

# True Zero Emission Electric Aircraft Propulsion Transport Technology

Rodger Dyson

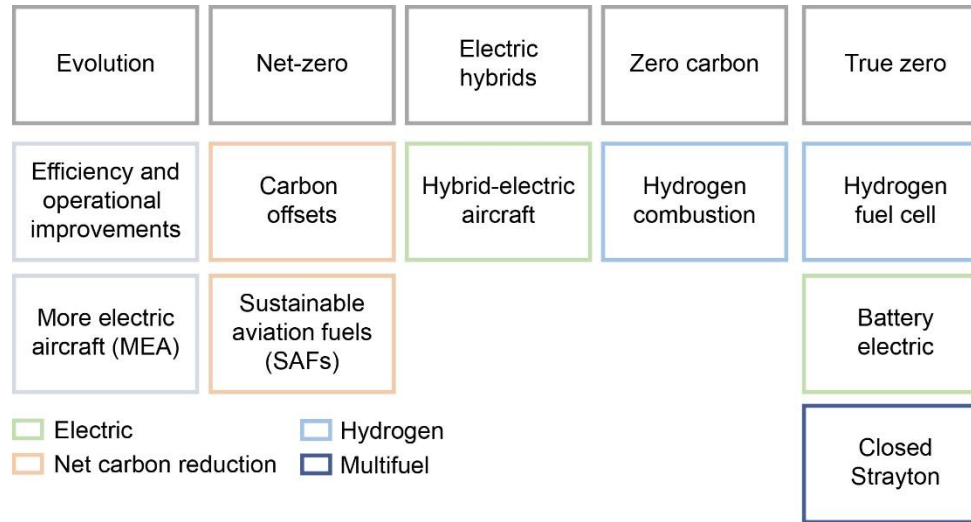
NASA Glenn Research Center

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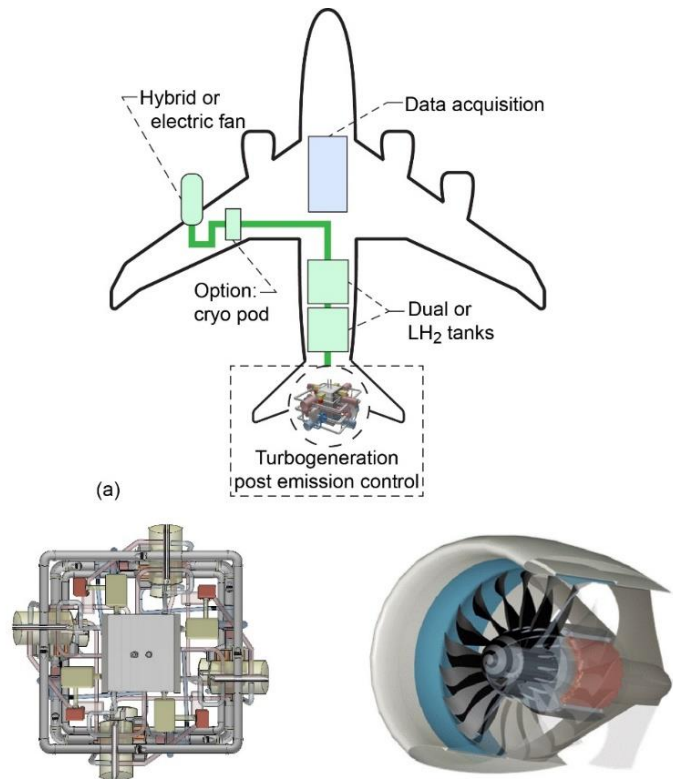
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# New True Zero Greenhouse Gas Technology



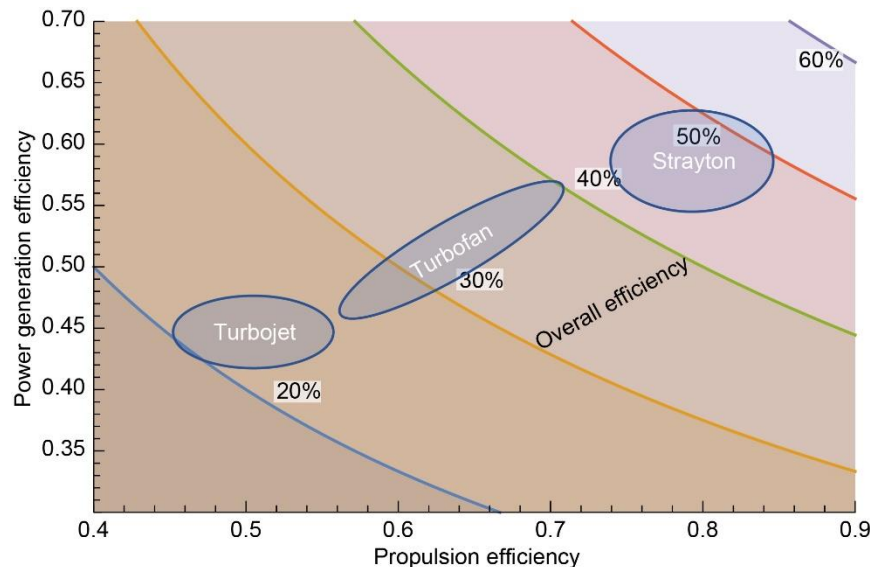
Propulsion power sources	(Emission reduction) × Scalability × Specific power = Net impact					
	CO <sub>2</sub>	NO <sub>x</sub>	Contrail	Scalability	Specific power	Net impact
H, fuel cell	Green	Green	Green	Green	Yellow	Yellow
H, combustion	Green	Red	Red	Green	Green	Yellow
Sustainable fuel	Yellow	Red	Red	Green	Green	Red
Battery electric	Green	Green	Red	Red	Red	Red
Hybrid electric	Yellow	Red	Red	Yellow	Yellow	Red
	Green	Good	Yellow	Moderate	Red	Limited

# Separately Optimized Power, Propulsion, and Combustion

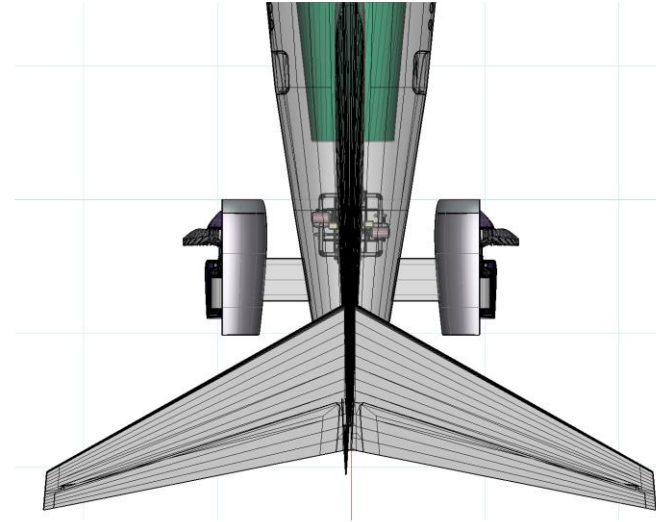
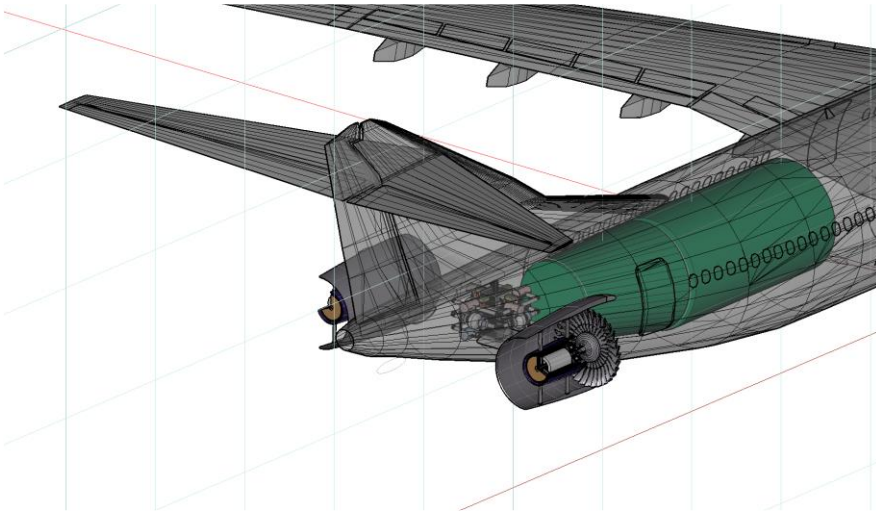


(b) No stall/surge/flameout, multifuel

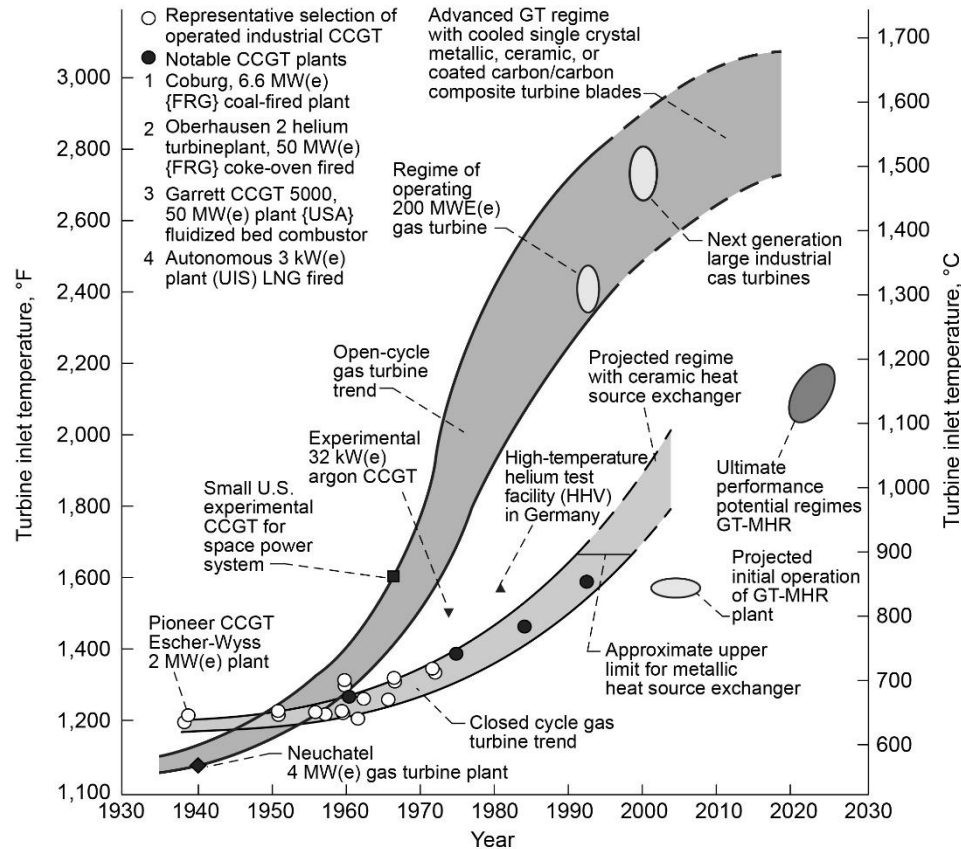
(c) Quiet, efficient, variable speed



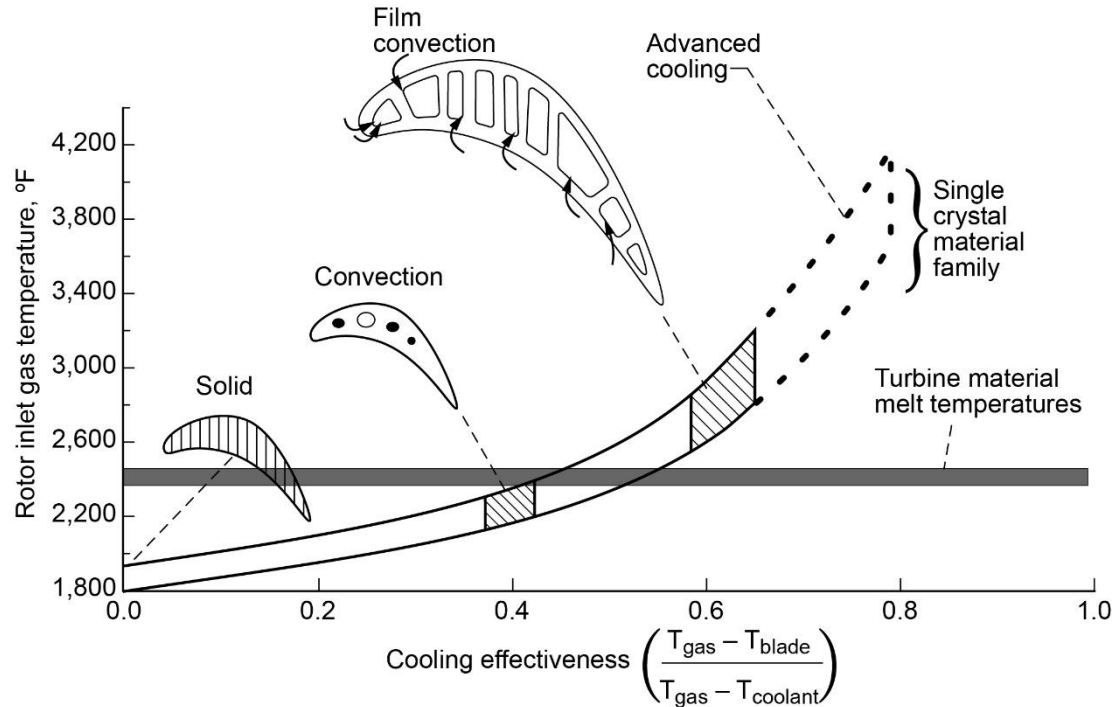
# Strayton Generator and Electric Propulsor Installation



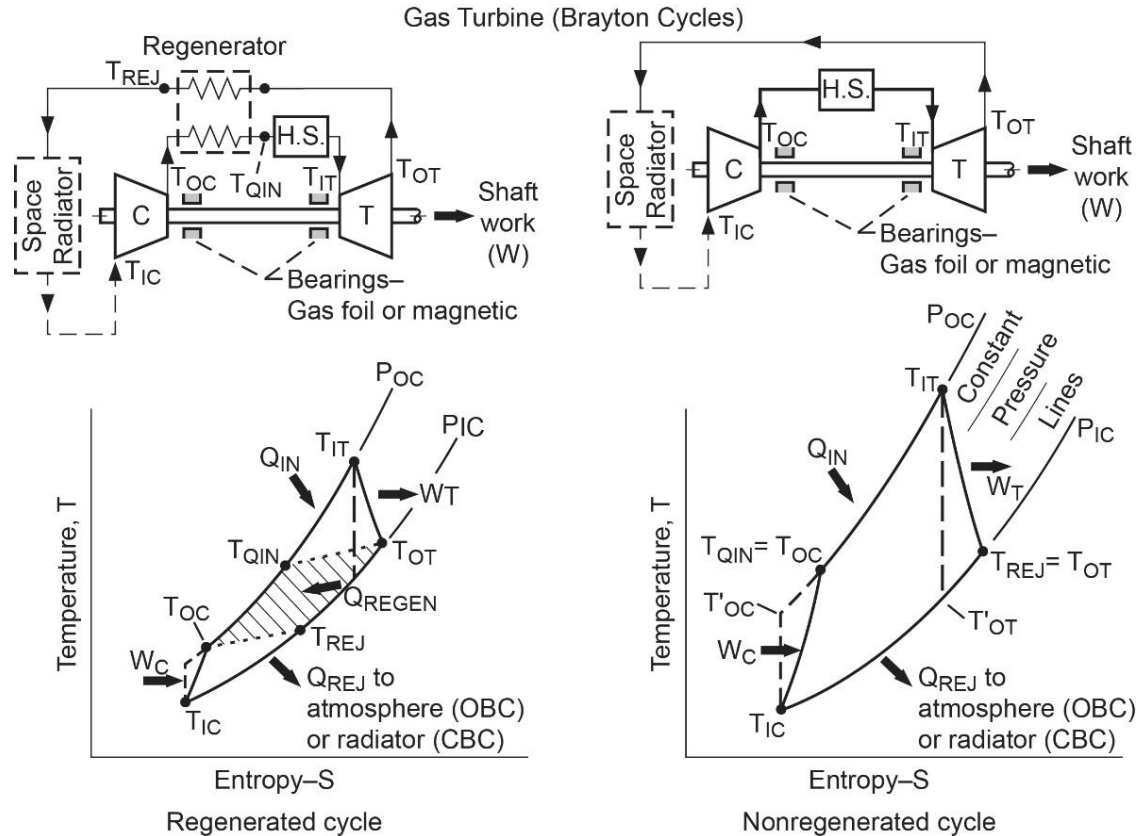
# Historical Limitation of Closed Brayton Turbine Inlet Temperature



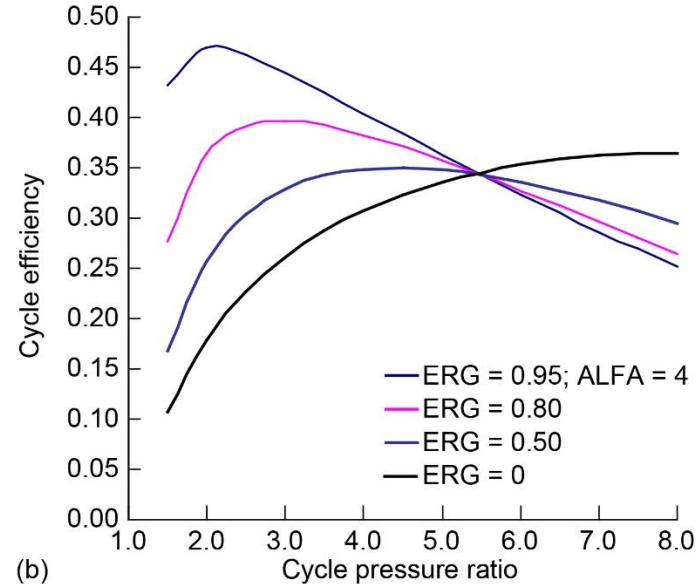
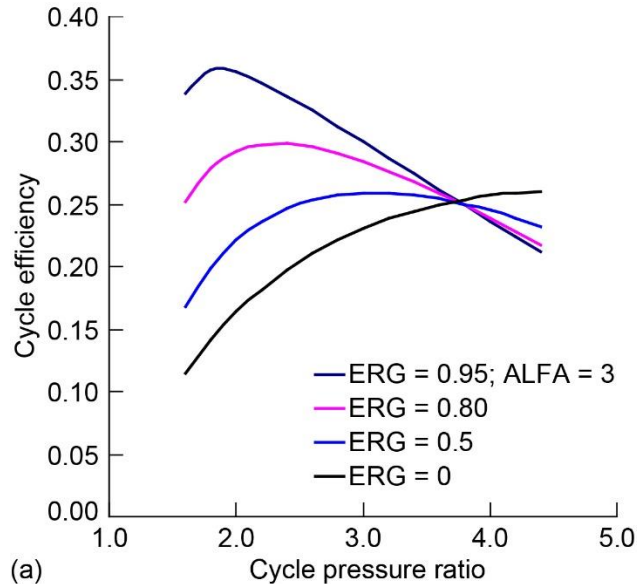
# Open Brayton Cycle Cooling



# Open, Closed, Recuperated Brayton Cycles

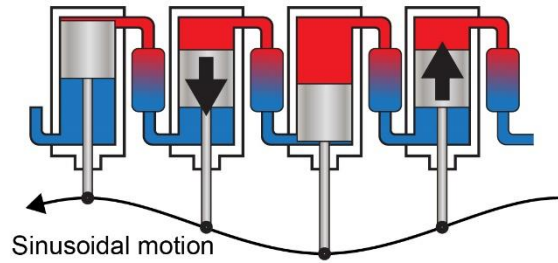


# Closed Brayton Fundamentals

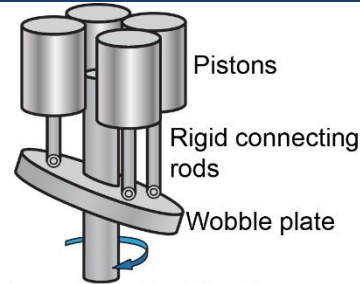




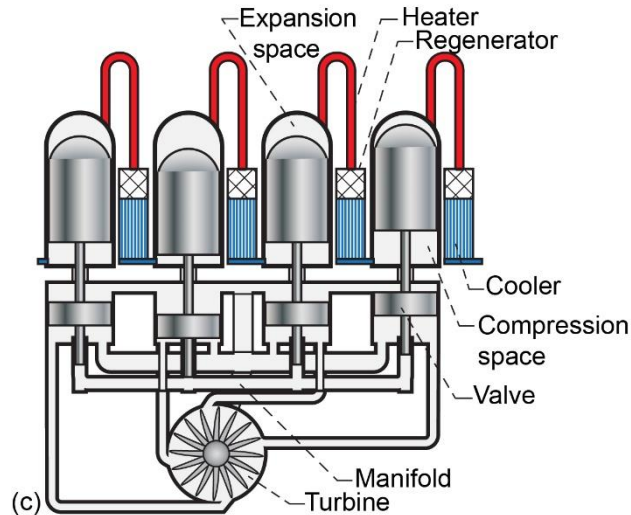
# Multistage Stirling Engines



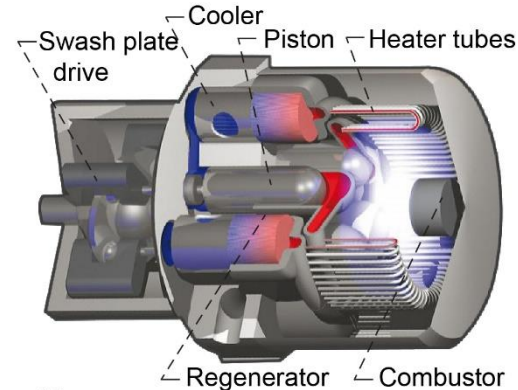
(a) Double-acting Stirling engine



(b) Swash plate drive

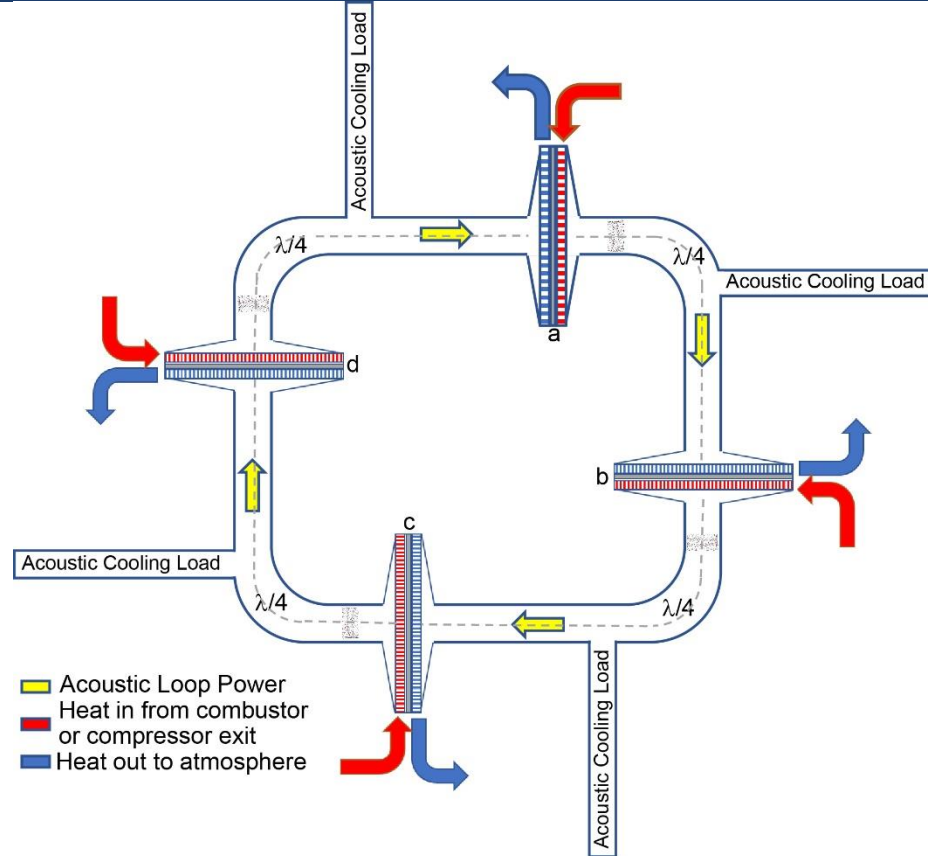


(c)

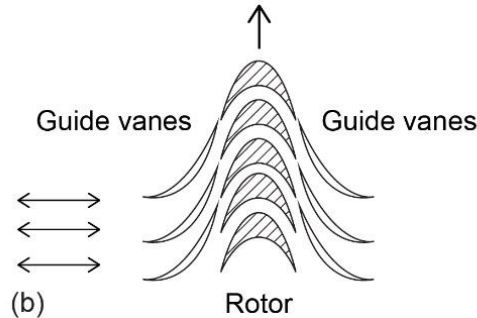
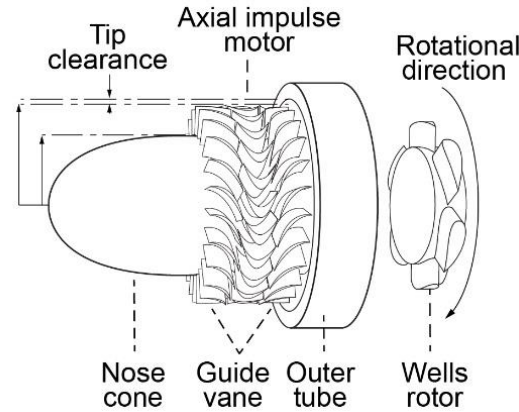
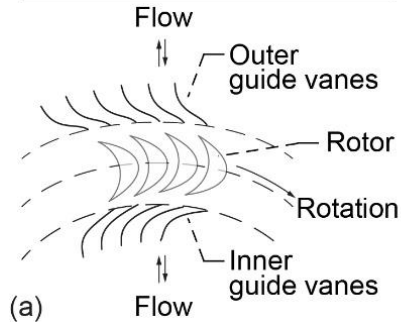
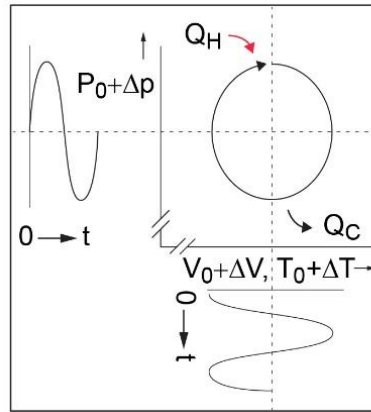


(d)

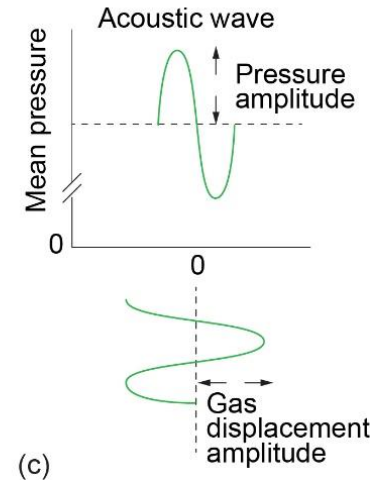
# Multistage Acoustic Stirling Engines



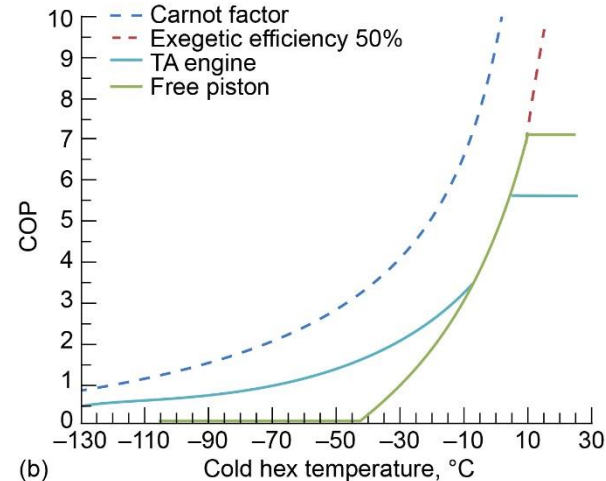
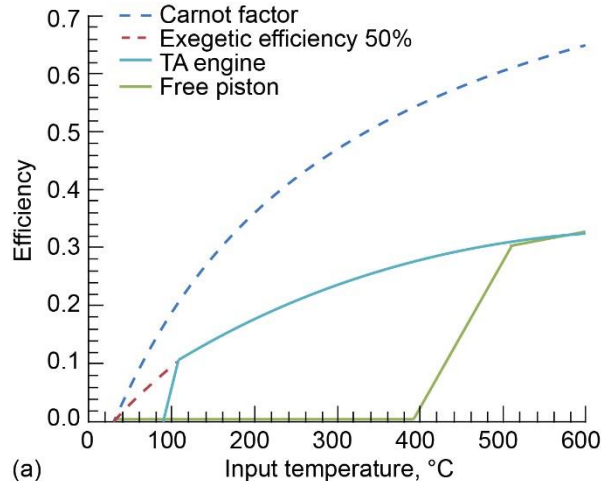
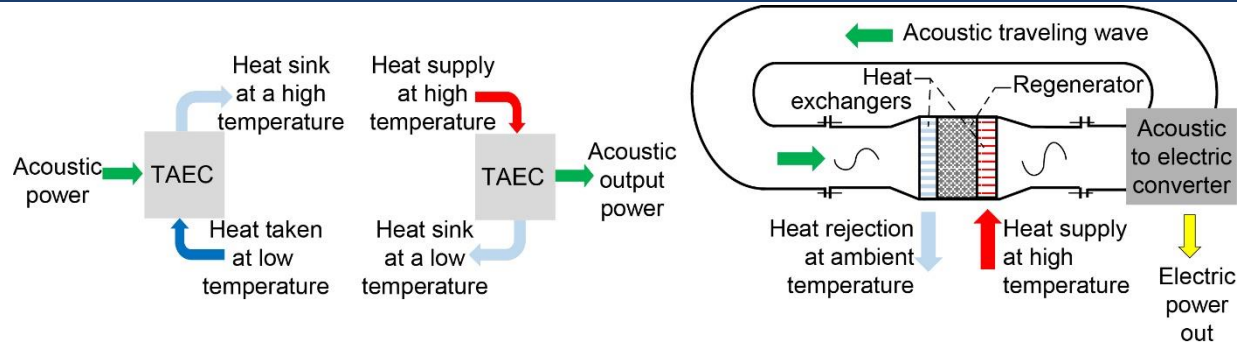
# Bi-directional Turbine Oscillating Velocity Wave Power Extraction



Ref. Kees de Block

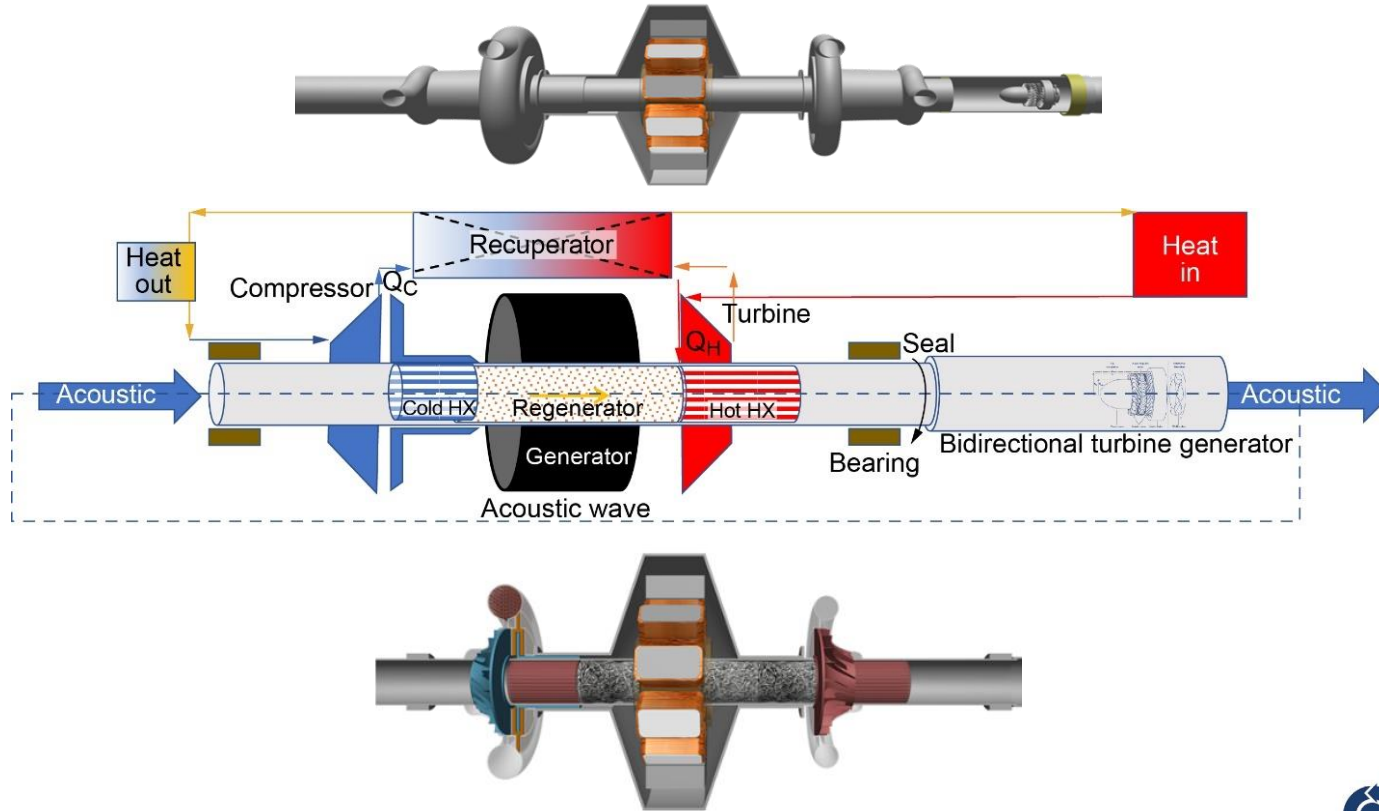


# Acoustic Stirling Fundamentals

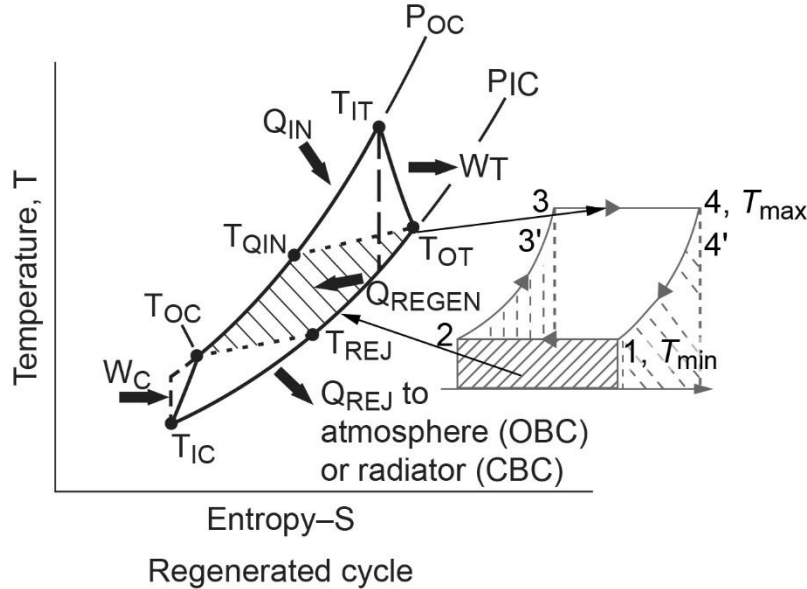


Ref. Kees de Block

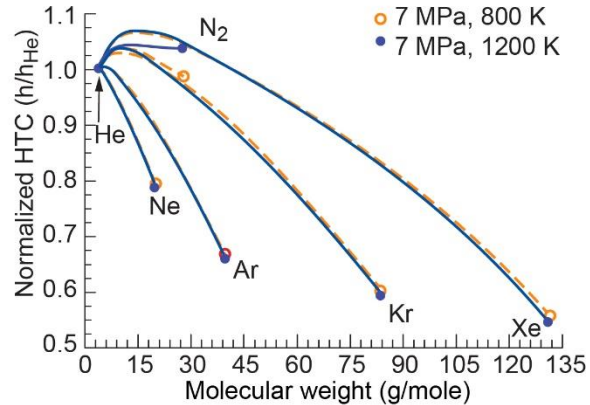
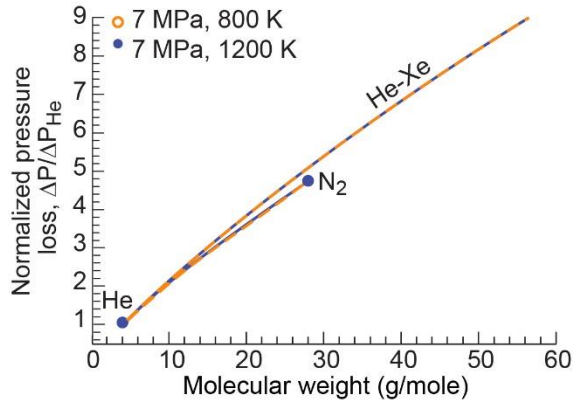
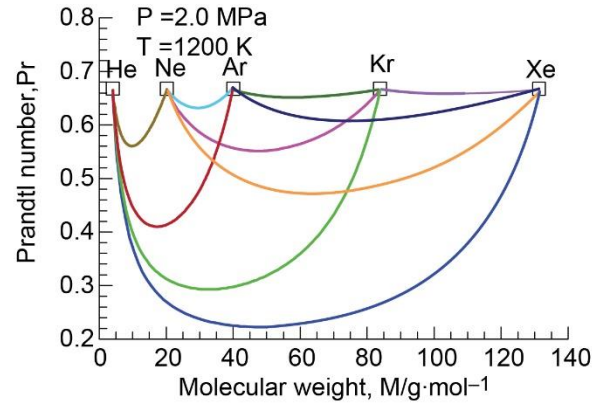
# Strayton Generator Fundamentals



# Closed Strayton Cycle

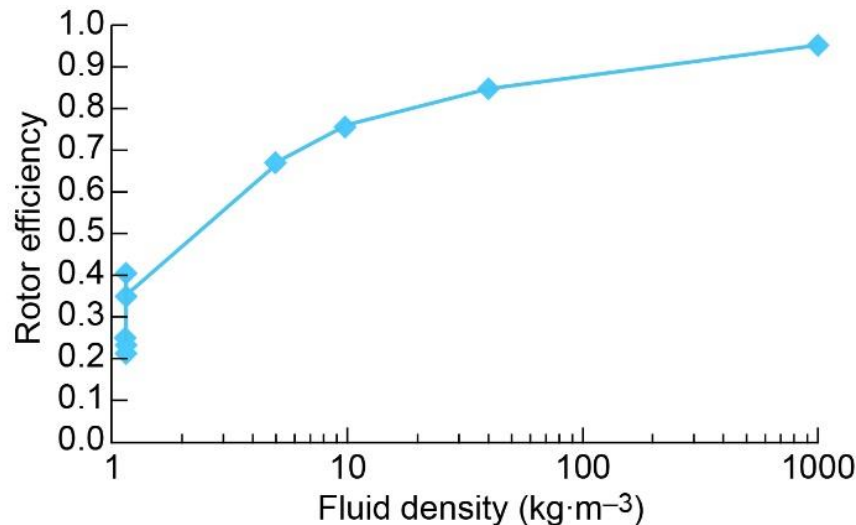
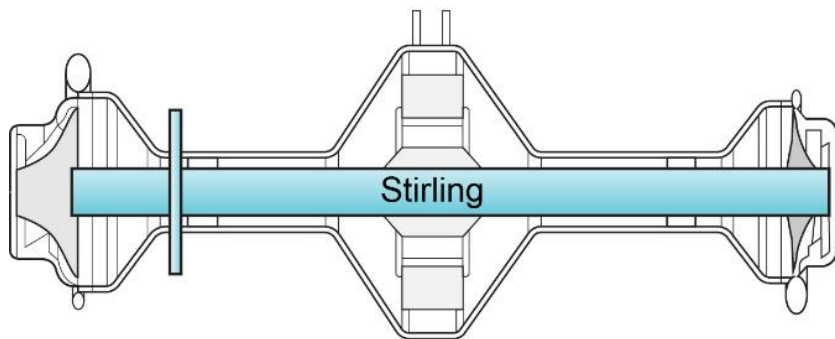


# Working Fluid



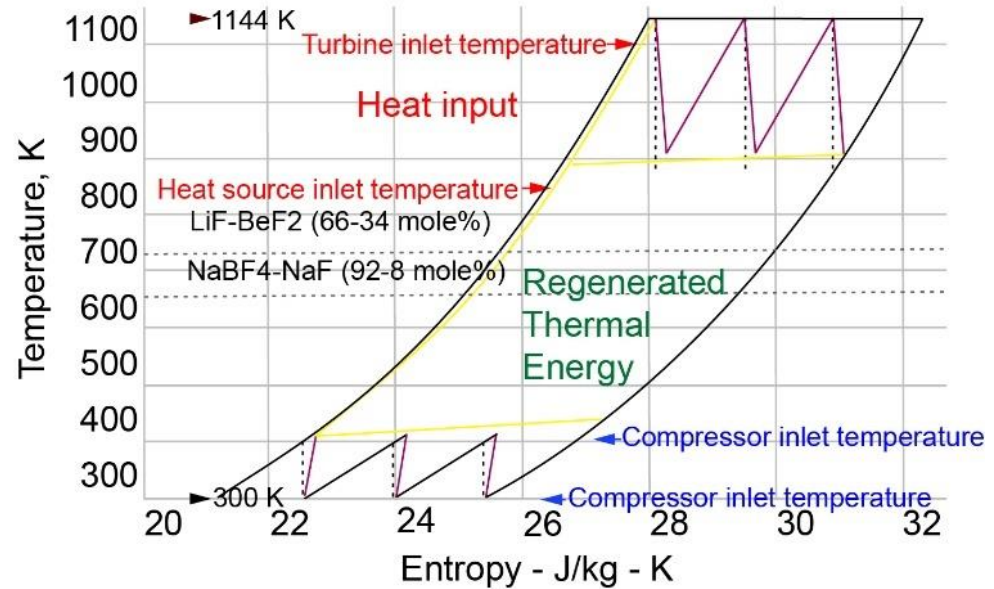
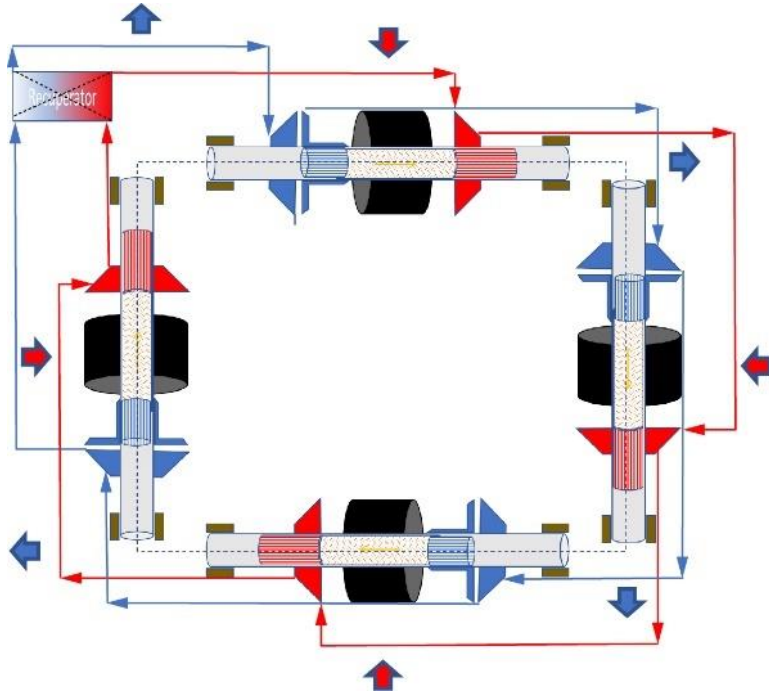


# Pressurized Fluid Reduces Size and Increases Efficiency



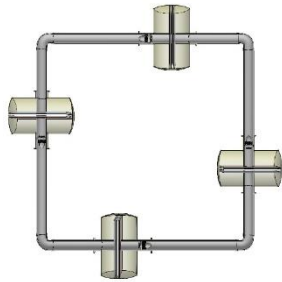


# Strayton Generator Quad Configuration

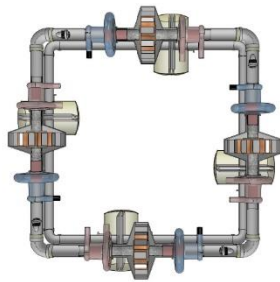


Acoustic Intercooling and Reheating

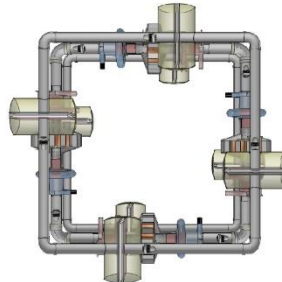
# Three Quad Layers



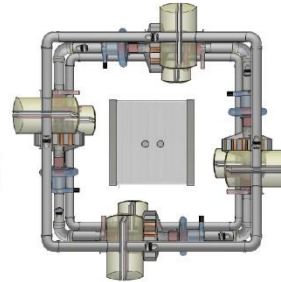
Acoustic interstage cooling quad



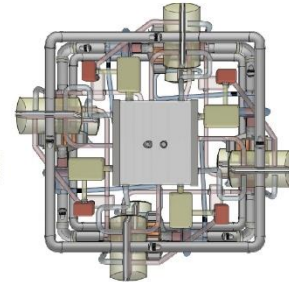
Closed Strayton quad



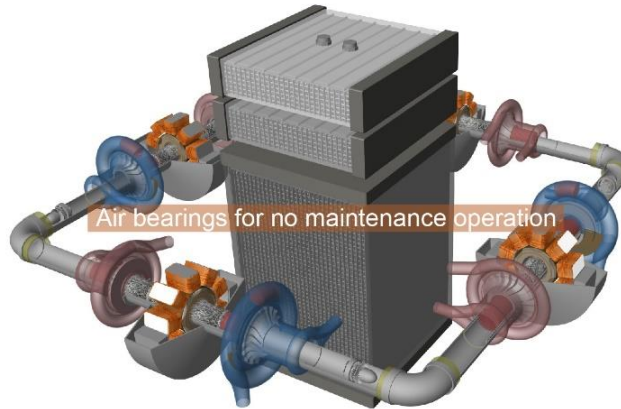
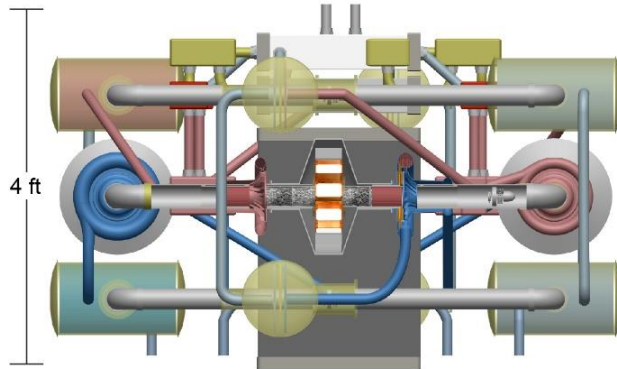
Acoustic interstage heating quad



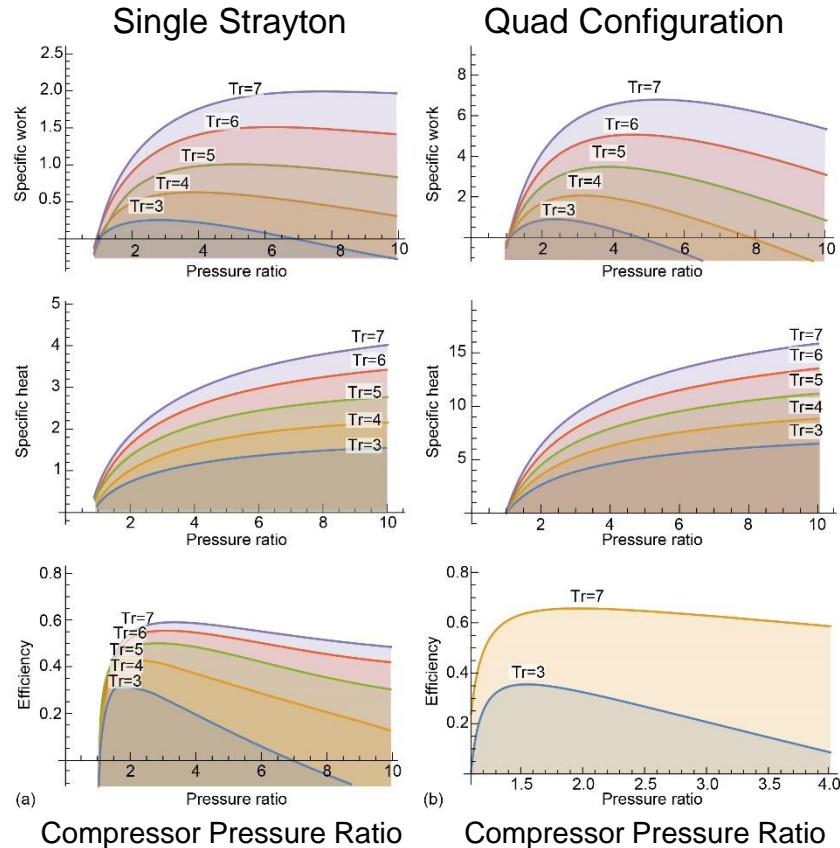
Central recuperator



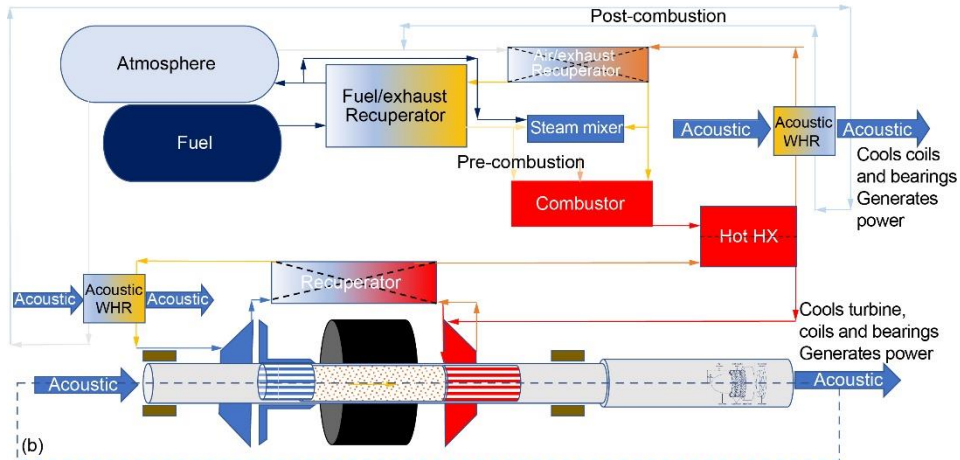
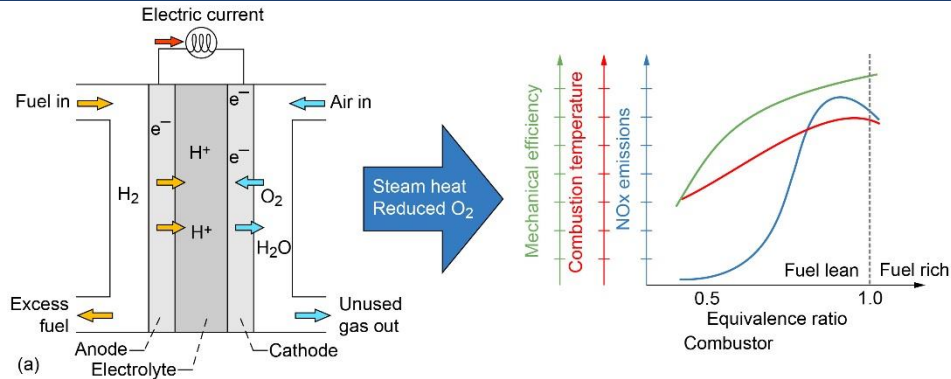
Connected system



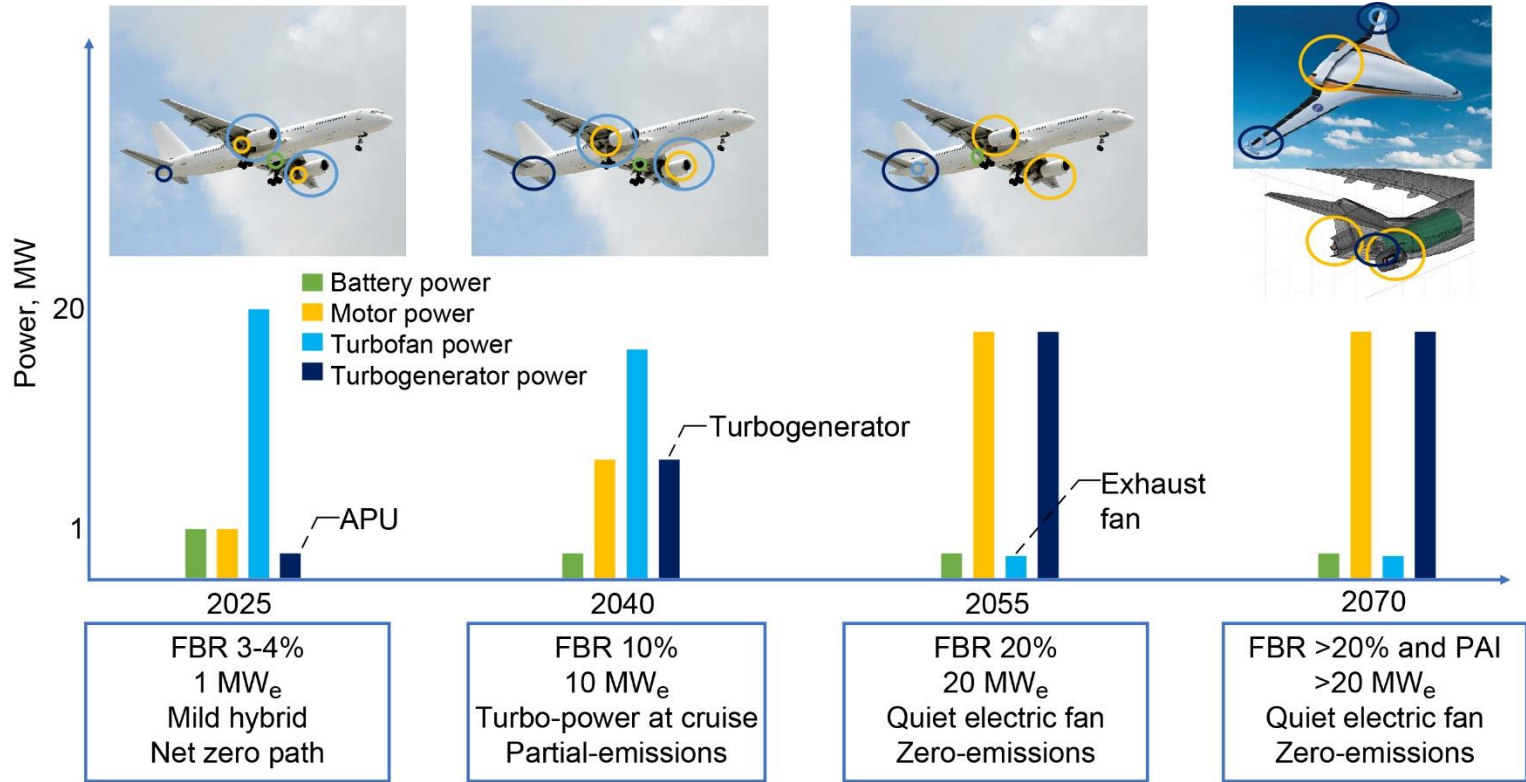
# Closed Strayton Performance



# Pre- and Post- Emission Control



# Dual-Fuel Transition



# Conclusion

- Closed Strayton Quad Generator is Lightweight and Efficient
- Enables separate optimization of combustion and propulsion
- Enables dual fuel transition
- Uses proven technologies and is patent pending

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