



Aircraft Propulsion by Directed Energy Beam Bursts



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GATEWAYS TO
BLUESKIES



Aviation in 2050

Highly interconnected systems

Growth of globalized trade

9 billion passengers per year

Demand for sustainability



What is *Directed Energy Beaming*?

Power transmitted via LASER
or MASER (Microwave Laser)



External power station
tracks and beams energy to aircraft

History of Directed Energy Beaming

1976

DEB first proposed for aviation purposes

2003

NASA Marshall flies first laser-powered aircraft

2000s–Present

DEB research continues, mostly in military sector

Late 70s–Early 80s

Majority of DEB research performed and published

2009

LaserMotive wins NASA Centennial Challenge





Why Directed Energy Beaming?

CONCENTRATION Densely-packed energy!

OPTIMIZATION Design around a specific wavelength!

DIRECTION Point and shoot!

OPERATION Works 24 hours per day!

DEB-B System Overview

PHASE I

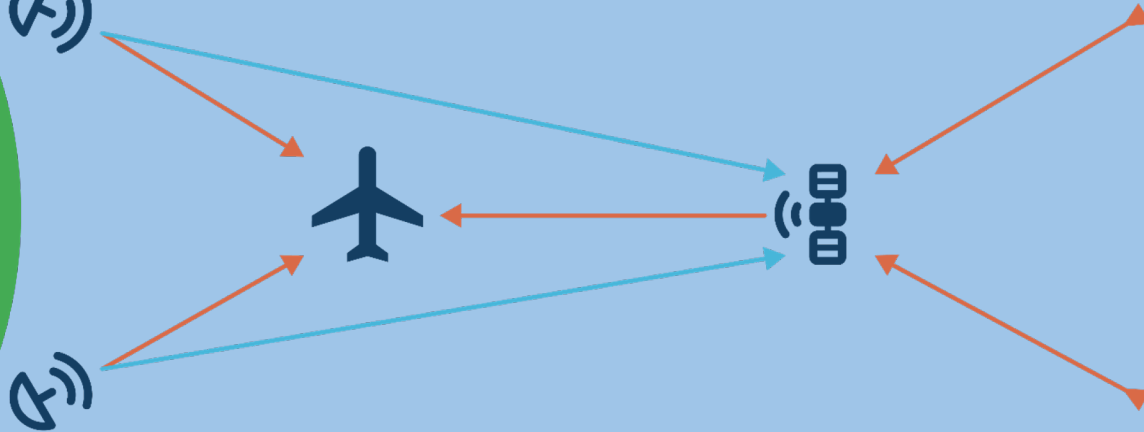
Laser-Powered Aircraft
and Ground Stations

PHASE II

Relay Satellites

PHASE III

Power Satellites



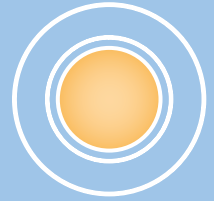


PHASE I

**LASER-POWERED AIRCRAFT
AND GROUND STATIONS**



Laser-Powered Aircraft



Option 1:

Laser Turbofans

Heat exchanger and
turbomachinery

Option 2:

Photovoltaics

Charge batteries to
power propellers

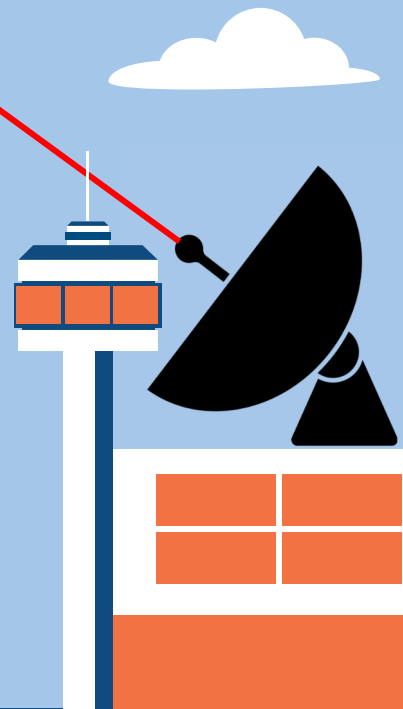
Ground Stations



Built along popular air traffic routes

Powered by renewable energy sources

Limited in scale and application





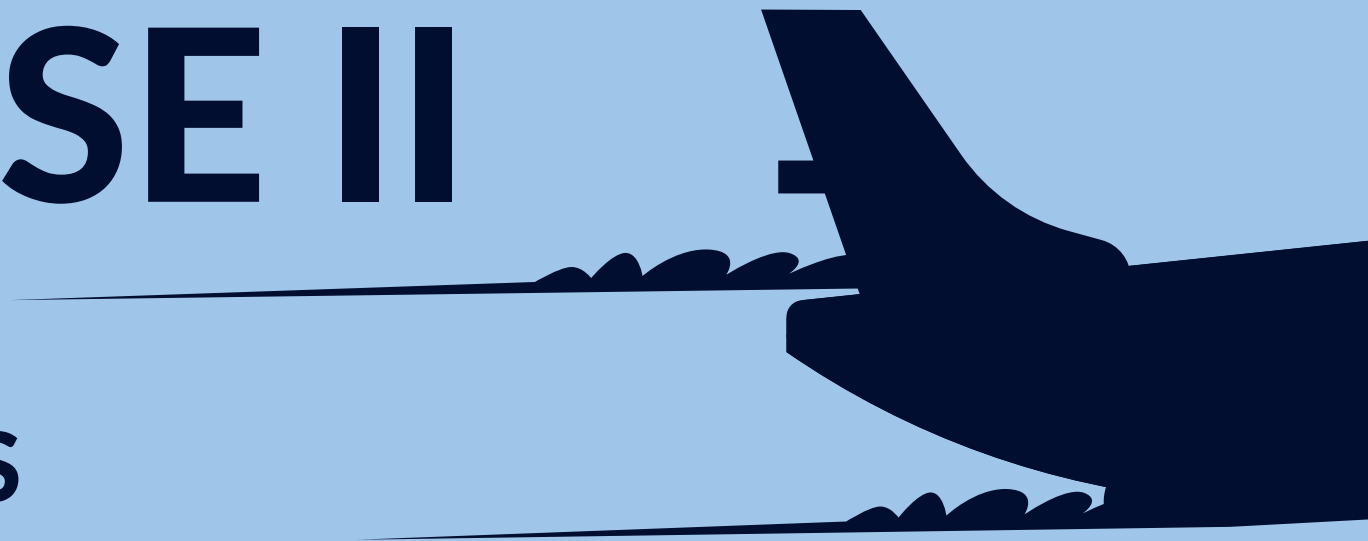
Example Flight Path

7x ground stations between LAX and SEA

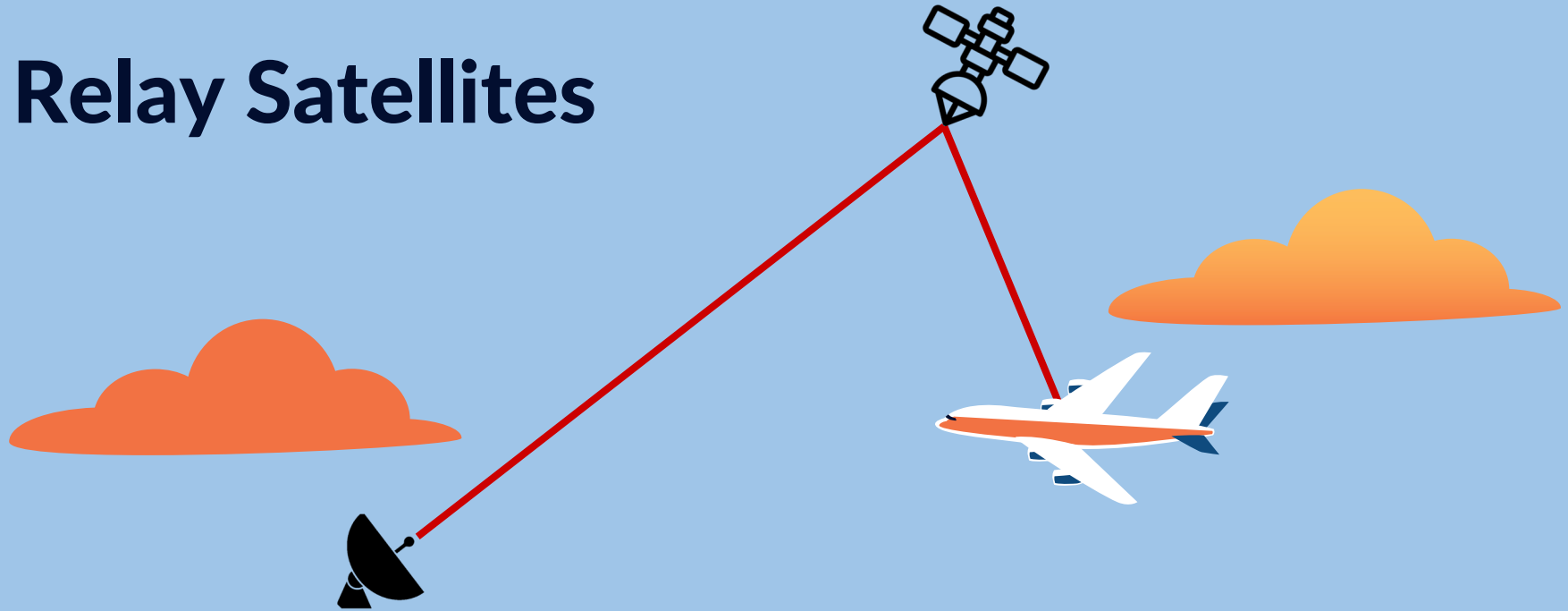


PHASE II

RELAY
SATELLITES



Relay Satellites



**Redirect Ground
Beams**

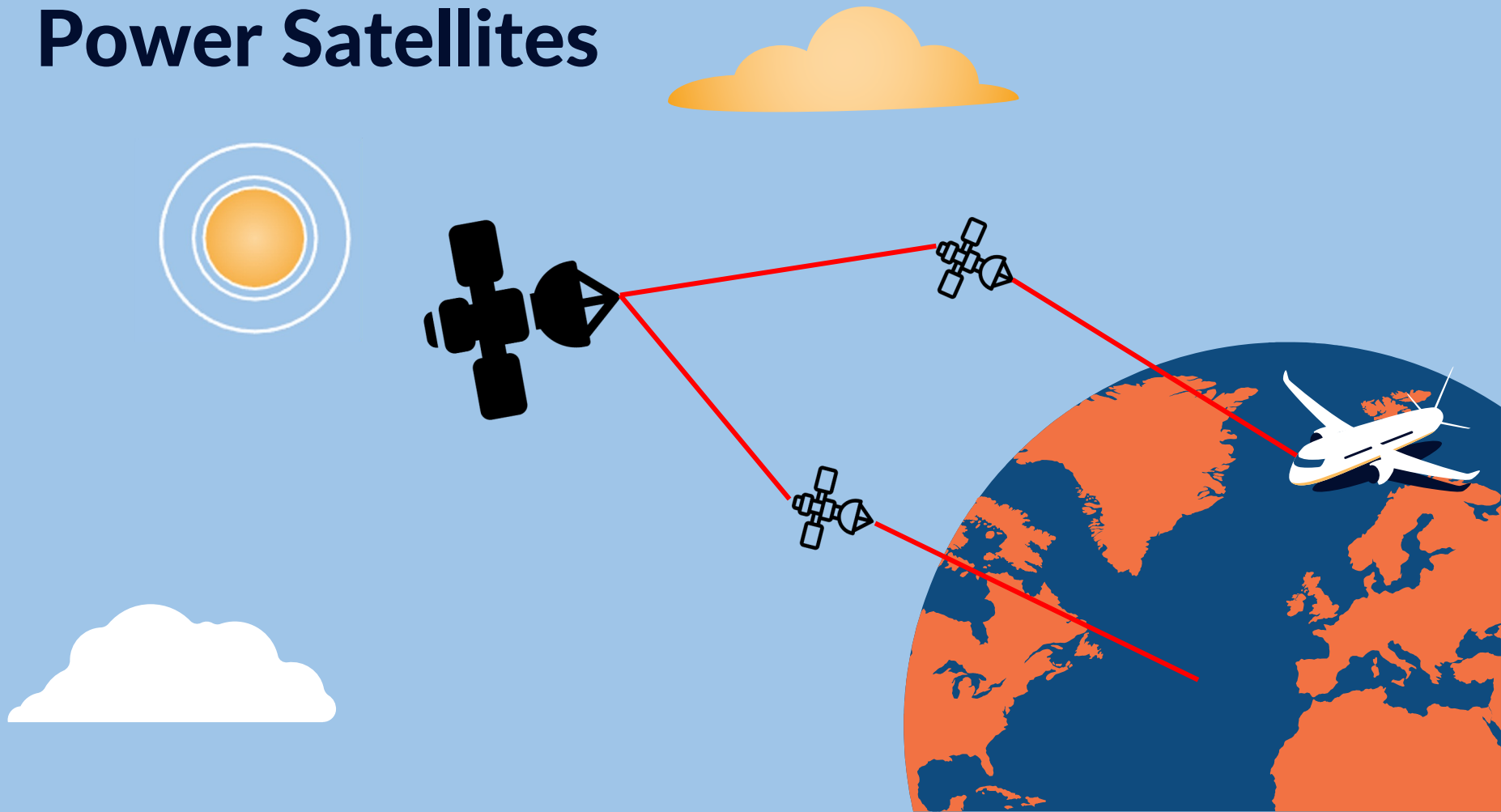
**Expands Aircraft
Range**

PHASE III

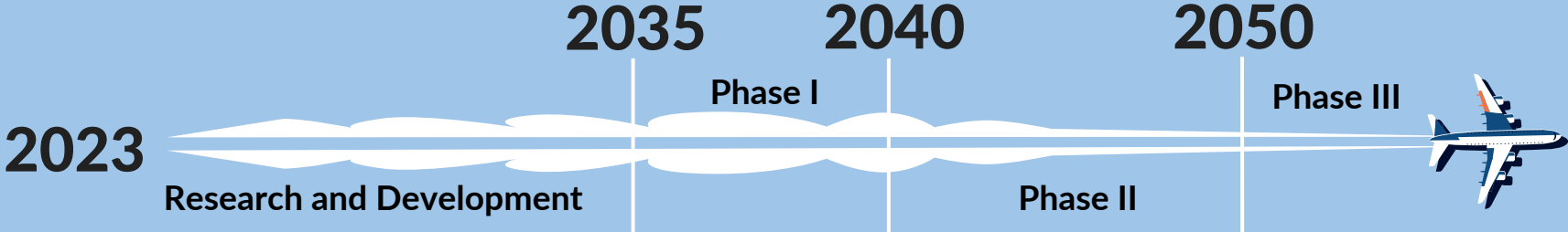
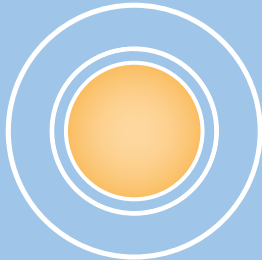
Power Satellites

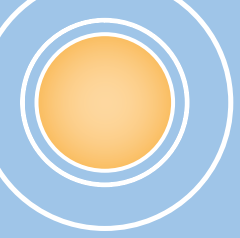


Power Satellites



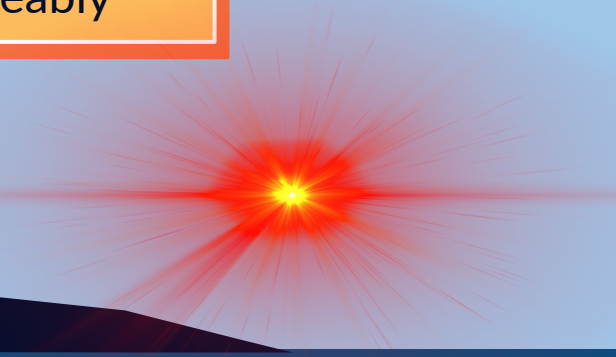
Projected Timeline





LASERS!

Or Masers. We use them interchangeably





Laser System

40MW Carbon monoxide laser with a 5 micrometer wavelength

Far below ionization energy of air

Highly accurate tracking system

Laser Manufacturing and Supply Chain



Scale current Manufacturing Facilities

Miniaturization of CO Laser Technology

Manufacturing and Supply Chain

A stylized sun icon in the top right corner, consisting of a solid orange circle surrounded by two concentric white circles.

Power Grid and Renewable Energy Development

- Infrastructure for Phase I ground stations
- Solar, Wind, Nuclear, Fusion development

Manufacturing and Supply Chain

A stylized sun icon in the top right corner, consisting of a solid orange circle surrounded by two concentric white circles.

Launch Cost and Satellite Swarm Technology

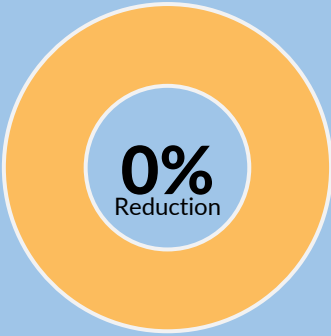
- Pound to orbit cost in the tens of dollars
- Anti-collision regulation, practice and technologies



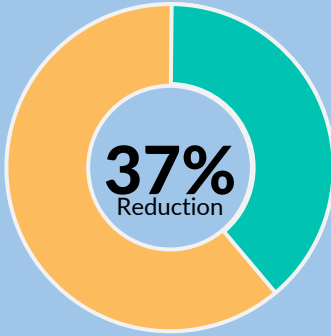
Impact

of DEB-B on commercial aviation.
Currently 2.4% of global emissions

Carbon Emissions



95 g CO₂/pkm
Current Emissions



60 g CO₂/pkm
Phase I Emissions



0.67 g
CO₂/pkm
Phase III Emissions

Environmental



CO Laser

Atmosphere-friendly

Ground Stations

Localized impact

Space Stations

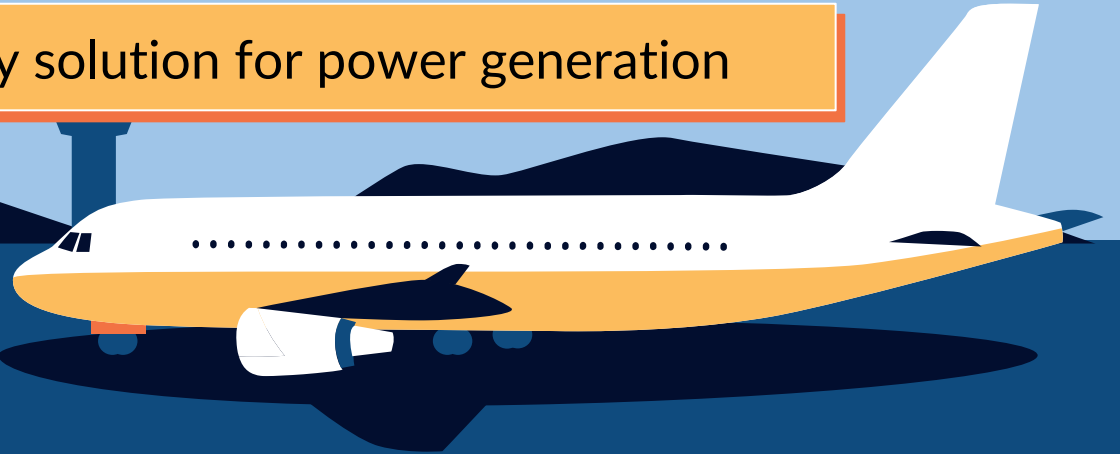
No operational
emissions

Financial

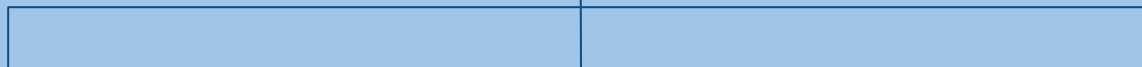
High capital, low operating cost for laser satellites

\$11.2 million break-even cost per satellite

Multi-industry solution for power generation



Industry



Aviation

Regulations to be introduced to ensure safety and security



Research

Partnerships between public and private entities needed



Beyond

Power-beaming becomes its own industry

Socio-Political

- Orbital Regulations
- Changing Perceptions
- Multinational Cooperation



Total Impact

0%

at least BREAK-EVEN

Financial Costs

99%

NEAR ZERO EMISSIONS

Emission Reductions

100%

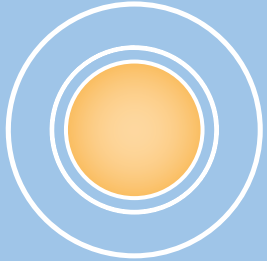
TRANSFORMATIONAL

Industry Change

!!%

OFF THE CHARTS

Socio-Political Growth



Conclusion

High-density energy

Safe to use

**99% Carbon Emission
Reduction**

**Global
Cooperation**

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Farhat Beg
John Sanford
Zachary Dake**

Additional Slides

Take-Off And Landing



**Onboard
Battery**

**Catapult
System**

**Laser Embedded
Runways**

