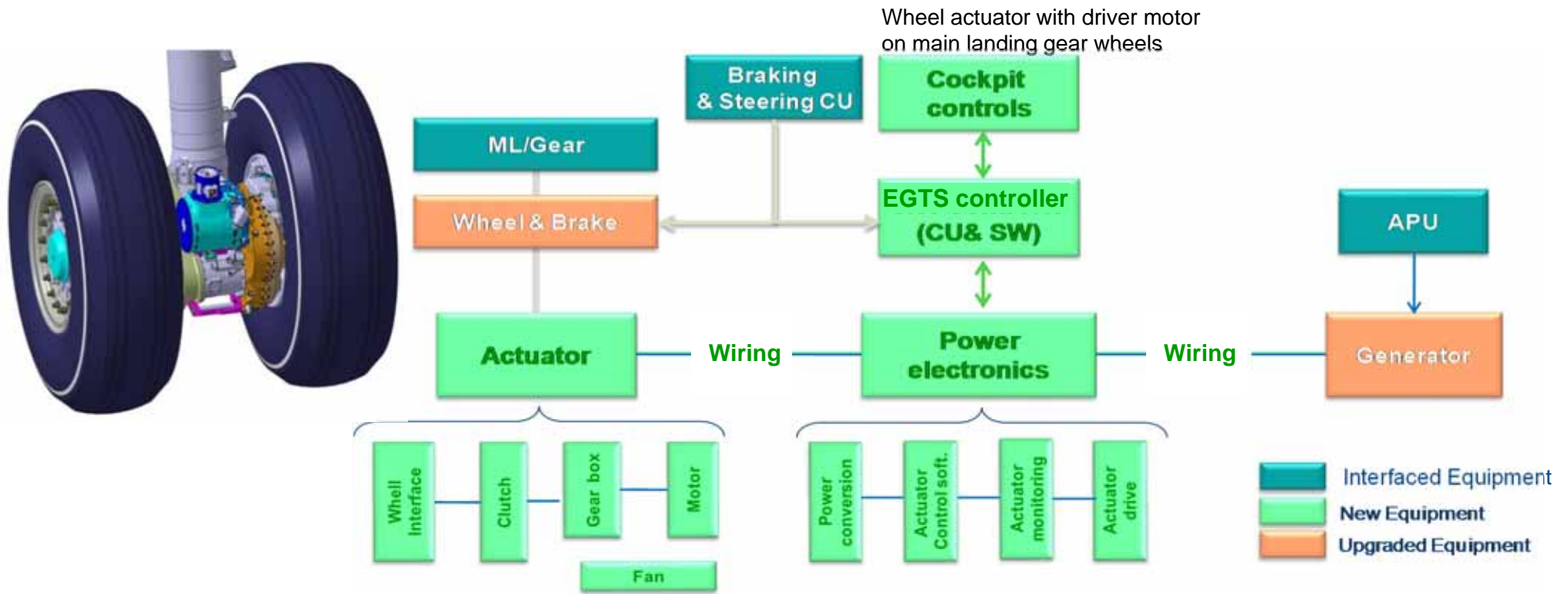
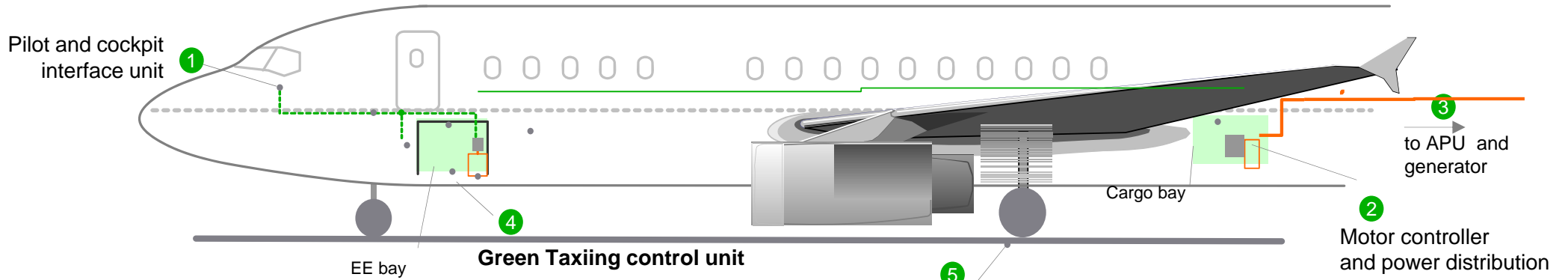
- **SAF-HON have established a JV for electric green taxiing system development**
 - Provides an accelerated time to market for **electric green taxiing system**
 - Partnership includes joint system development, production, marketing and support
 - JV to provide a superior product and global customer support
- **Partnership provides systems expertise and early availability of electric green taxiing system**
 - Honeywell Avionics and APU system breadth
 - Safran landing gear systems breadth
 - Complementary capabilities in electric power products and systems integration

electric green taxiing system

technical overview



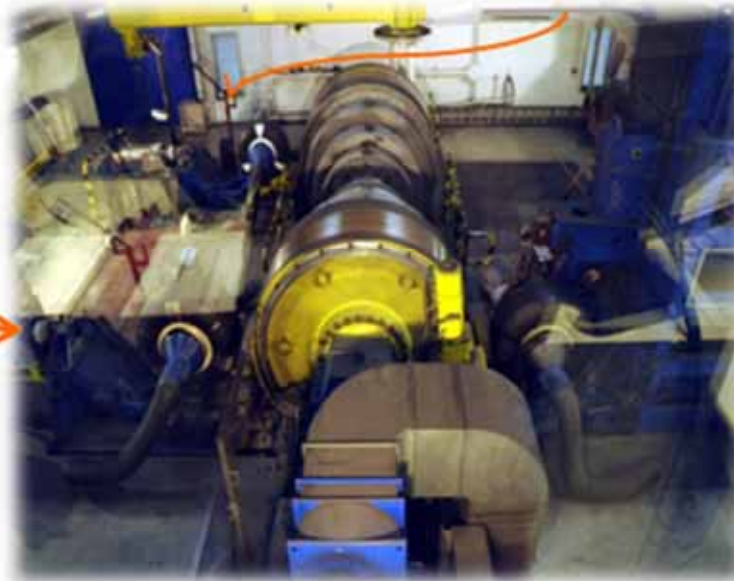
EGTS schematic architecture



Prototype Testing



WA Full perfo Testing



Dyna bench test



Equipped LG



EP system bench test



Full system integration on Airplane
Testing started in March '13

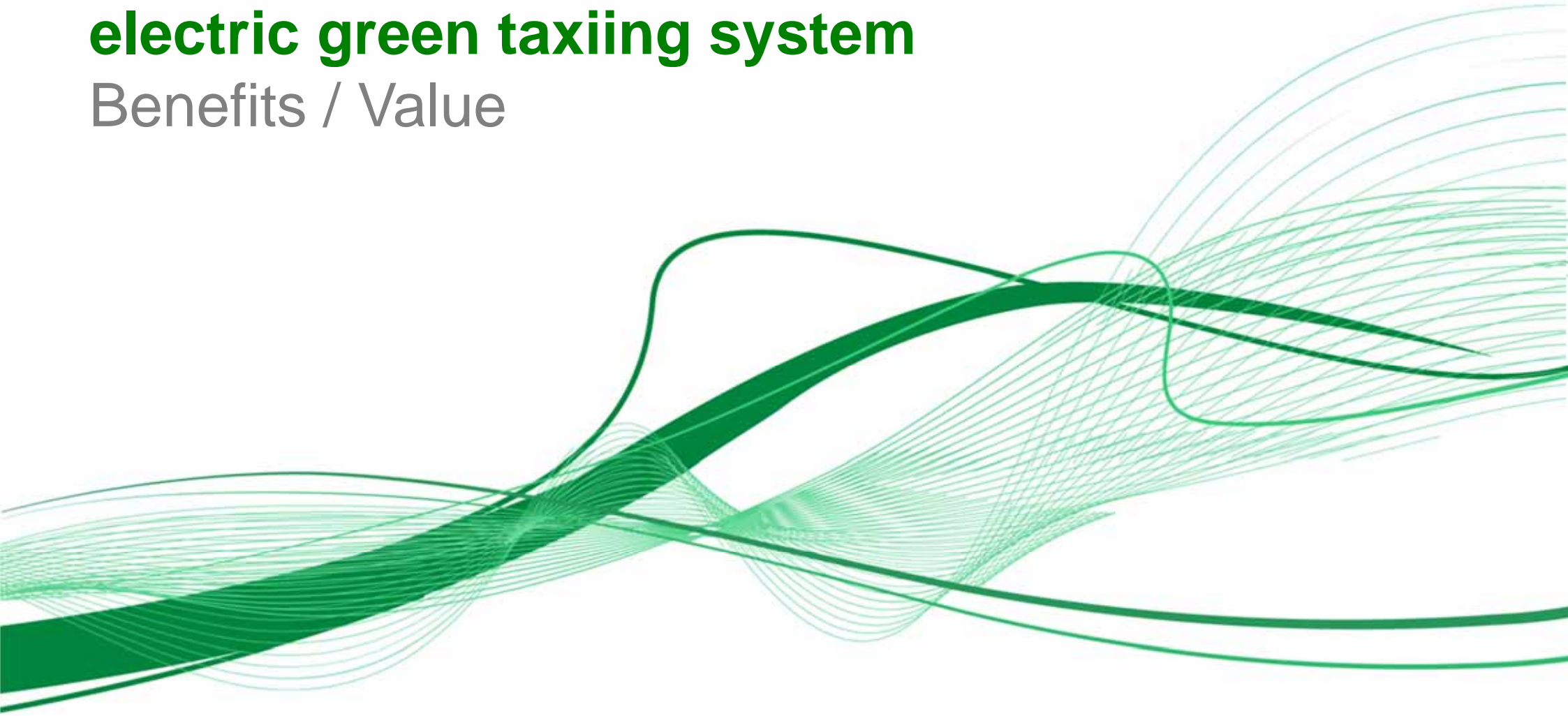
On-Aircraft testing



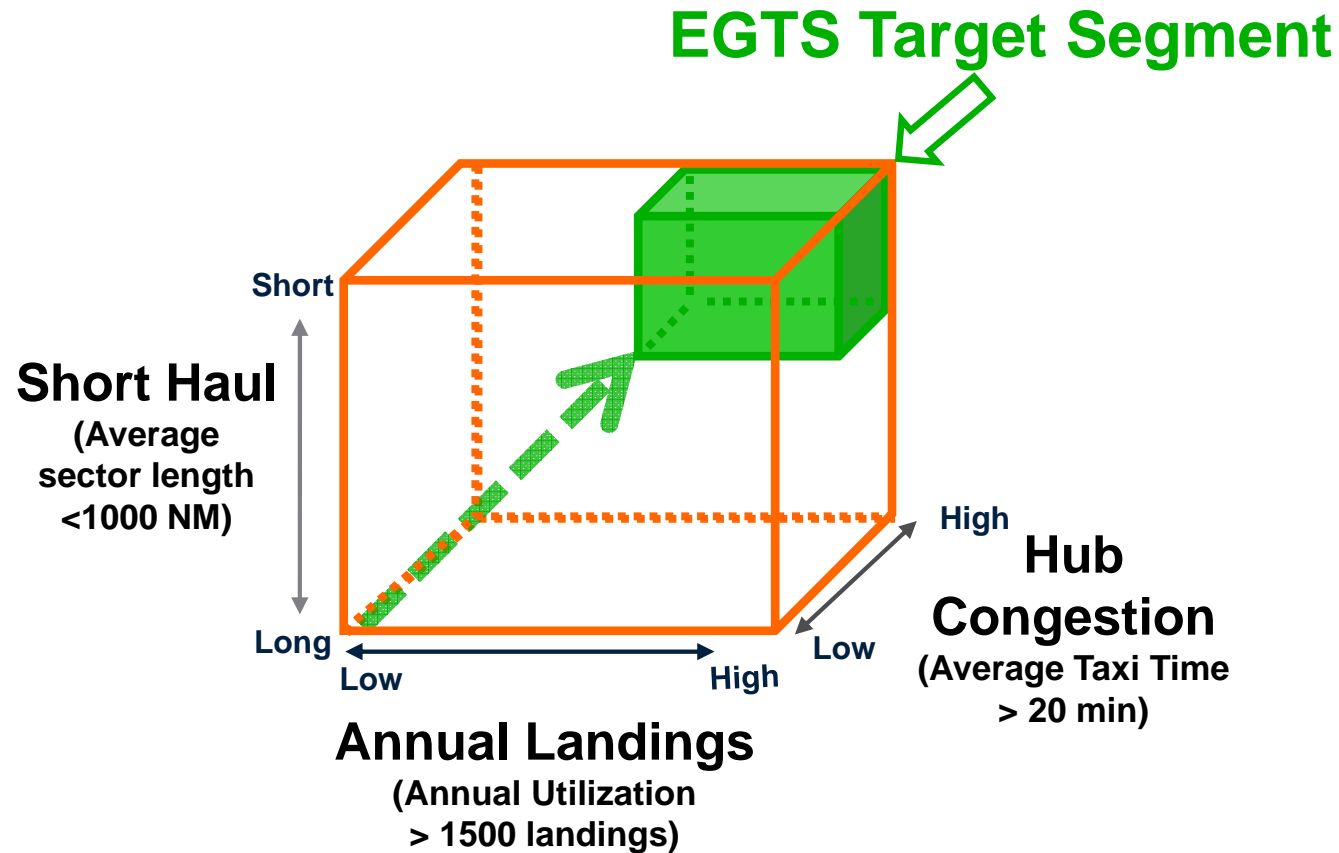
*On-Aircraft testing began end of March
on Safran A320 MSN 234*

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Benefits / Value



EGTS: substantial **benefits** depending on operational profile



Target segment based on value drivers

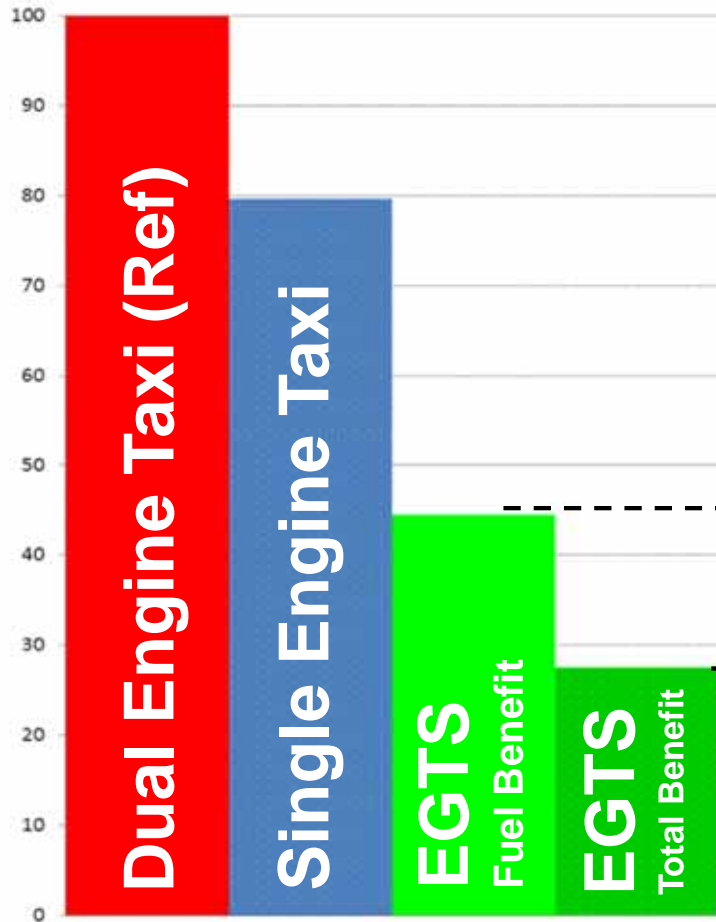
EGTS: benefits to airlines and environment

- Benefits **quantified**:
 - Reduced fuel burn and brake wear
 - Reduced ground tug operation
 - Reduced Foreign Object Debris damage (Estimate – Insight SRI)
 - Elimination of taxi out fuel contingency
 - Reduced emissions / carbon taxes
- Benefits recognized but **not quantified**:
 - Reduced noise in airport environment
 - Improved safety at apron: No engines running / no jet blast
 - Taxi to hangar / gate and stand positioning
 - Increased gate autonomy / Improved OTP
 - Reduced ground operations damage
 - Engine maintenance cost savings
 - Higher precision manoeuvring
 - Lower pilot workload vs. Single Engine Taxi
- Additional costs **quantified**:
 - Increased APU fuel burn
 - EGTS and additional APU Maintenance
 - Additional aircraft fuel burn due to EGTS Weight



Reducing fuel use and ground operations costs

Dual / Single Engine Taxi / EGTS
Fuel burn and Costs



Value model delivers over 50% savings compared to Dual Engine Taxi

Additional EGTS savings :

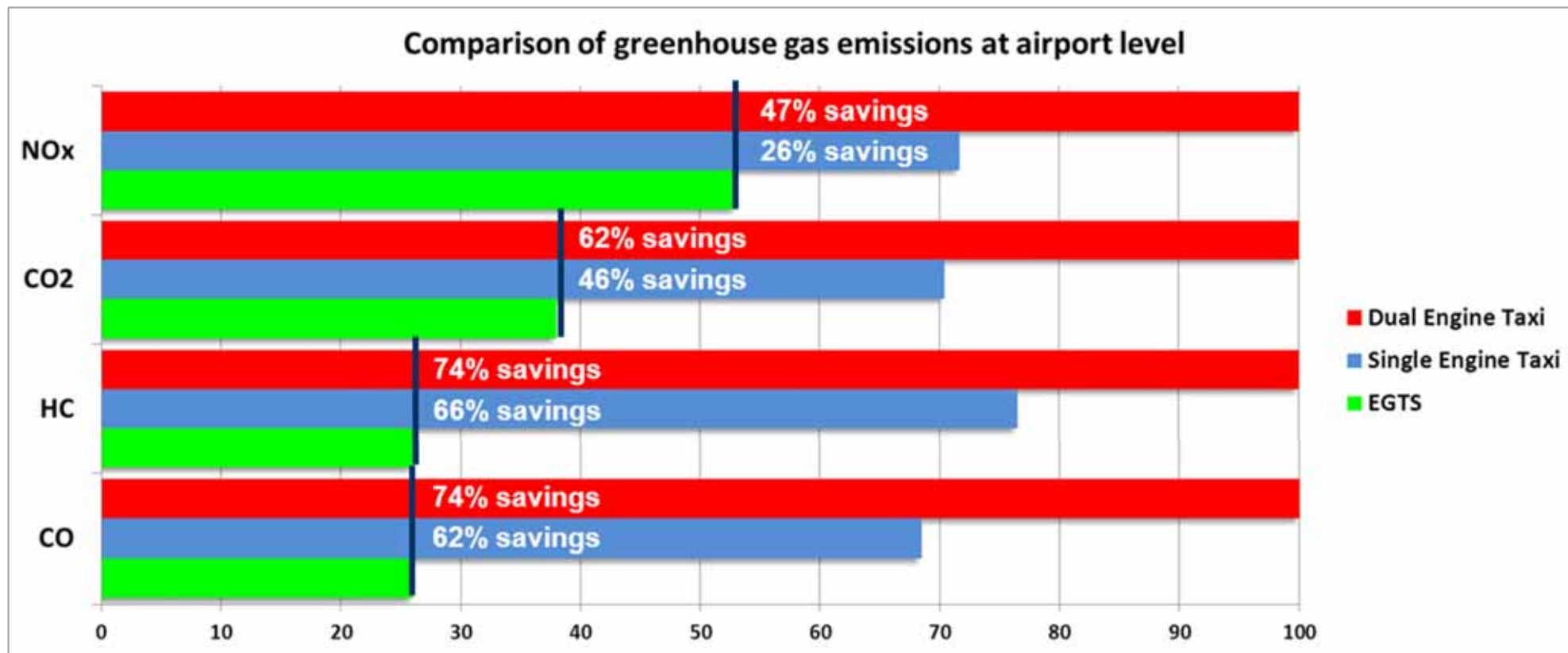
- Pushback costs
- Brake wear
- Carbon credit
- Foreign Object Damage
-

As well as:

- Aircraft positioning
- On Time Performance
- ...

Reducing airline and airport environmental footprint

- Reduced carbon and greenhouse gas emissions linked to aircraft ground operations



- Reduced noise in the airport environment



Improving operational efficiency

- **Improved health, safety and efficiency for airport ground personnel**
 - No engines running in gate area
 - No jet blast
 - Personnel can get to work sooner after aircraft arrival at gate
- **Improved performance for airports...
.... and passengers**
 - Reduced Turn Around Time at gate
 - Faster passenger disembarkation
 - Earlier luggage delivery
- **Increased aircraft autonomy**
 - Ability to “Pushback and Go”
 - No reliance on tug



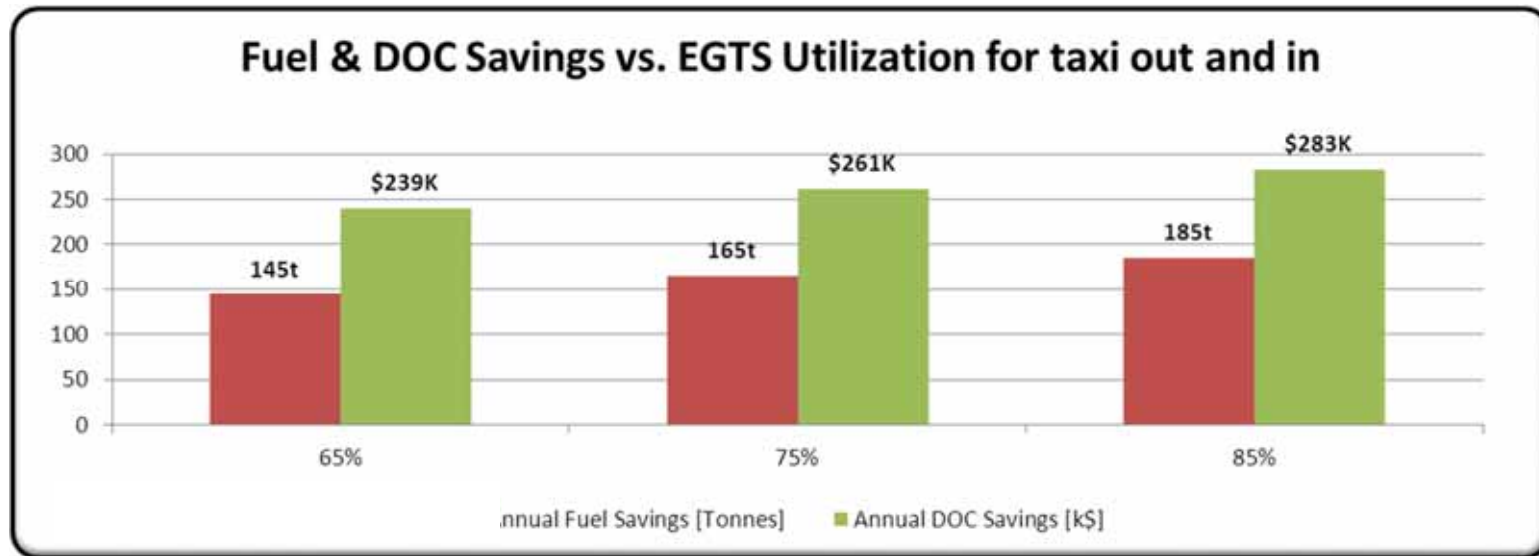
***Towards ultimately improving gate capacity
via improved On Time Performance***

Value model: annual savings ranges

- Airlines will value **electric green taxiing system** differently depending on annual cycles & other operating parameters (i.e. \$ benefits derives from the usage):

- Taxi time (In + Out)
- Flight Cycles / year
- Electric GTS Utilization
- Flight Ranges

	\$ savings		\$\$\$ savings
Taxi Time	10+5	15+10	20+10
Utilization	55%	65%	90%
Flight cycles	1000	1800	2500
Flight range	1500	600	500
\$/USG	2\$	3\$?



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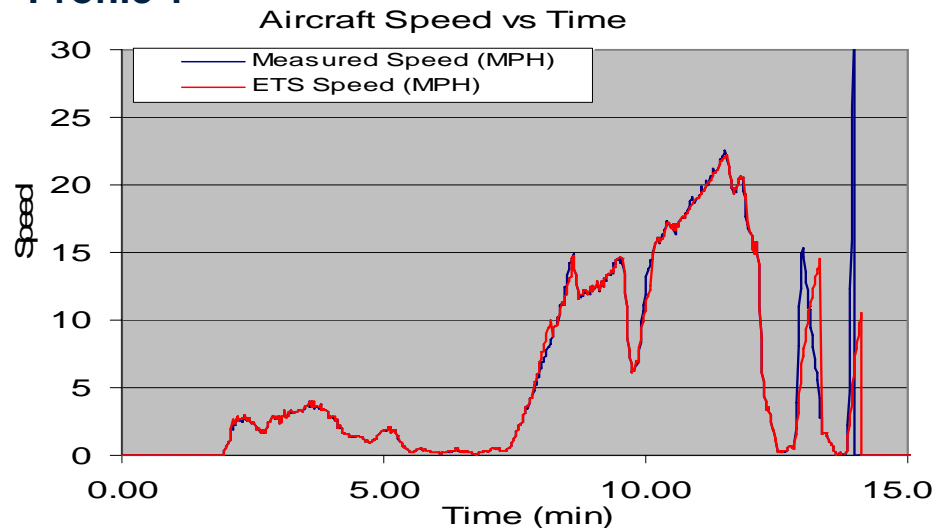
focus on ground operations



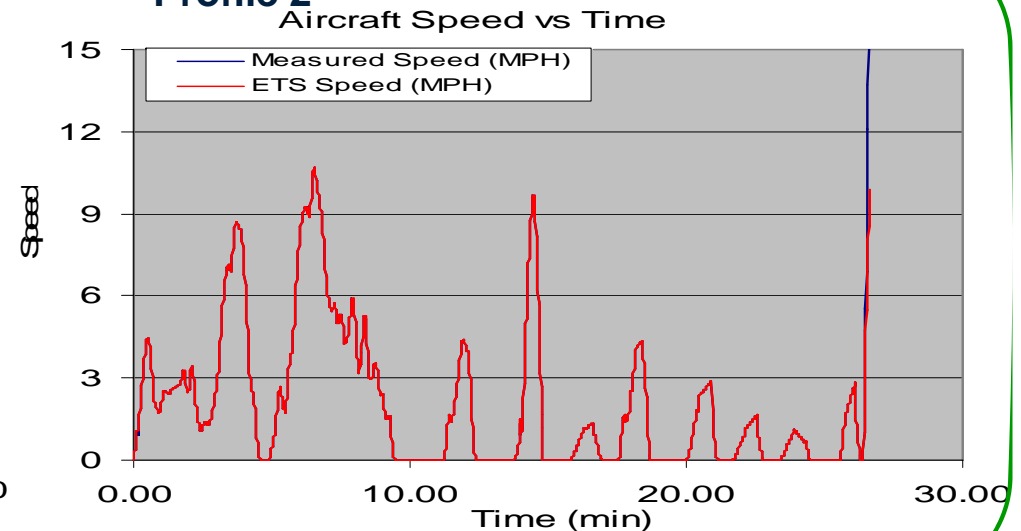
Designed to meet Airlines & Airports operational requirements

- Key system features:
 - ≈ 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 degradation on current availability (dispatch; accessibility for line maintenance)
- Measured taxi profiles vs. **predicted performance**

Profile 1



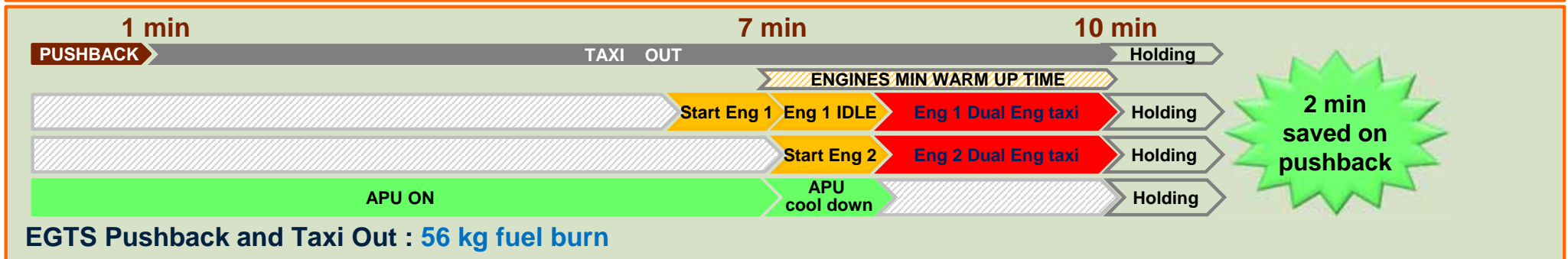
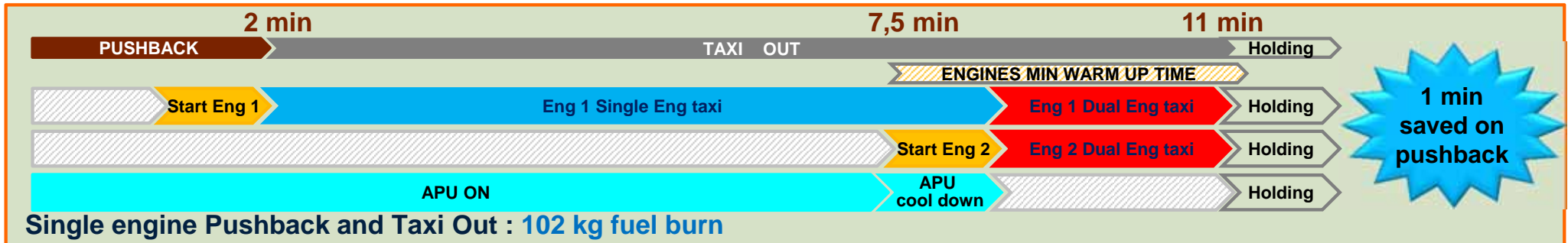
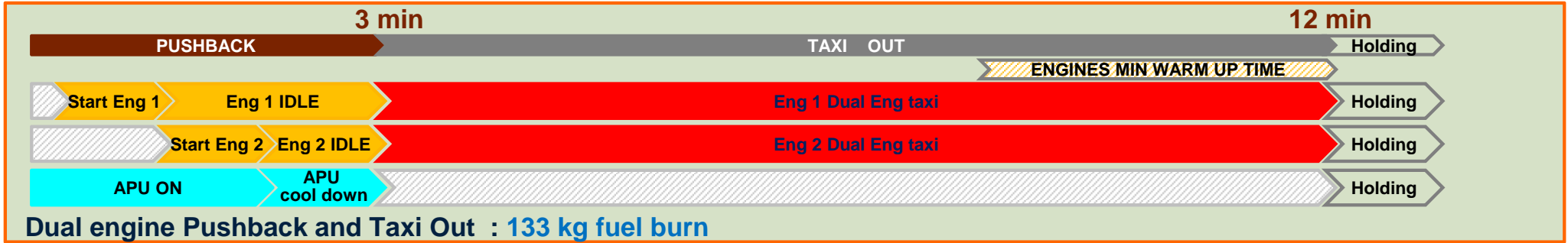
Profile 2



Dual Engine taxi fuel burn	5,8 kg / min
Single Engine taxi fuel burn	7,42 kg / min
Idle fuel burn	5 kg / min
APU standard fuel burn	1,81 kg / min
APU EGTS fuel burn	2,07 kg / min

Ground operations fuel burn segmentation

- Pushback and Taxi Out : different procedures, different fuel burns (ex 12 min PB & taxi out up to holding point)

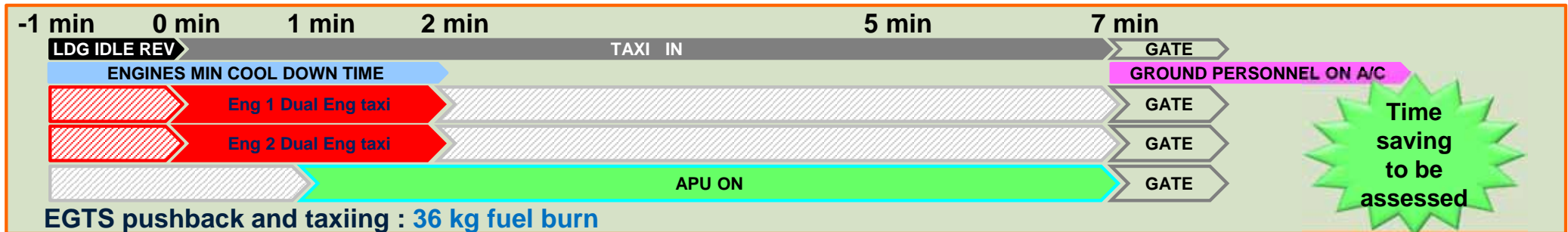
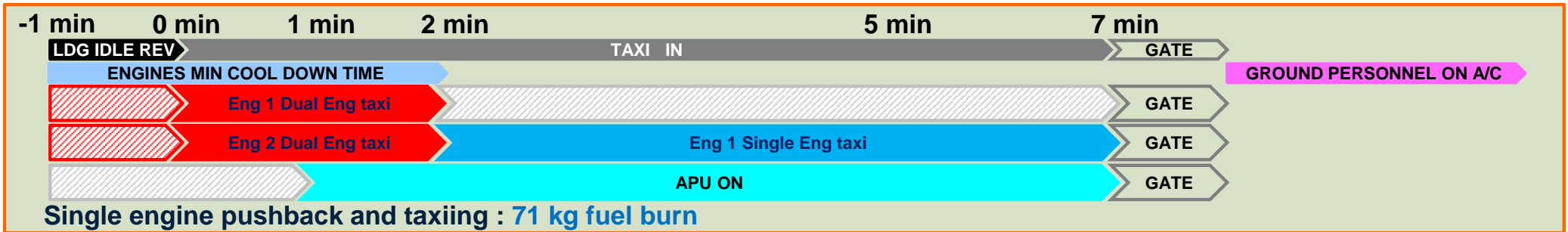
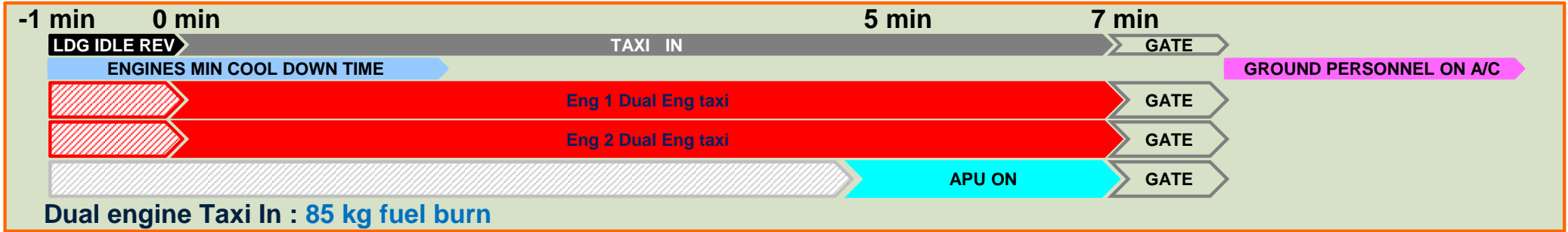


>50% fuel burn reduction & 2 min time savings with EGTS vs. Dual Engine taxi

Dual Engine taxi fuel burn	5,8 kg / min
Single Engine taxi fuel burn	7,42 kg / min
Idle fuel burn	5 kg / min
APU standard fuel burn	1,81 kg / min
APU EGTS fuel burn	2,07 kg / min

Ground operations fuel burn segmentation

- Taxi In** : different procedures, different fuel burns (ex 7 min Taxi In from end of landing roll, Idle Reverse)



>55% fuel burn reduction with EGTS compared with Dual Engine taxi

electric green taxiing system

conclusion



Strong VOC Interest From Airlines

■ Airlines

■ **Highly interested** due to **fuel burn** and **“Green”** benefits

“EGTS has big impact on fuel savings and we are **very much focused on that**”

“**Green issues** are becoming more and more **important** for us.”

■ Completely **driven by cost reduction** and agrees that system provides significant savings

“...if Flt Ops, Ground Ops & Engineering happy, would likely order EGTS”

■ **“Green taxi will happen”** “We are focused on reducing taxi fuel consumption”

■ Focused on reducing fuel burn and evaluating ways **to achieve more efficient taxi ops**

“...would order if investment criteria met and comfortable with risk”

■ Interested in concept and want to understand value proposition

“Very interesting...like the concept...a real benefit is **increased flexibility on pushback**”

■ N European airline: Even with short taxi times, interested in EGTS due to “Green” and other benefits

■ Interested in EGTS as it aligns with focus on fuel reduction.

“We are focused on fuel reduction and are currently assessing a number of fuel saving measures with less or much less benefit than what EGTS would provide.”

■ Head of NA Airline Fuel Efficiency Group, with long sectors resulting in ~1.5% fuel savings

“...this system is very exciting and has a **very good future ahead** of it....philosophy is sound....it is **the way of the future!**”

Strong VOC Interest From Airports

- North American and European airports
 - Highly interested due to Green and other benefits
 - “.. **lower emissions is a real benefit**”
 - “...we see a benefit from the environmental impact – **lower noise** and emissions.”
 - “...we hope EGTS will **put our tug business out of business!**”
 - Willing to work with airlines to **change ground operations procedures**
 - “...we'll do what we need to do to accommodate electric green taxiing system.”
 - Believe that aircraft with EGTS could pay lower landing and other fees
 - “**Differentiation fees for EGTS vs. non-EGTS may be possible.** Airport community could be driven to accept this change, globally.”



electric green taxiing system: **summary** and **way forward**

▪ **Main benefits**

- **Increased fuel efficiency**
- **Operational benefits**
- **Environmental benefits**
- **Operating cost savings**



- **Honeywell and Safran: A powerful partnership bringing a mature EGTS to market**

A green and innovative concept