



Developing Carbon-Free Technology

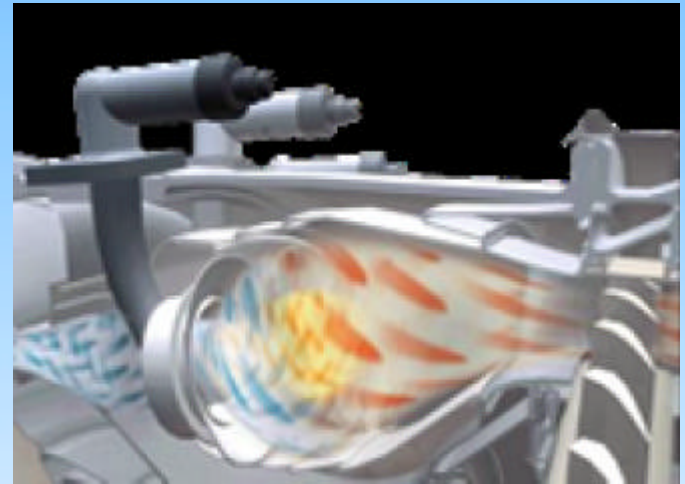
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Technology potential

➤ Engine technology has significantly lowered fuel consumption, noise, and emissions

➤ ... still need developments in:

- Propulsive efficiency
- Combustion technology
- Aircraft/engine integration
- Mechanical systems, etc.



➤ Materials technology could facilitate these gains



Short-term: reducing noise & CO₂

- Noise & emissions improvements have historically gone hand-in-hand
 - We cannot afford to lose ground on either
- Conventional architecture can both improve fuel burn **and** reduce noise levels to be within airport boundary
- Open rotors, while promising, require more development to resolve inherent noise issues

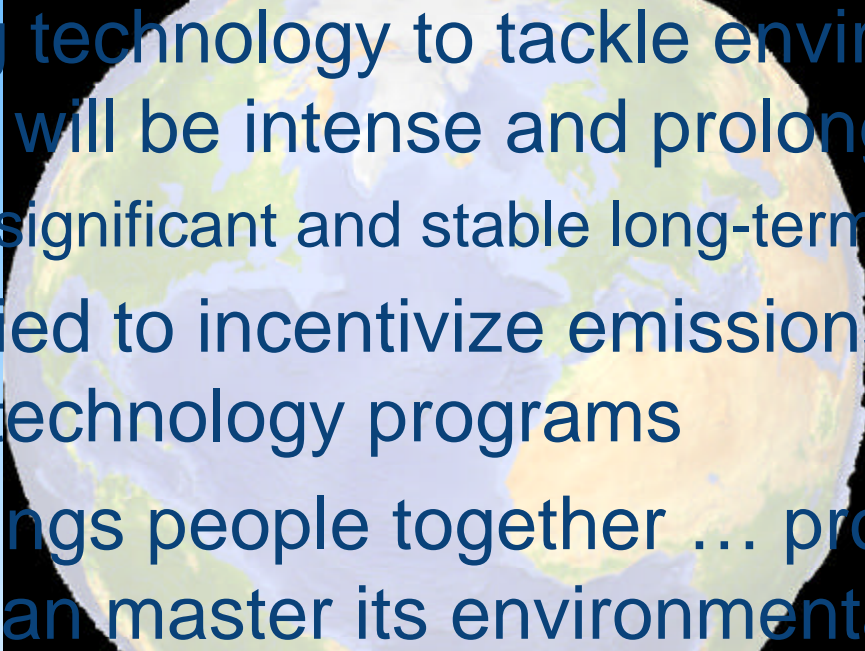


Alternative fuels ... evolution, not revolution

- Carbon free implies alternative fuels ... but there is no instant fix
- Hydrogen is still far away
- CO₂ captation needs to be developed
- Biofuels are hugely complicated
 - Technology is just one piece of the puzzle
 - Many stake holders are involved
 - Gains will be step-by-step improvements
- Will require considerable, global R&D



Funding technology for mobility

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- Developing technology to tackle environmental challenges will be intense and prolonged
 - Requires significant and stable long-term funding
 - Monies levied to incentivize emissions reduction must fund technology programs
 - Aviation brings people together ... properly funded, it can master its environmental impact

