BEING AHEAD STC

Overview of alternative and advanced thermal propulsion and power generation concepts

2002
Founded

~ 100
Employees

10%
Of turnover invested in R&D

27+
patents

100+
Customers with global presence

ONE
Global partner for Product and Process Development

Shaping the Future of Innovation
Where Innovative Design Meets Cost Optimization and Sustainability

STC at a glance

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Global Footprint

Engineering Consulting Service Product Development & Value Optimization

SME Innovative

Network agreement with R&D center, University and selected Engineering Partners

Business Pillars

STC

COST & VALUE OPTIMIZATION

- Teardown
- Material characterization
- Benchmarking
- Cost analysis
- Ideas generation for optimization
- COST for LCCA

PRODUCT DESIGN

- Concept analysis
- Pre-Study development
- 3D design
- 2D design

PRODUCT QUALITY & SUPPLY CHAIN

- Risk Assessment
- Reliability Growth
- Process analysis
- Customer Quality
- Documentation

PRODUCT MANUFACTURING

- Lean Management
- Supply chain analysis
- MTM
- Plant & toolings maintenance
- Realization of testing solutions

AI & DIGITAL

- PLM integration
- A.I. Cost Analysis
- A.I. Design
- IoT & software development

ENERGY SOLUTIONS

- Electrification
- H_2 Technologies
- Alternative Fuels

Thermal propulsion/generation systems: the context (1)

The Energy Transition: Setting the Context

Boundary Conditions
Before analyzing thermal propulsion/generation systems, it's essential to clarify the current landscape:

•**International Milestones:**
- *Kyoto Protocol* (1997), *Paris Agreement COP21*, and *Dieselgate* (2015) prompted regulatory urgency.
- In **2021**, the EU announced the **ban on internal combustion vehicles (Diesel/Gasoline)by 2035**.

•**Policy Trends:**
- Biofuels and bioenergy options were dismissed by EU leaders (e.g., Timmermans, Hoekstra) as "too complex.“
- Requests to consider realistic well to wheel emissions and negative CO2 potential solutions coming from re-use of otherwise pollutant producing matters were rejected
- Addition of ban on combustion/hybrid heating systems by **2040 c**ould potentially double the demand for E energy and distribution
- Push for **fully electric systems** for mobility and building heating diverted funding and industrial investments in the temptative to create a competitive industry on batteries and fuel cells with the bad results (Northvolt in bankrupcy ,Ballard FC closing Denmark centers and facilities,Bosch closing the FC unit…).

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Thermal propulsion/generation systems :the context (2)

Complexity of the Transition & Real-World Frictions

- **Emerging Issues**

The electric-only approach has exposed major systemic challenges:

•**Grid Infrastructure**: High cost and complexity; current grids are not suited to massive power and distribution demands.

•**Renewables**: Intermittent generation with poor predictability; strong need for large-scale energy storage.

- **Essential Services Must Stay Online**

Hospitals, civil protection, water/sewage systems, underground transit, and military zones require **uninterrupted energy**, challenging full dependence on renewables.

Recent Stress Cases (Winter 2024–25):

•**Germany**: Energy collapse due to wind/solar shortage; coal/methane generation ramped up.

•**Spain & Portugal**: Major blackout (~70% renewable energy suddenly failed without backup).

Industrial Responses:

•**ZF, Renault, Geely**: Launch of **range-extender divisions** to address **EV range anxiety**.

•**Elkann, De Meo, Toyoda**: Raise concerns on oversimplified transition paths.

📌 **Conclusion**: The zero-CO_2 transition demands technological evolution, **not erasure** of previous systems.

Thermal propulsion/generation systems :the evolution(1)

– Technological Evolution in Thermal Systems

- **Integrated Thermal + Electric Innovations**

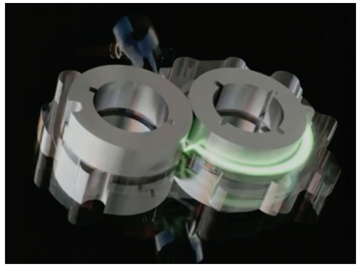
Electric systems will never more disappear from any type of energy mastering solutions **BUT f**ar from disappearing, **thermal systems are evolving** into hybridized, modular solutions that complement electrification:

- **Rotative/turbines evolution (examples)**

Hitachi MAGT: Turboelectric system with separated compressor-turbine linked via electric machines (high power density increased efficiency due to separated matching operation of turbine and compressor)

ASTRON Starfire H_2 Engine: 2-rotor design internal combustion rotor targeting 30–60k rpm, built to drive compact generator units ..

Wankel Rotary Revival: WPI and others targeting drones and light weight RE applications.



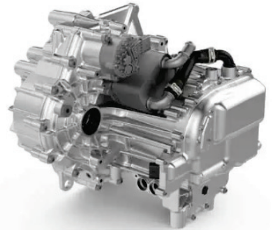
Astron engine

- **Automotive Range Extenders (REs):**

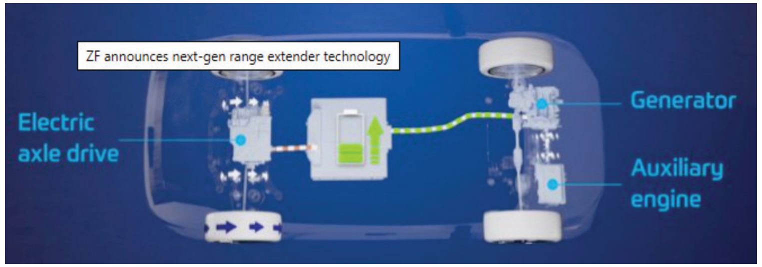
•**ZF eRE & eRE+** (up to 150kW) – quick integration into EVs with minimal adaptation.

•**Horse (Renault-Geely)**: New dedicated companies for RE units.

•Objective: Reduce battery size by 50%, enable 600+ km range.



ZF eRE



ZF eRE +

Thermal propulsion/generation systems :the evolution (2)

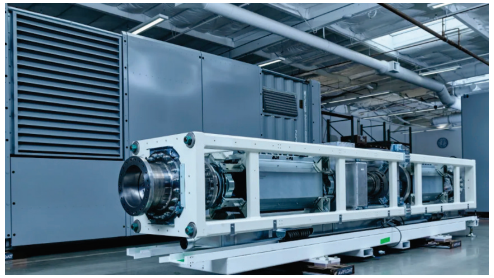
- **Really conceived for a breakthrough are the fundamentally integrated Generators concepts**

Floating Piston Linear Generators (FPLG) – Company MAINSPRING (USA)
– already in commercial use for refrigeration and EV charging (California but extending)

•Features:

- **Multi-fuel, about 0 -NOx certified**
- Perfect mechanical balance
- Modular design for various power needs
- Scalable, cost-effective production (new 1000 unit/year factory)

Mainspring generators field



Mainspring generator unit

APLG & FPLG: Future RE Stars

•As APLG (Axial Piston Linear Generators) or FPLG are gaining attention

•Benefits:

- High efficiency
- Low emissions
- Lightweight & compact
- Ideal for Passenger car Res, Heavy transport, Off-grid industrial machines,Avio and drones

Libertine UK study FPLG for base development

These innovations point to **a diversified, hybrid energy future**, blending electric precision with thermodynamic reliability. Italy still has the KH ,components industry capability , interest and time (not much) to race and position on this product .

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Thermal propulsion/generation STC environement

- **In which areas STC is engaged and for which products Axial MGEN can result in a breakthrough**

  →Assume that conversion on drive system flows rapidly towards electrification :

  - electrified drives allow more precision and higher efficiency than Hydraulic ones
  - as a replacement of mechanical multi gear systems result in silent continuos variation drive
  - In built energy recovery is natural including in built high braking power

- **Considering our current highly diversified engineering areas (**Marine ,Railway ,Automotive ,Off road ,E power-gen…)








→ We could not imagine one single of those applications that would not take advantages in a next future from a combination of a combined E-drive and thermal low emission or about 0 emissions generator .

- High energy comsumption applications could not rely on batteries only considering recharge and network availability …
- Many of those applications operate in remote zones where recharge is difficult or impossible
- Ideally a AXMGEN could replace a Fuel Cell for long life and difficult/harsh environement applications
- Modularity ,perfect balance ,durability/reliability and availability of materials/technologies/components would offer greayt opportunities for the EU industrial environement

→ STC supports STEMS for a doctorate in order to study and create the maximum efficiency axial elctrical generator and the best options/layouts for pistons motion control .

Thermal propulsion/generation systems :the challenges

- **The AXMGEN big opportunity generates several major challenges, we'll face in part in the current project.**

  →Obtain best efficiency including thermal as well as generation efficiency (over 50 % @SOP)

  →Create a agnostic engine structure capable to operate with sets of low emissions and 0/lowCO_2 fuels (H_2 ,CH_4,NH_3 …)

  →Design for a multicylinder compact and modular solution including connections to ancillary systems (cooling,air handling ,exhaust ATS …)

  →Design for in built durability and reliability independent from the specific application .

  → Ensure best cooling of the electrical generation area ,define unusual air /coolant cooling paths and architectures adopt in built cooling matrixes (geoids , micromatrixes ,DLMS …   )

  →Fundamentally increase power density and operation frequency up to 60 Hz and over .

  → Ensure the Epower gen area to operate with about 0 oil presence.

  → Think since the beginning to applications compatible and friendly layout in order to ensure a fast acceptance

  → Monitor since the beginning the potential product cost and advantages .

Conclusion: Even if only preliminary results will emerge , data and indications created in the project will allow to evaluate and launch projects oriented to pre-production solution and technologies .