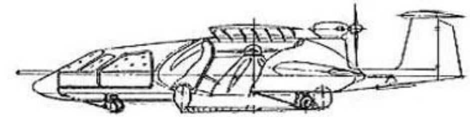


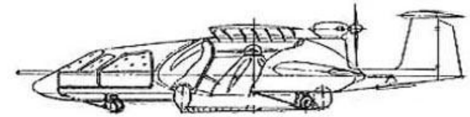
Main Aspects of Gasturbine Generator Integration in Electric Aircraft on Example of ESTOLAS

Oleksiy Antoshkiv

Agentur Kronstadt

Riga, 11.04.2014

SEVENTH FRAMEWORK PROGRAMME

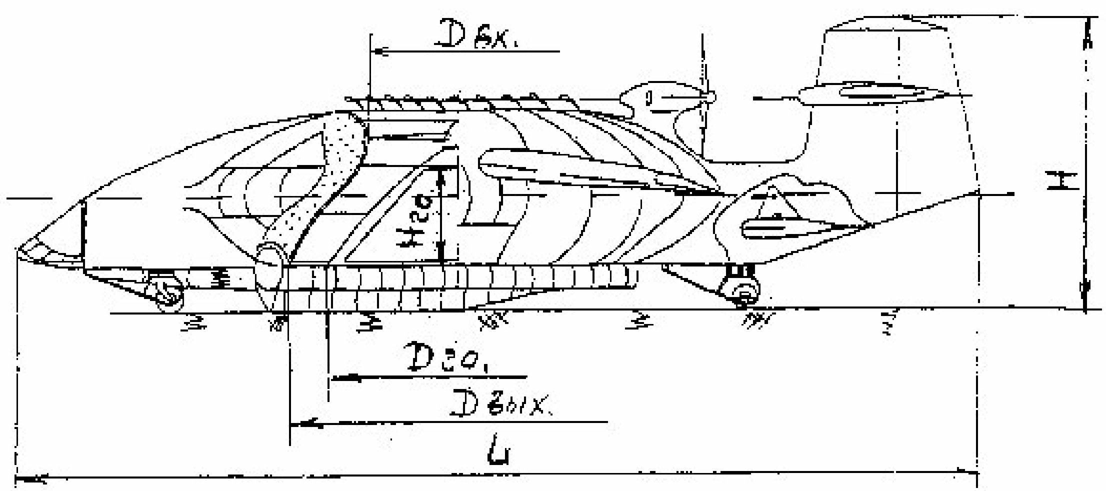


Introduction

ESTOLAS

• **General Characteristic of ESTOLAS**

- The plane is built according to "all wing" scheme with the tail section of extended surface and pilot-passenger cabin in the front
- The main part of the aircraft is the diskshaped centerplane with the central tunnel where the cargo cabin and propeller system are located.



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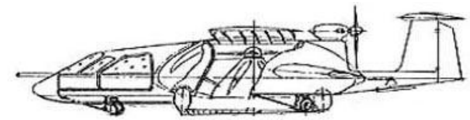
Problem Definition

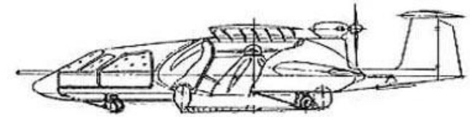


❖ An efficient operation of ESTOLAS demands many engine points at the aircraft analog to air ship

- The power per engine is reduced
- The engine efficiency is decreased

Type	Cargo, kg	Engine Points x Power, kW
LZ 18	11,1	4 x 134
LZ 127	15	5 x 4189
CL 160	160	8 x 5882

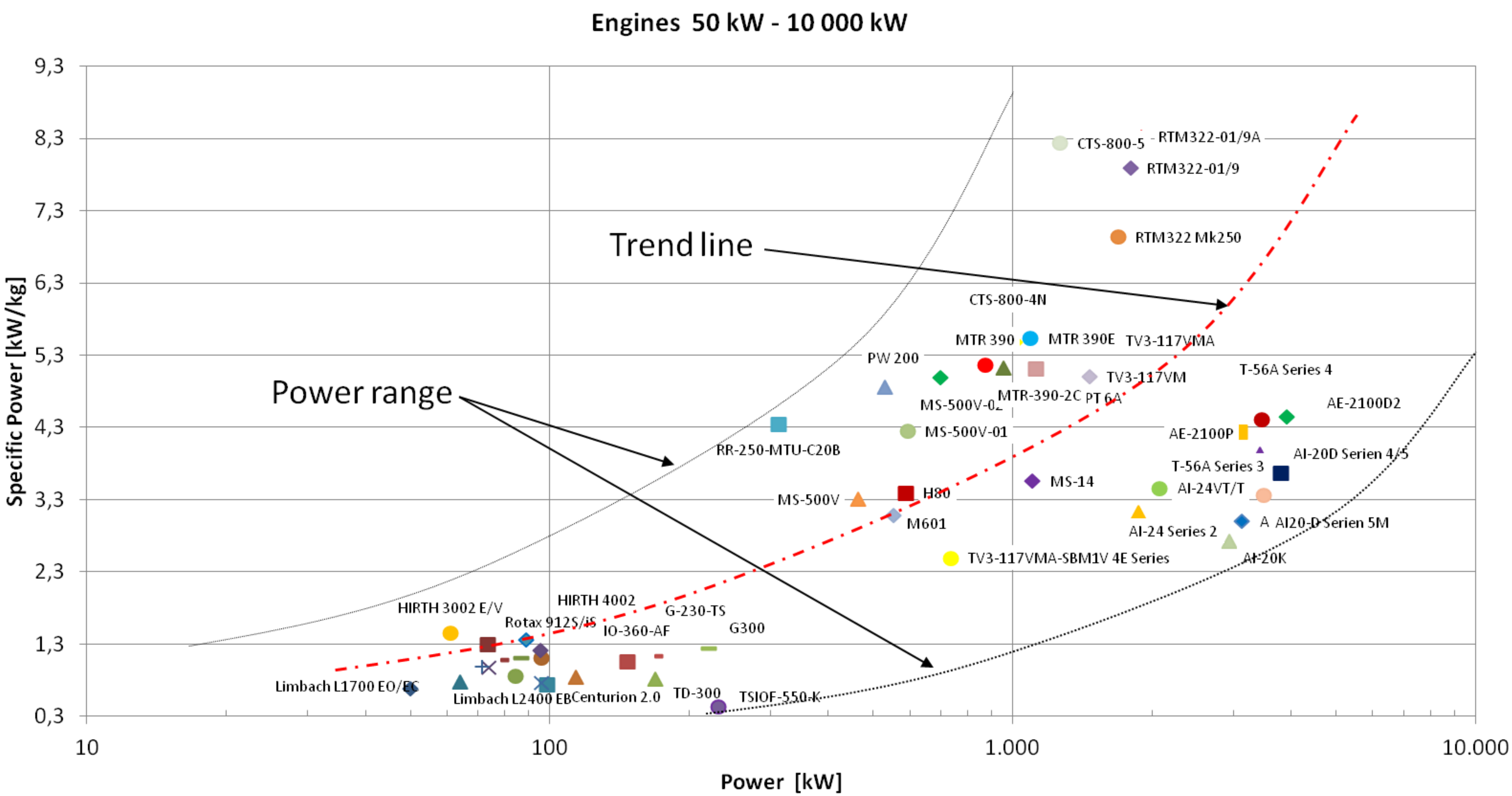
Comparison of main parameters and engine points of Zeppelin and Cargolifter airships



Main Achievements

ESTOLAS

• **Comparison of engines of 50–5000 kW range**



➢ **Engines with higher Power show better Specific Power values**

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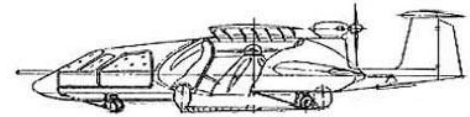
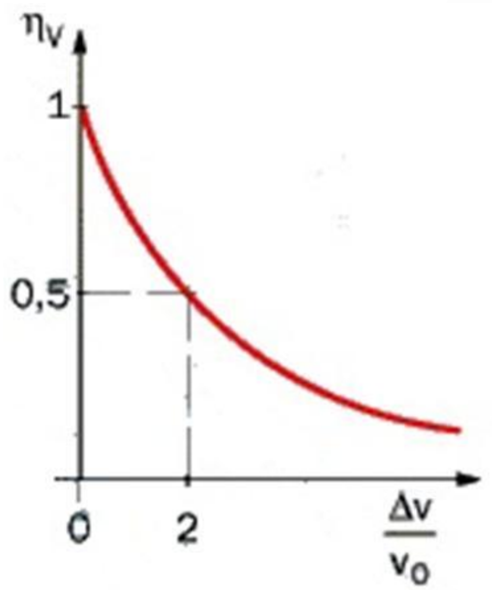
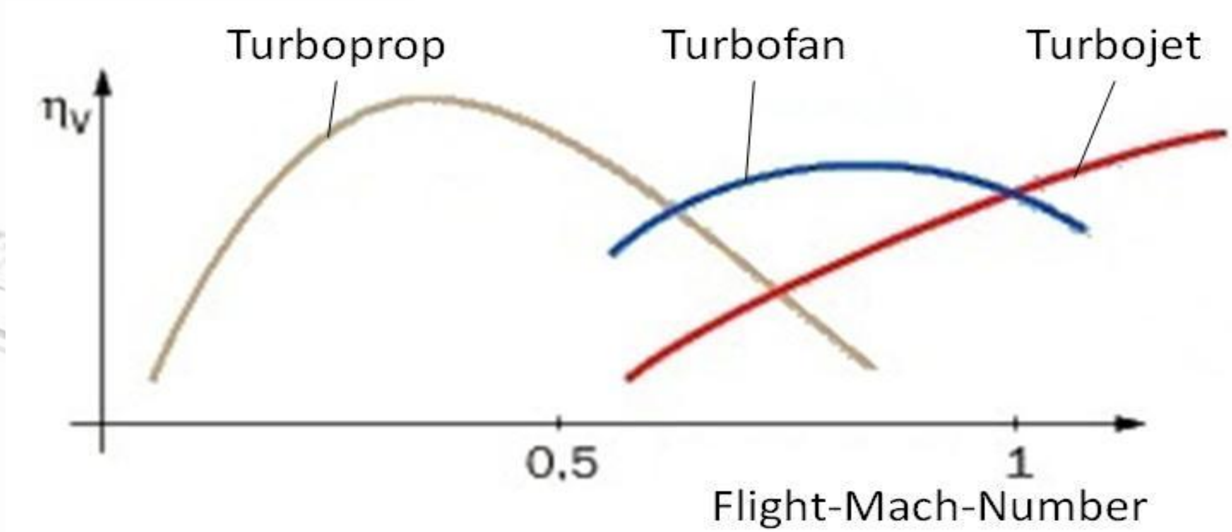


Problem Definition

- **Propulsion Efficiency**





$$\eta_V = PropulsionEfficiency = \frac{PropulsionPower}{EffectivePower}$$

$$\eta_V = \frac{2}{2 + \frac{\Delta V}{V_0}}$$

➢ **A Turboprop Engine is required for ESTOLAS**

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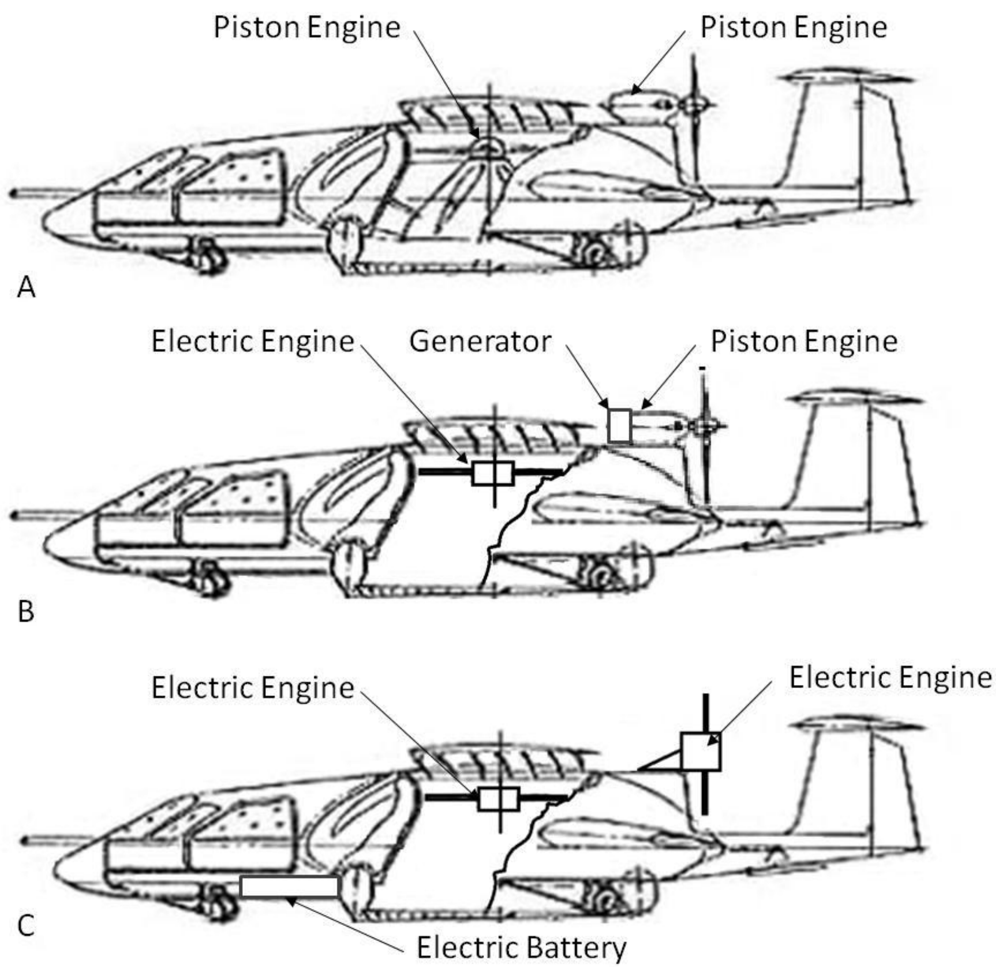
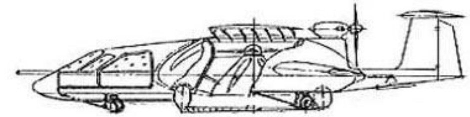
Main Achievements

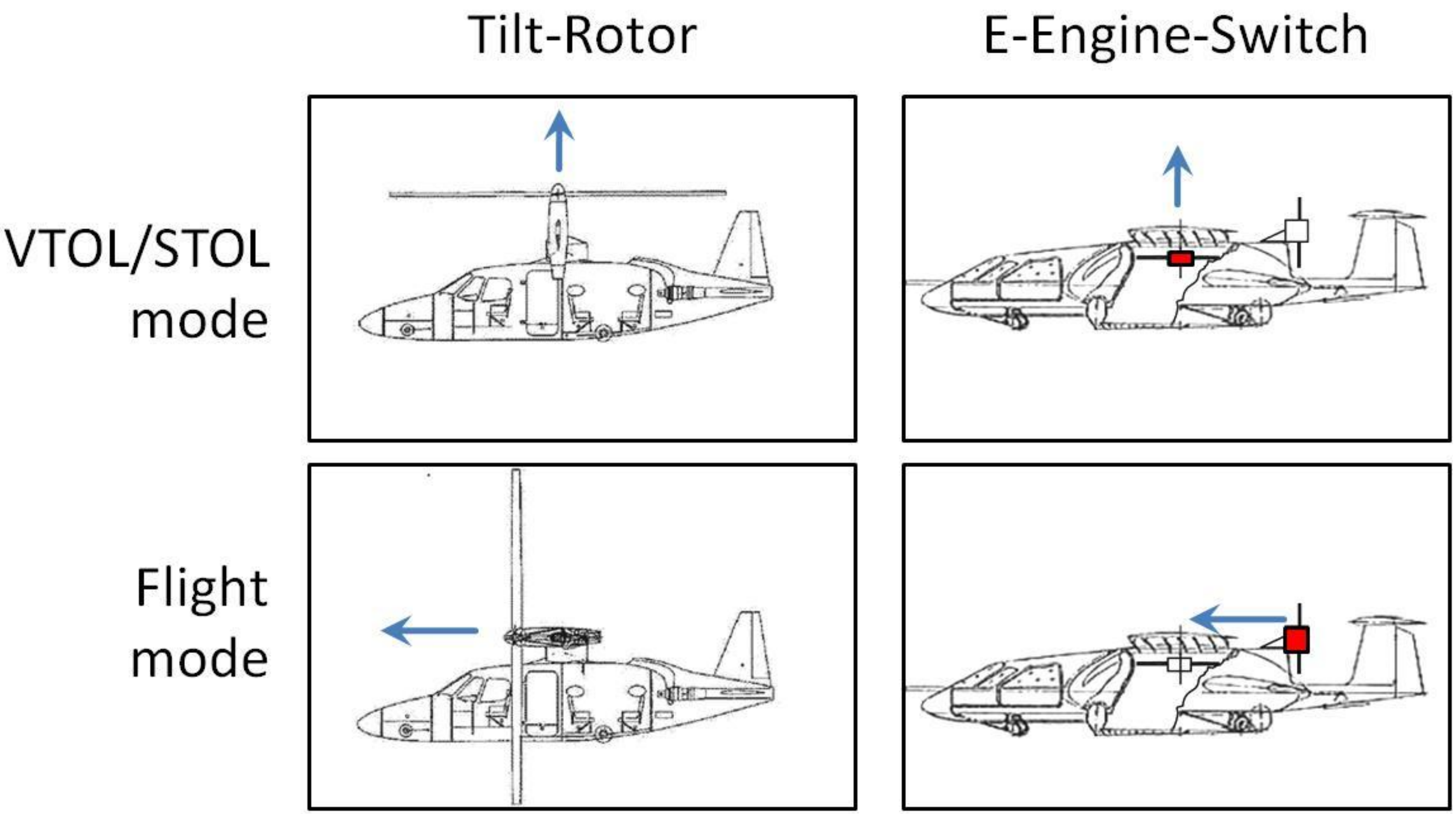
- **Electric Engine Integration**





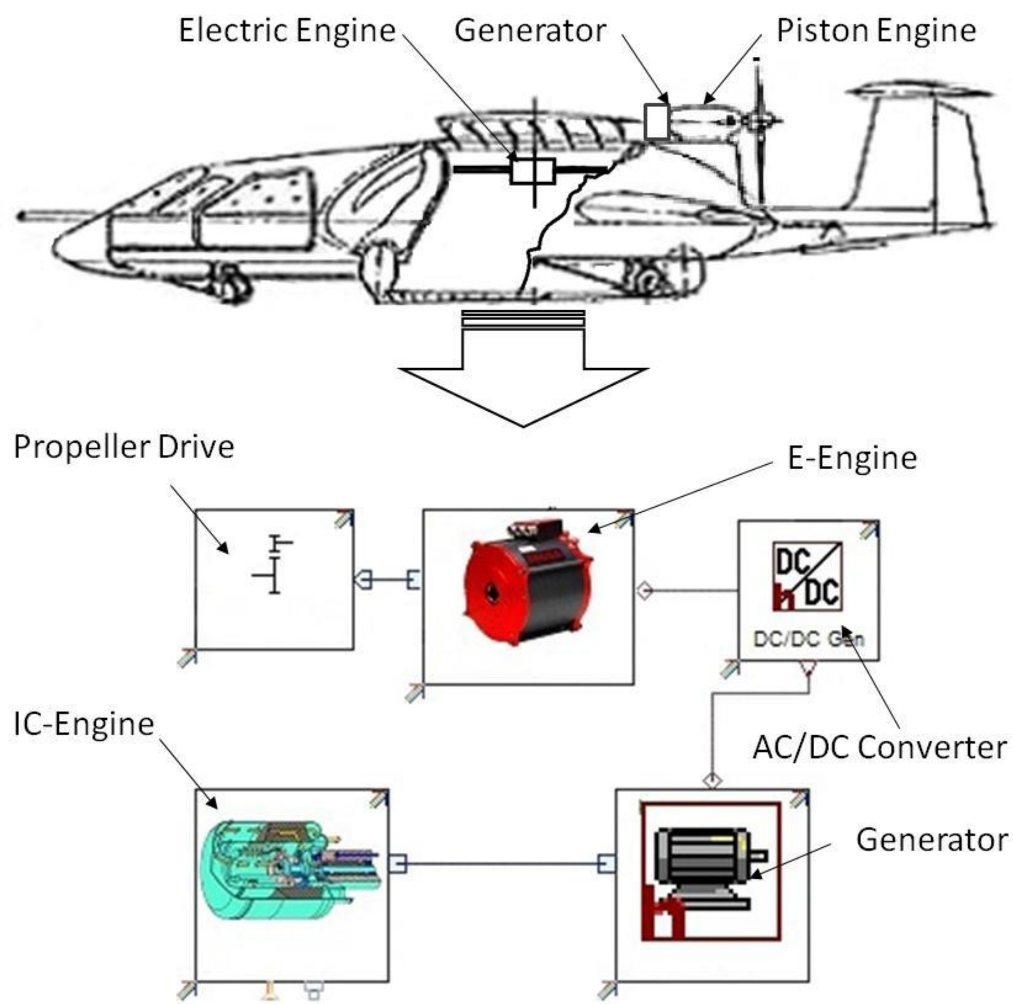
Main Achievements

- **Electric Engine Integration**



Main Achievements

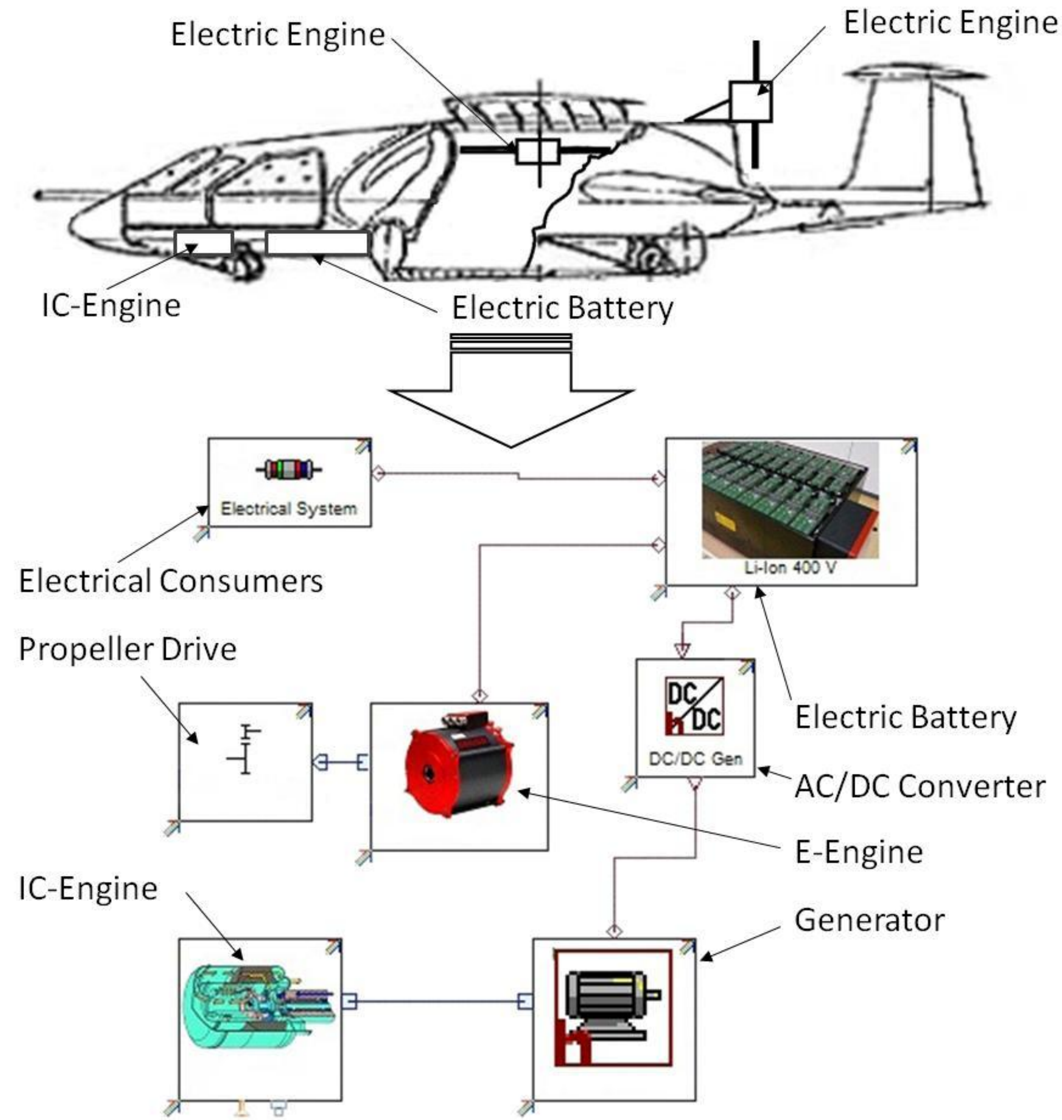
- **Electric Engine Integration**



Main Achievements

ESTOLAS

- **Electric Engine Integration**



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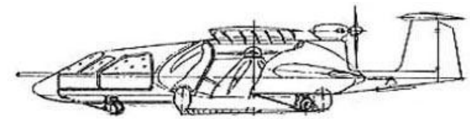
Main Achievements



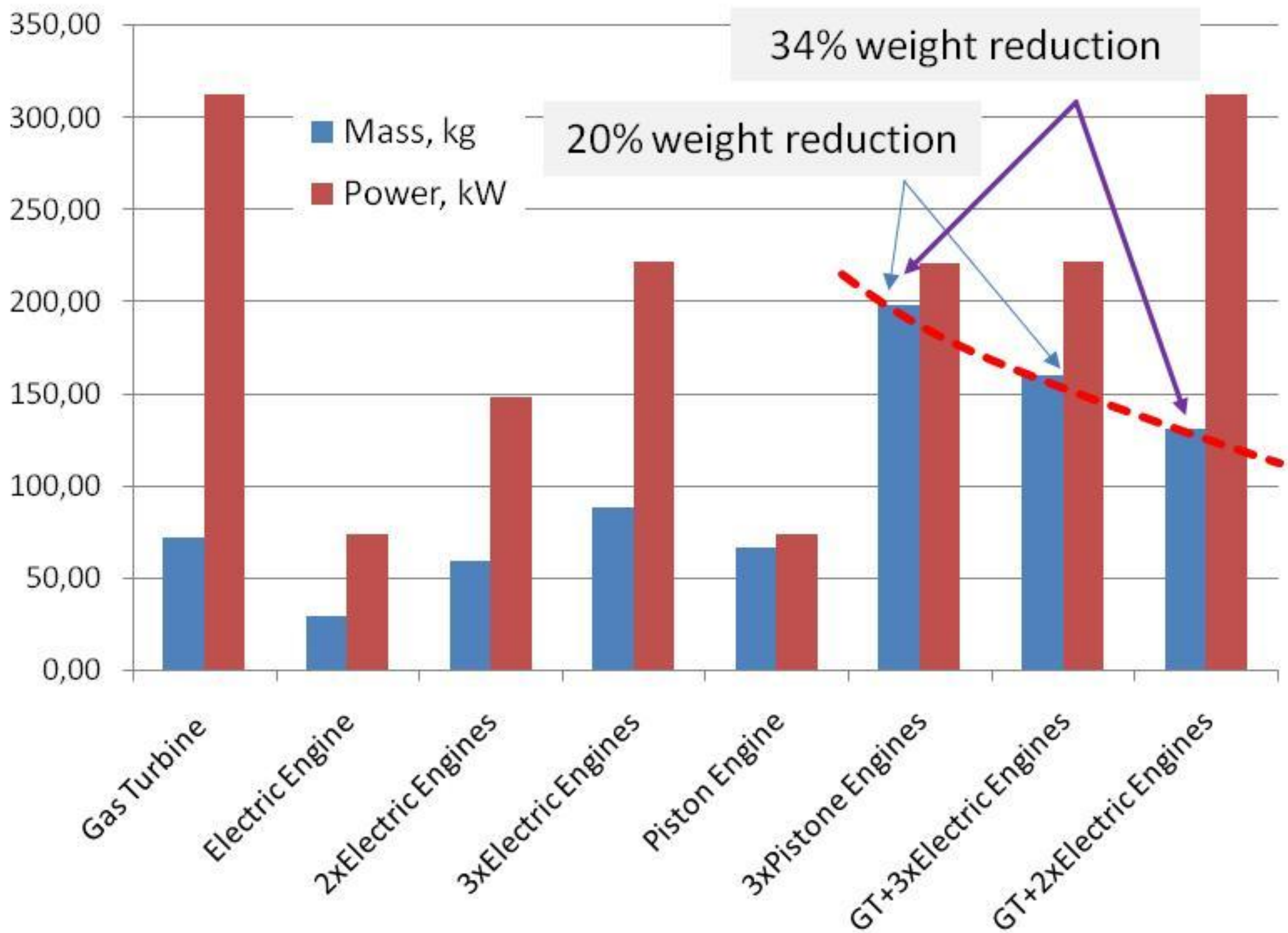
- **Electric Engine Integration**

Type of Power Unit	Mass, kg	Power, kW
Gas Turbine	72,00	313,00
Electric Engine	29,40	74,00
2xElectric Engines	58,80	148,00
3xElectric Engines	88,20	222,00
Piston Engine	66,00	73,50
3xPistone Engines	198,00	220,50
GT+3xElectric Engines	160,20	222,00
GT+2xElectric Engines	130,80	313,00

Rough comparison of main parameters of electric engines and piston engines

Main Achievements

- **Electric Engine Integration**



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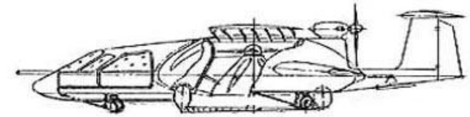
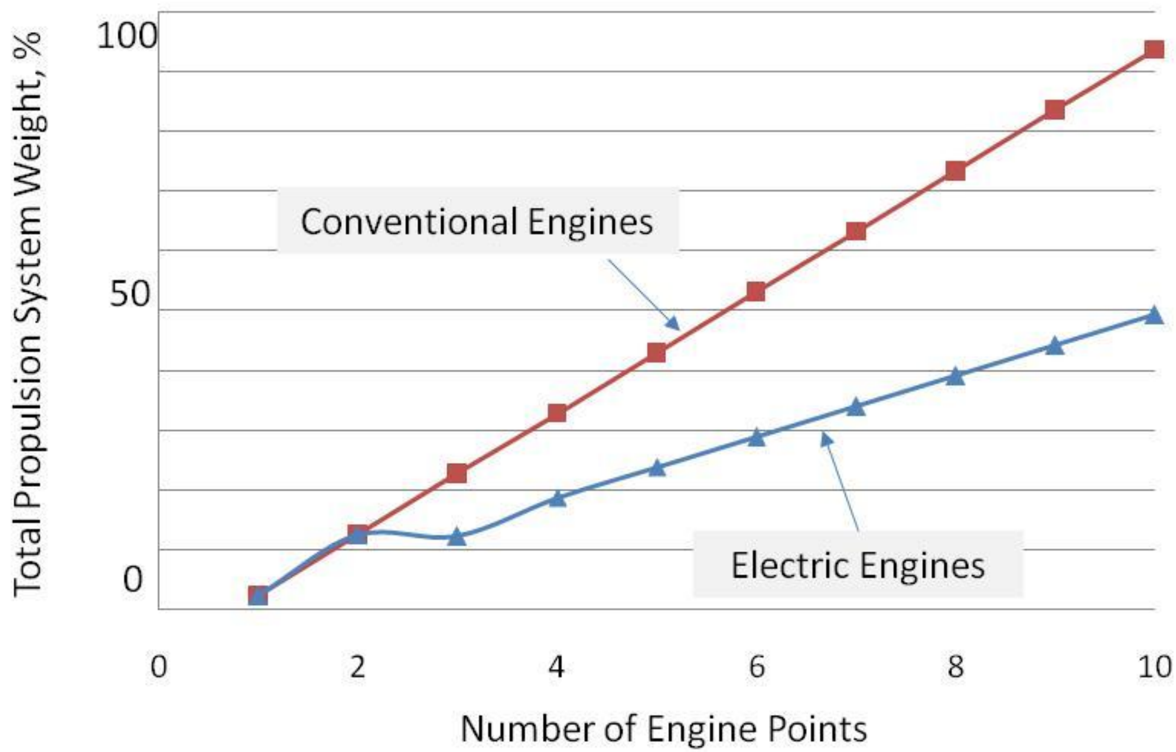
Main Achievements



- **Electric Engine Integration**



Expected system weight reduction due to application of electric propulsion system in ESTOLAS

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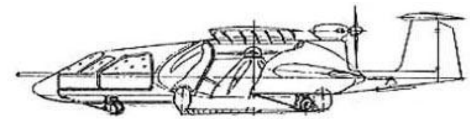
Future Fuels

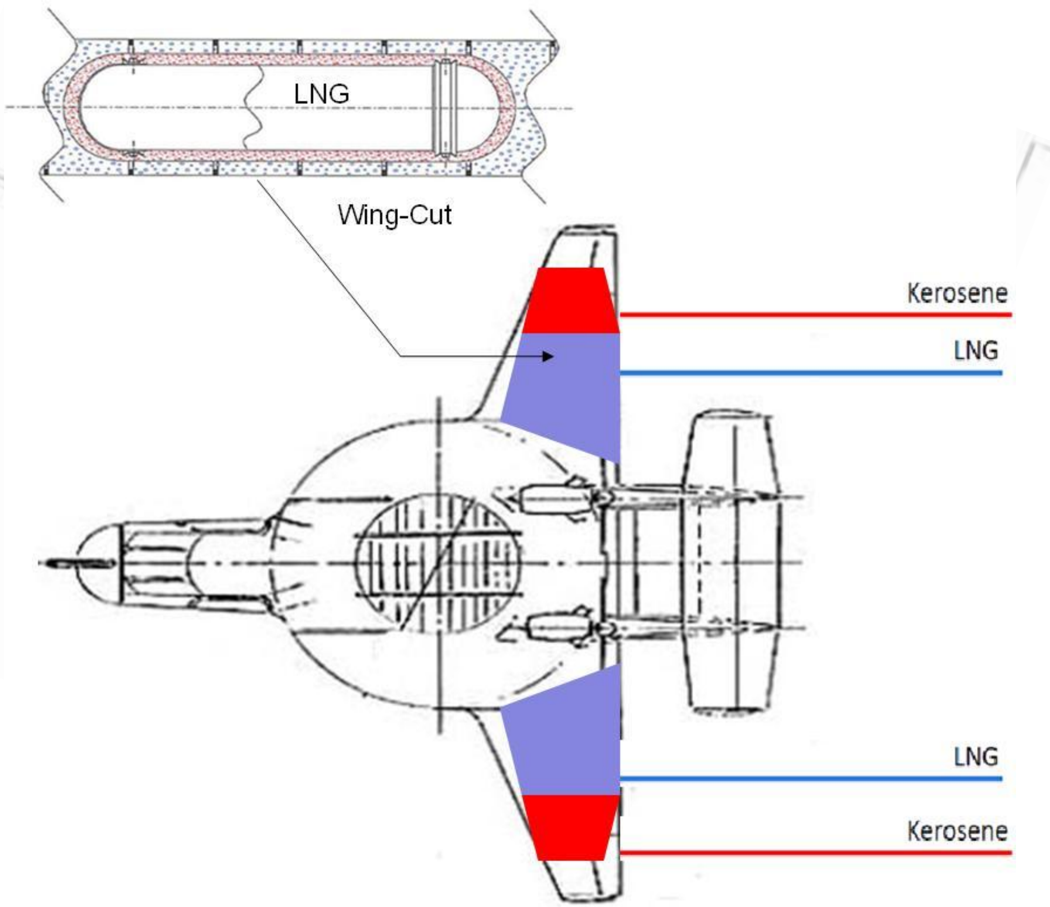


• Properties of available fuels

Fuel type	Energy source	Energy density	Storage Handling	Longtime	Climat impact
Kerosene	Oil, Oilsand	+	+	-	-
GTL, CTL Kerosene	Cole, Naturalgas	+	+	0 Coal	-
LPG ASKT	Oil; Natural gas	0 0	Pressure-tank	- 0	- -
LNG BioLNG	Natural gas Biogas	0 0	Isothank	- +	- +
Ethanol, Methanol	Biomass	-	+	-	+
Vegetable Oil	Biomass	0	- Frosen	-	+
BTL Kerosene	Biomass	+	+	0	+
BioLNG	Biomass	0	- Isotank	0	+
LH2	solar	+	- Isotank	+	+

Future Fuels

- **LNG fuel system arrangement**



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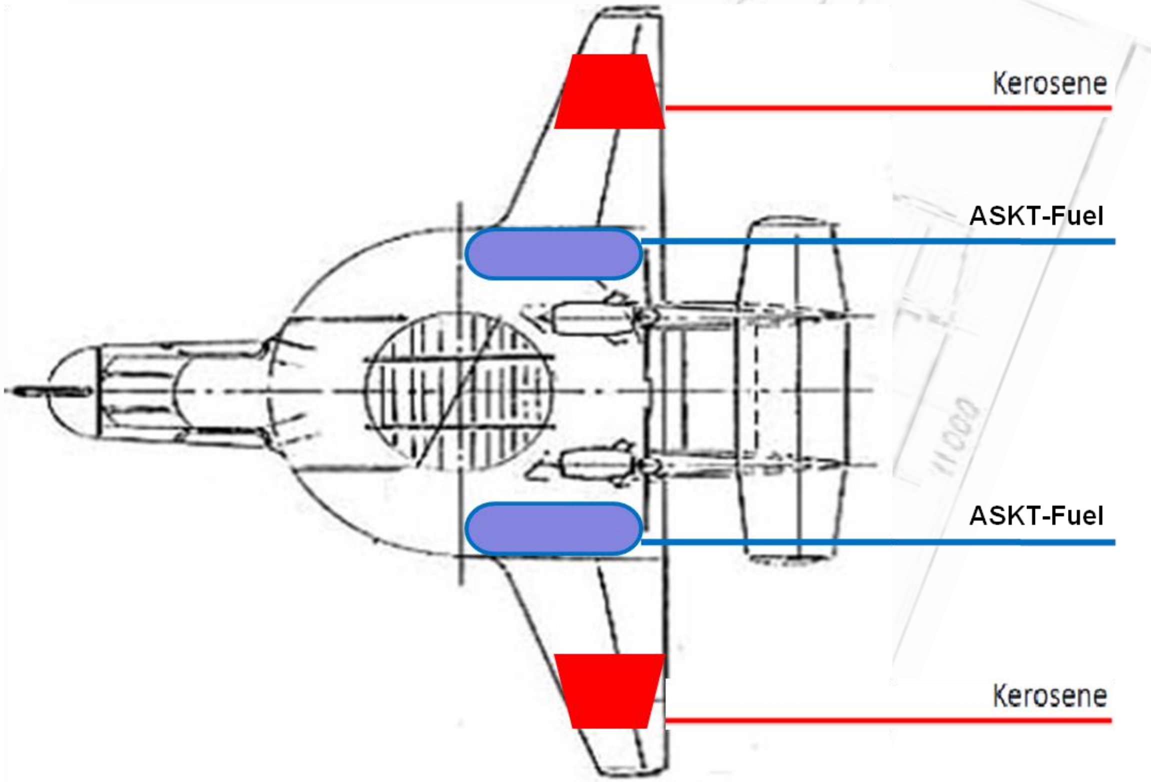
Future Fuels

- **ASKT fuel system arrangement**



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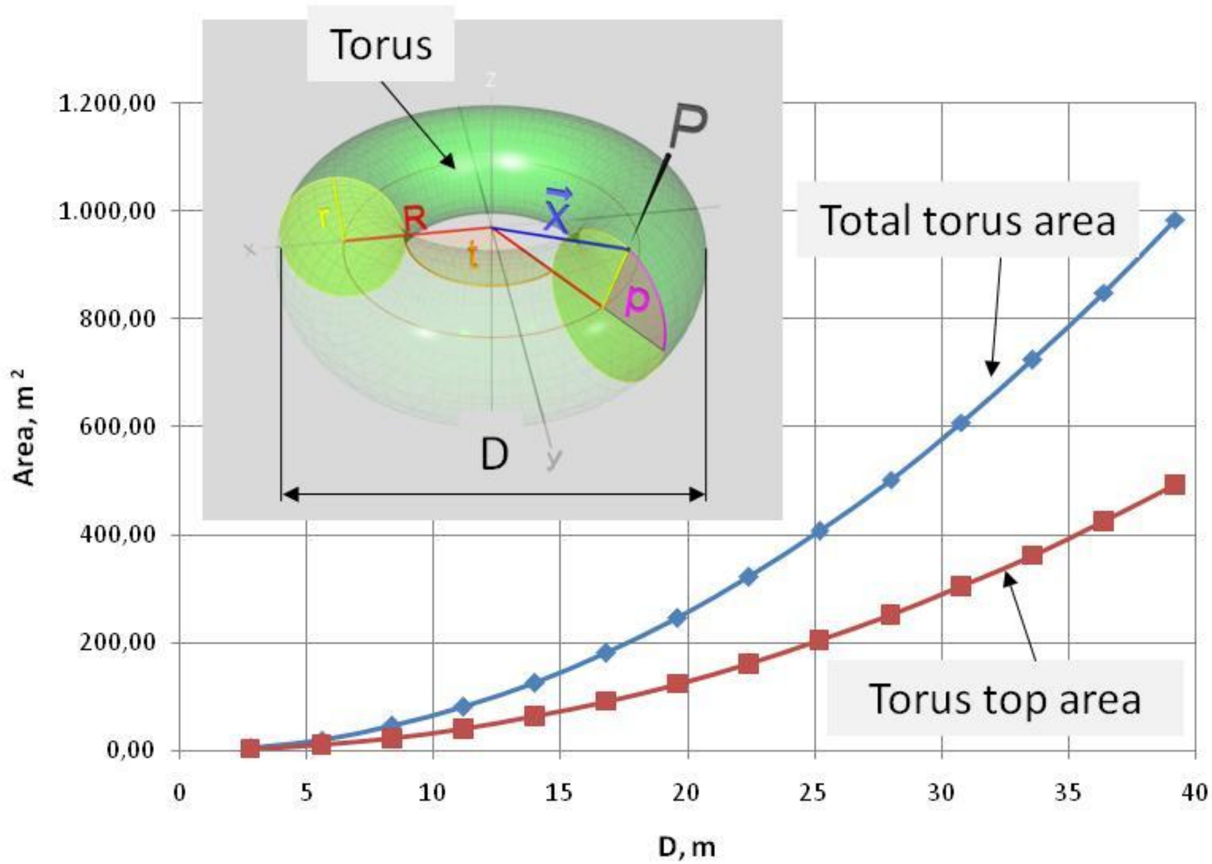
Main Achievements

• **Solar Energy Souses**



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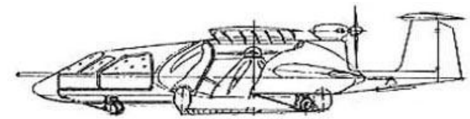
Conclusions



• In the frame of performed investigations an optimal architecture for electric ESTOLAS was proposed

• The analysis shows that the application of electric components (electric engines, generators and batteries) can improve the flight properties of ESTOLAS in the future

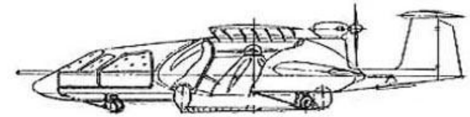
• Proposed propulsion system structure on board of ESTOLAS opens new strategy for flight control during the flight, which enables VTOL-operations for the flight vehicles with high payload

•The perspective architecture allows to reach significant weigh and costs reduction at minimal emissions level

• Electric engines powered by solar energy are environmentally friendly and can ensure a largely carbon-neutral energy supply for aviation

•The further simulations and tests of main energetic parameters of an electric ESTOLAS are planned

Teams and recourses involved



Thank You!

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