

AVDASI-3: Sustainable Aviation & Ethics

Lecture-4: Sustainable ATC & ATM, ground / airport operations etc.

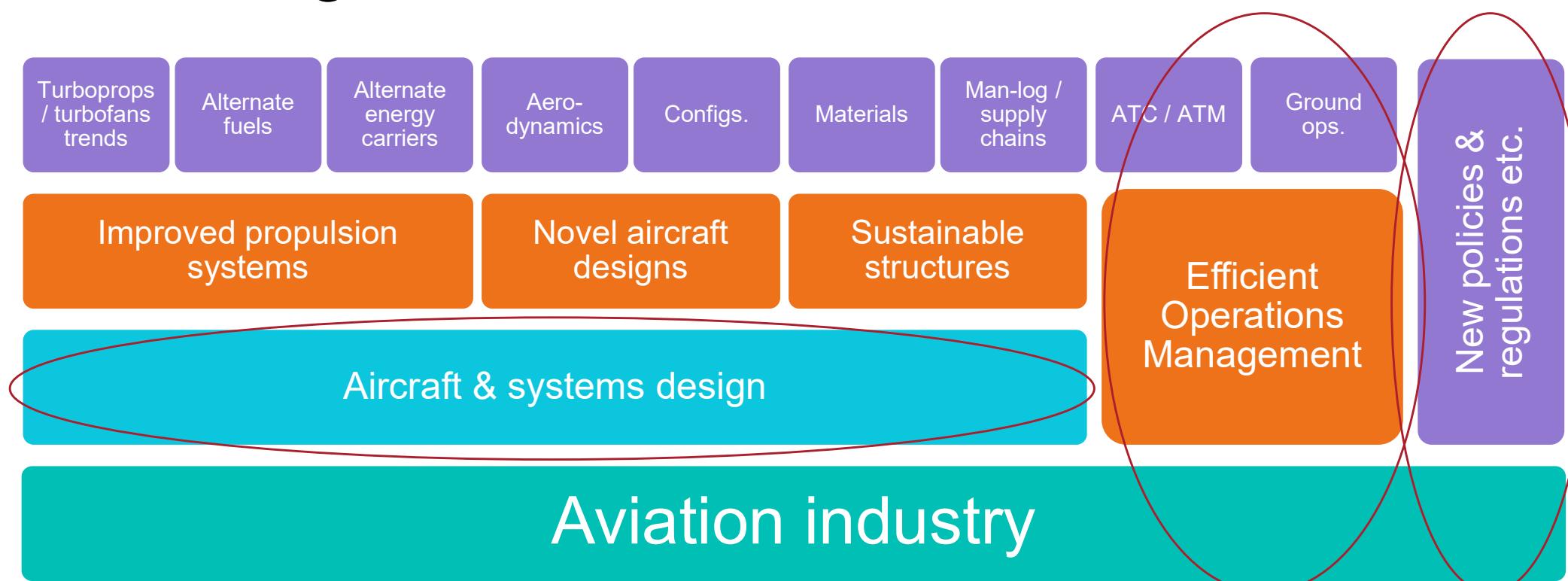
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Building blocks for sustainable aviation



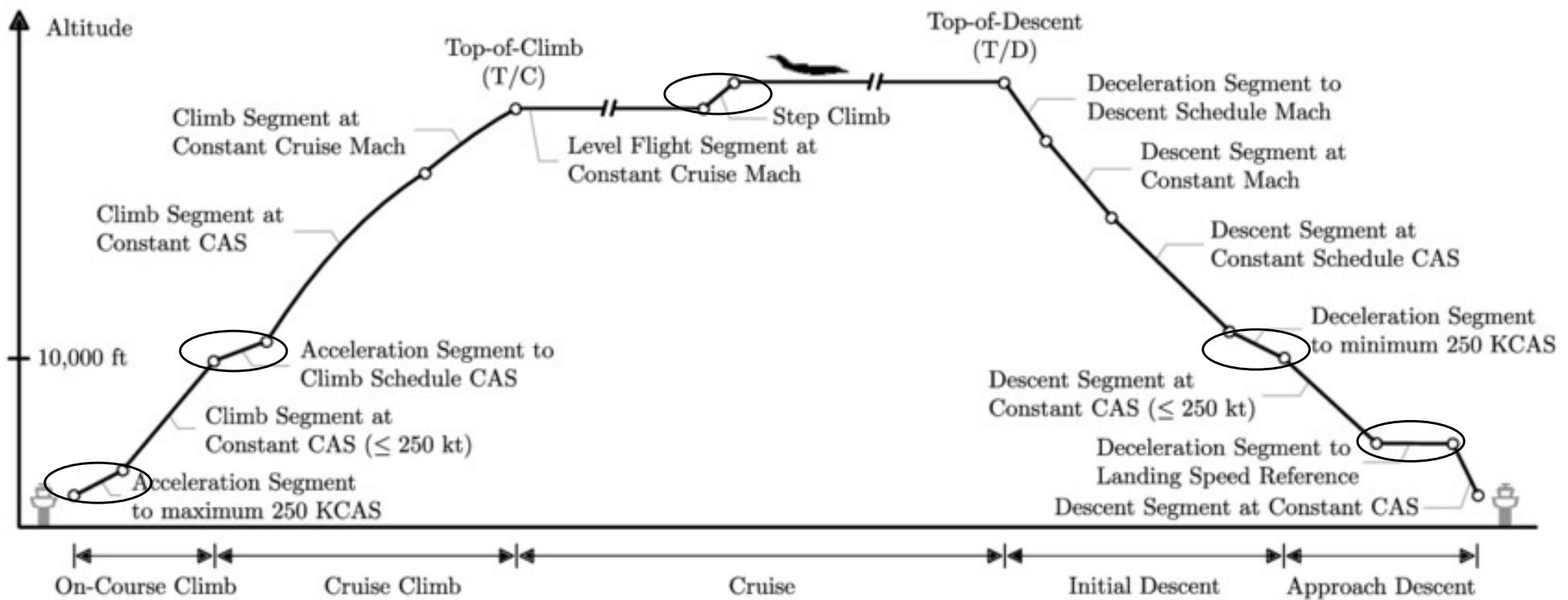
Possible sustainability measures

Greener flight
paths

Greener airlines
operations &
practices

Greener taxiing
& ground
operations

Classic flight profile



Air traffic management



**Visual flight
rules (VFR)**

**Instrumented
flight rules
(IFR)**



T/O&L	Sequencing by ATC
Up & Away	By level difference
Communications	Radar, RF, SATCOM
Routing & Separation	Conventional airways, often with procedural separation (beacon to beacon)

Greener flight paths - PBN

- Performance based navigation (PBN)
- Free route airspace (FRA) instead of conventional airways: Optimal flight route (direct great circle) based on wind vector field
- More sensors (collision avoidance & situational awareness), MSDF, onboard data processing, AI based decision making etc.
- Hybrid ATM?



Centralised	Decentralised
Global optima ✓	Short term opportunity ✓
Sensitive info like weight X	Pilot overload X
Missing short term opportunities (tail wind) X	Chaos in the sky? X

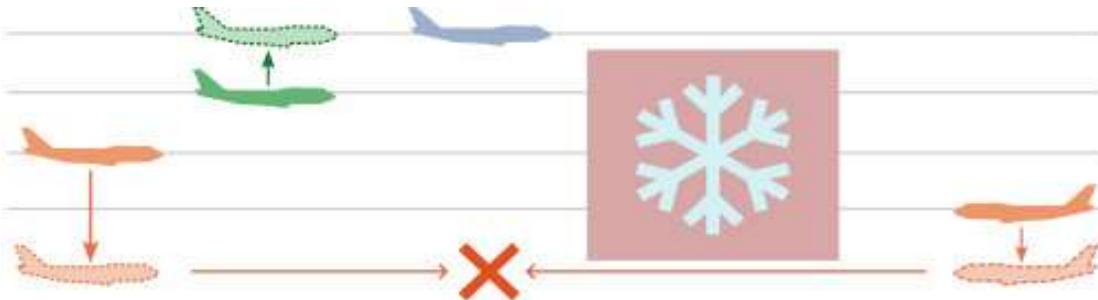
Case study: NATS deployment of Free Route Airspace

In December 2021, NATS implemented the biggest airspace change ever undertaken in the UK, over Scotland and surrounding areas – a footprint twice the size of the UK and airspace that controls over 80% of transatlantic traffic. The introduction of Free Route Airspace (FRA) removes traditional air routes and allows airlines to flight plan and fly an optimal trajectory based on weather and wind speed between a defined entry and exit point.

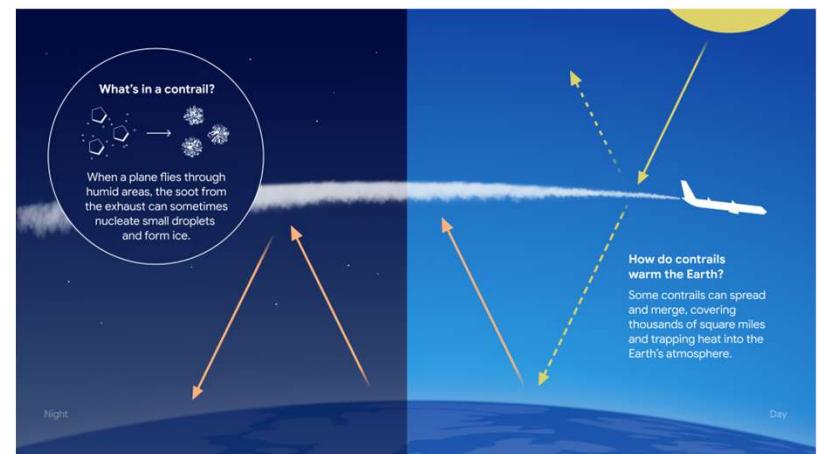
It is estimated that the deployment of FRA in this area will enable a reduction of 500,000nm flown and up to 12,000 tonnes of CO₂ per year. Further benefits will be realised when FRA is extended across the rest of the UK in the coming years. FRA is also being implemented across Europe as part of a wider European plan to introduce cross-border FRA, which is estimated to result in a reduction in flying of one billion nautical miles and 20 million tonnes of CO₂.

Other greener flight paths

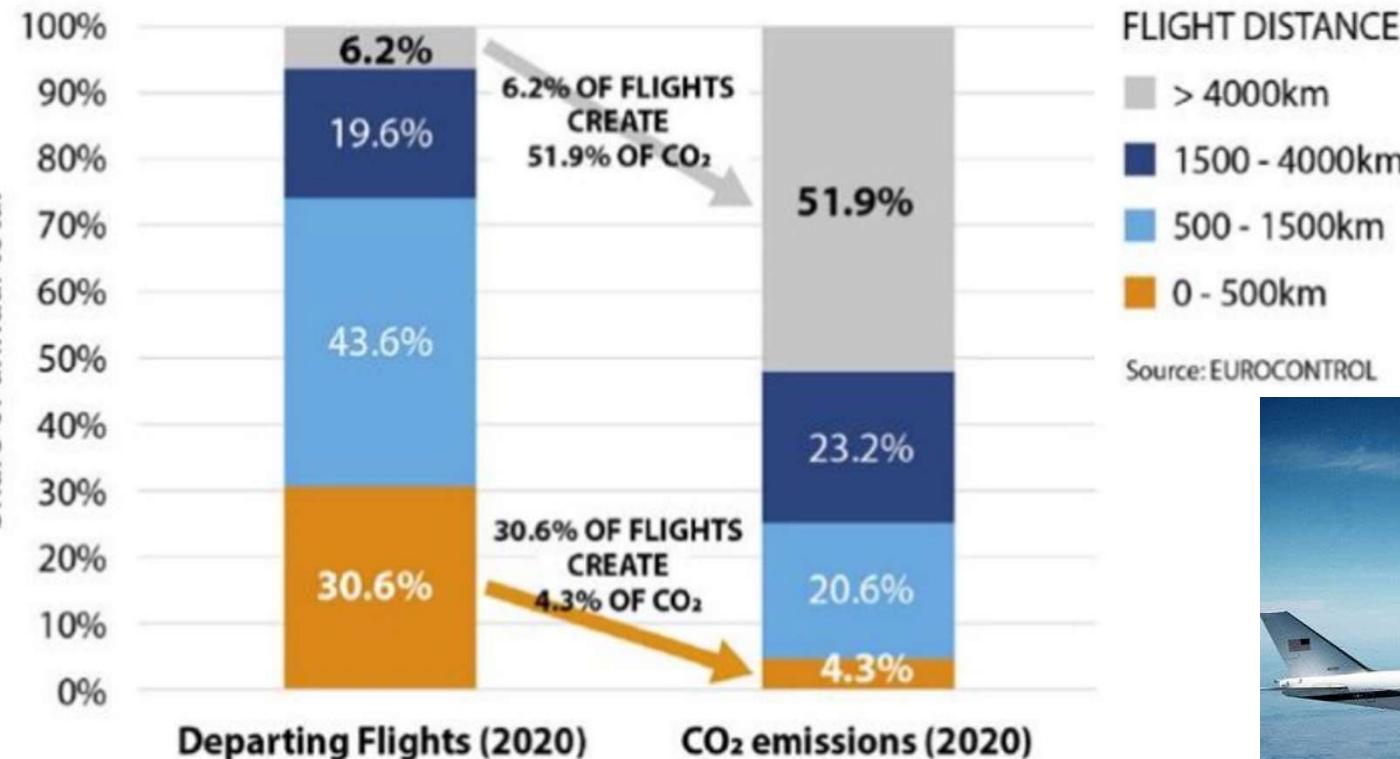
- Continuous climb (to reach thin air) & cruise climb (as aircraft loses fuel weight)
- Continuous descent and avoid landing sequencing loiter
 - Introduced at nights, but will take time to scale (different drag / speed for different aircraft weights at same glide slope)
- Avoid altitudes to prevent contrails



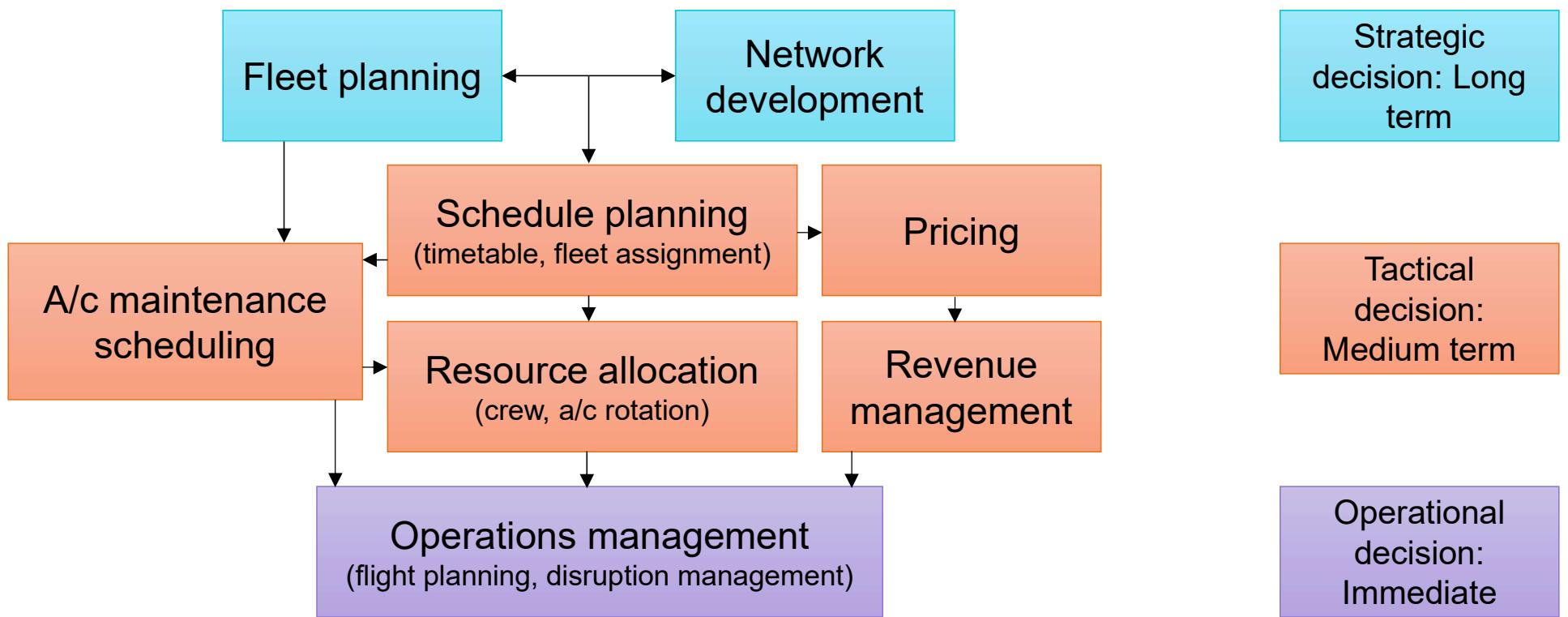
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Long haul flights...



Greener airlines: Typical planning framework



Strategic decisions (t_0 - 2 to 5 years)

- Fleet planning (& renewal)
 - Greener aircraft
 - Green taxes / penalties (CORSIA)
- Airlines network
 - Differential carbon taxes
 - Innovative solutions
 - Intermediate stops in long haul flight
 - Smaller a/c or
 - Less fuel carried or
 - Hybrid flights etc.
 - Stop short haul flights



Guardian graphic. Note: the times shown are the fastest possible train times from a Paris terminal.

Tactical decisions ($t_0 - 1$ to 12 months)

- Scheduling & resource allocations
 - Up to 10% fleet reduction with more loaded flights
 - Machine learning can help?
- Pricing & revenue management
 - Carbon offset program (passengers voluntarily pay for their footprint)
 - Airlines pay directly
 - VR experiences in lieu of flying?
- A/c maintenance scheduling
 - Eco-friendly methods & materials/ chemicals
 - Need based maintenance through IVHM?

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Operational decisions (t_0 & during flights)

▪ Flight routes

- Climate optimised routes for up to 40% reduction in impact
- Real time local weather sensing & dynamic re-routing algorithms (AI?)

▪ In-flight services

- Zero waste flights (compost / reuse / recycle wastes)
- Reduced in-flight sales
- Smart duty-free selling?



Media Releases

QANTAS OPERATES WORLD'S FIRST ZERO WASTE FLIGHT

Published on 8th May 2019

The first-ever commercial flight to produce no landfill waste took to the skies this morning, marking the start of Qantas' plan to cut 100 million single-use plastics by end-2020 and eliminate 75 per cent of the airline's waste by end-2021.

All inflight products on board QF739, flying from Sydney to Adelaide and staffed by cabin crew from the Qantas 'Green Team', will be disposed of via compost, reuse or recycling.

Speaking today at the flight's departure, Qantas Domestic CEO Andrew David said the trial flight was an important milestone for the national carrier's plan to slash waste.

"In the process of carrying over 50 million people every year, Qantas and Jetstar currently produce an amount of waste equivalent to 80 fully-laden Boeing 747 jumbo jets," Mr David said.

"We want to give customers the same level of service they currently enjoy, but without the amount of waste that comes with it."

Greener ground operations

Ground handling

Energy efficient airport buildings

Electric buses / tractors / fuel & food carriers etc.

Future fuelling (H₂?)

Transfer H₂(l)? Least efficient

Produce H₂(l) at airport? / Transfer H₂(g) by pipeline and liquify at airport?

Taxiing & runway operations

Automation to optimise runway selection w.r.t. fuel, noise & safety

Electric motors for taxiing?
Heavy batteries @ 2W/kg MTOW=less flight efficiency

Taxibots

Taxibot challenges

- Limiting loads on NLG
- Time for engagement / disengagement
- Extra traffic on taxiways
- Extra resource (driver)



Thank you

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