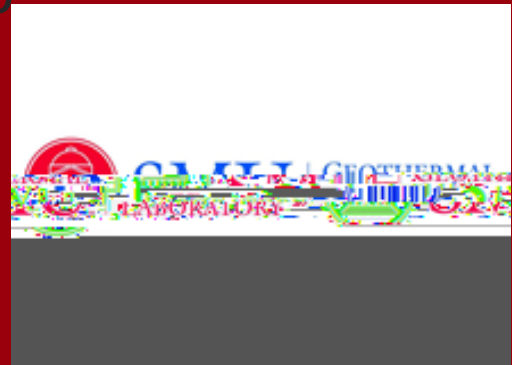
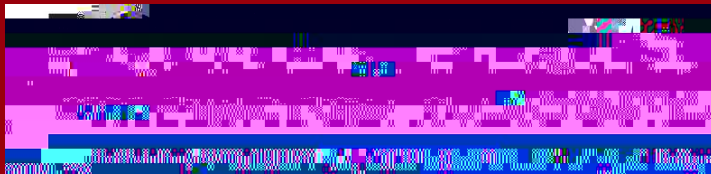


Enhanced Efficiency, Sustainable Power Generation, and CO₂ Emission Reduction through Organic Rankine Cycle Technology

Simone Passera
Dallas, April 26th 2016

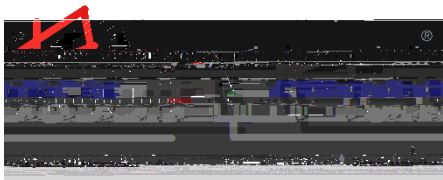
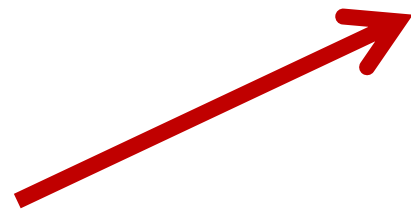
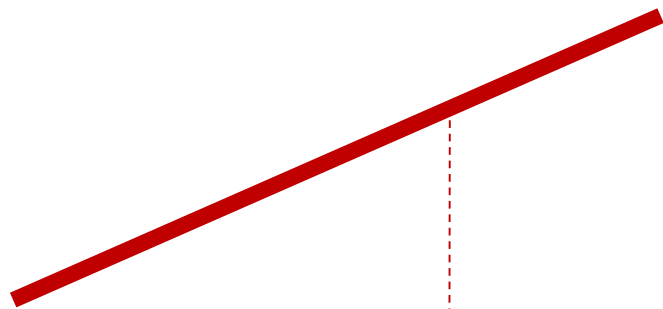
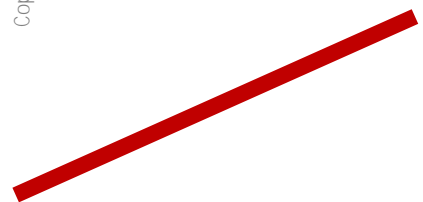


A PROVEN SOLUTION

- ‡ The design of the turbine (casing, blading) is carried out by Turboden representing the core know-how since its foundation in 1980
- ‡ 300 Turboden ORC turbines successfully implemented with sizes from 200 kW to 20 MW
- ‡ Proven experience with 10 different ORC fluids
- ‡ Axial geometry is a traditional configuration, the most widely adopted in turbomachinery design
- ‡ Axial is the reference design

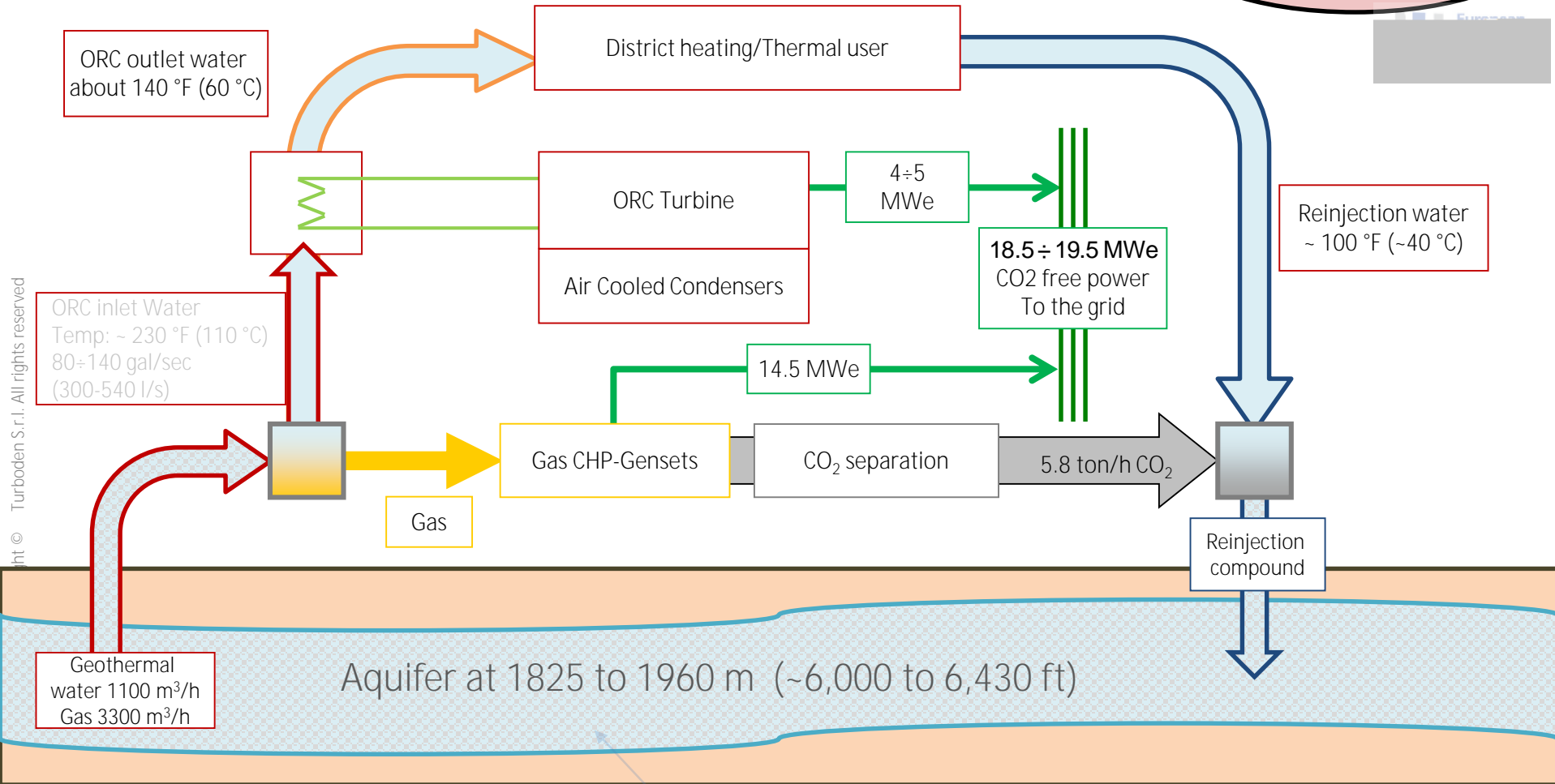


1980



Reference project Intelligent use of aquifer gases

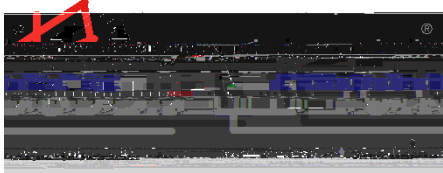
Pilot project in Croatia with BEI support starting phase of project on-going



ht © Turboden S.r.l. All rights reserved

Aquifer at 1825 to 1960 m (~6,000 to 6,430 ft)

Gas composition: 94% CH₄; 6% CO₂
 Gas content: 3 ÷ 3,5 Nm³/m³

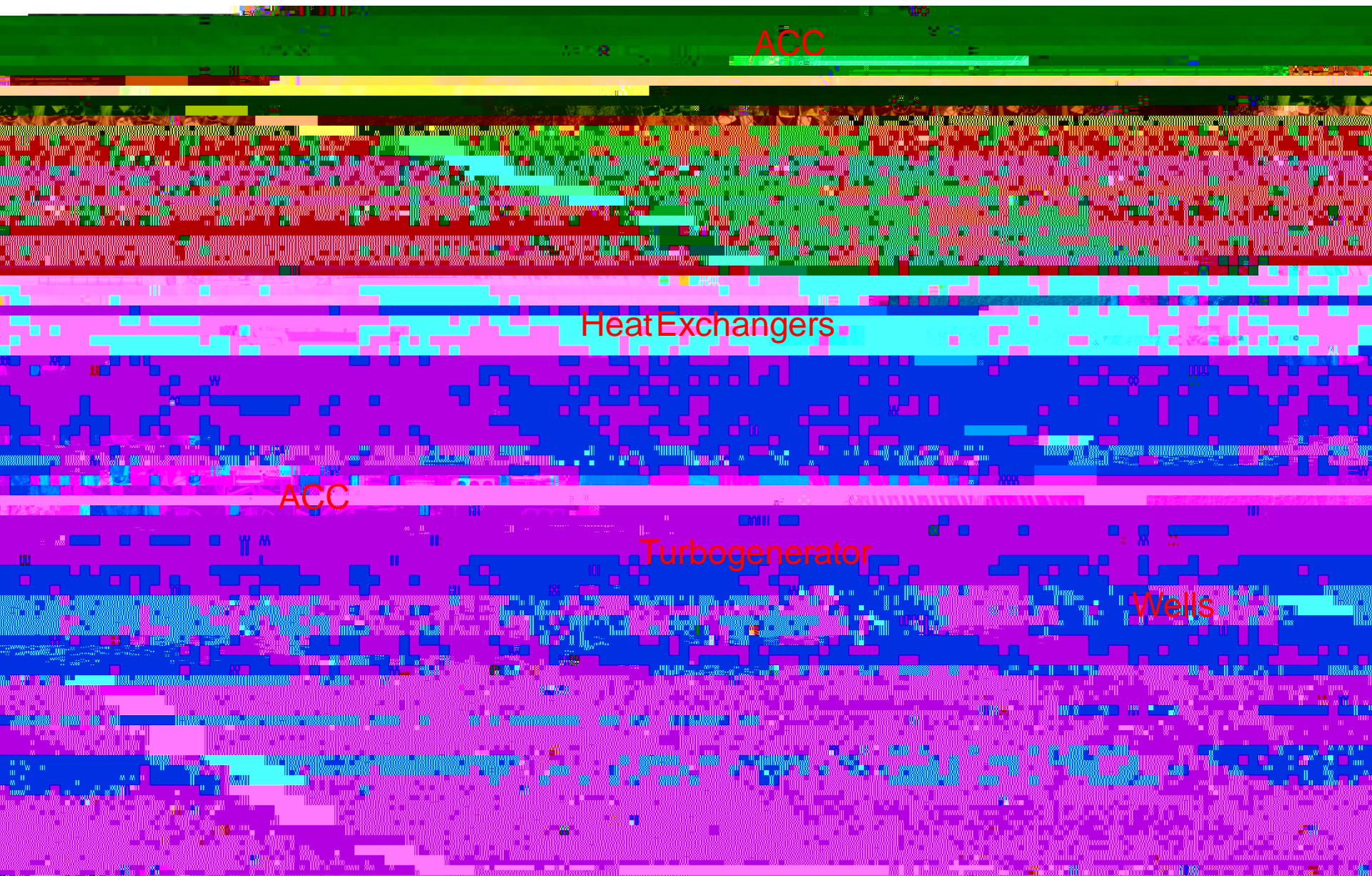


Reference project Intelligent use of aquifer gases

1. Hybrid geothermal/gas power plant for combined electric and heating generation (20 MWe with zero CO₂ emission)
2. Turboden ORC binary technology improves of around 30% the electrical efficiency of the power plant
3. Valia in fan nc n en i nal ce i e he mal a i fe i h methane content)
4. Pilot project is the result of intensive researches combining different expertise and the best technologies from different fields



Layout example of Turboden reference



Reference Plant - Sauerlach

Plant type: Two-level cycle geothermal unit

Customer: SWM - StadtWerke München (public utilities company)

Site: Sauerlach, Munich, Germany

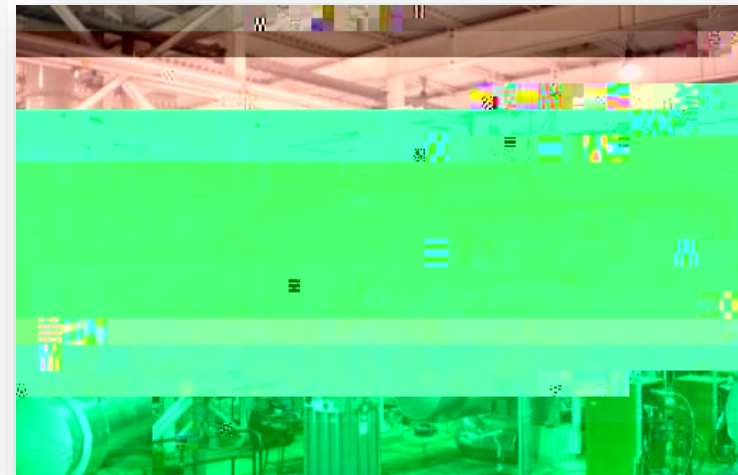
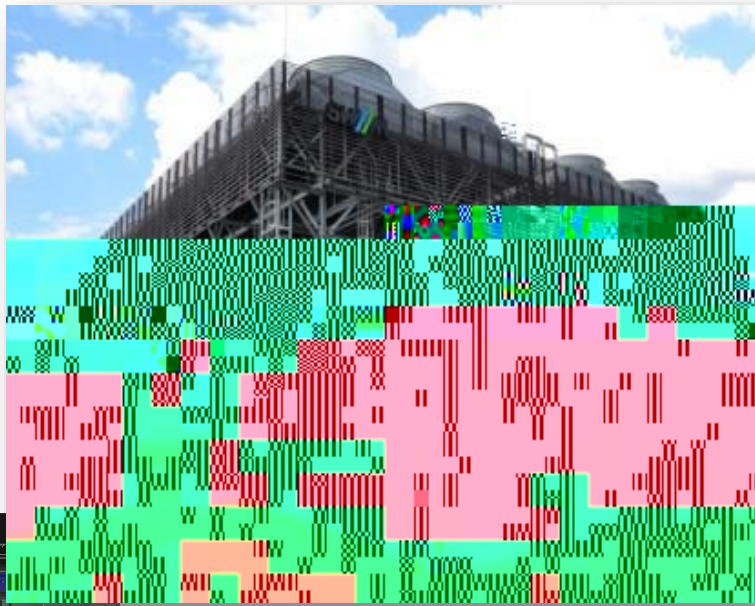
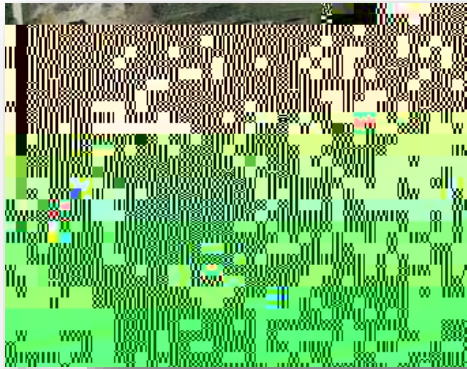
Start-up: December 2012

Heat source: geothermal fluid at 140 °C

Cooling device: air condensers

Total power: 5+ MW_e plus 4 MW_{th} (13.6 MMBtu/h) decoupling for district heating

Working fluid: refrigerant 245 fa (non flammable)



Custommade solution according customer requests



Oil&Gas applications

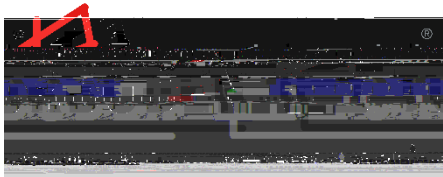
2. Gas turbines exhaust gas

Turboden References

‡TransGast Canada

GT power: 3.5 MWe

ORC power: **1 MWe**



Oil&Gas applications

3. Associated Petroleum Gas (APG) exploitation

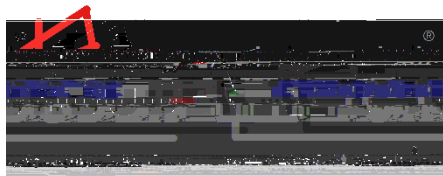
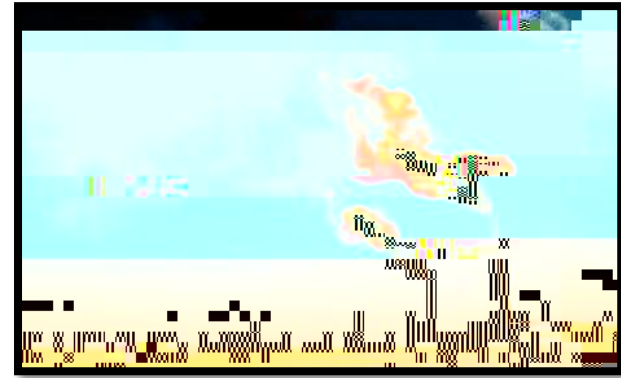
APG produced in oil extraction fields is often flared to the atmosphere because its economic valorization as hydrocarbon is unfeasible

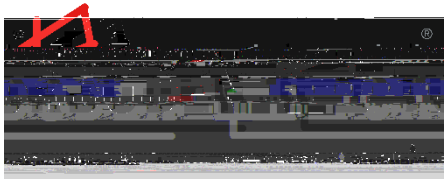
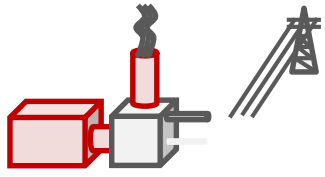
Main reasons:

Cycling availability, low calorific value, variable composition, high sulfur content, etc.

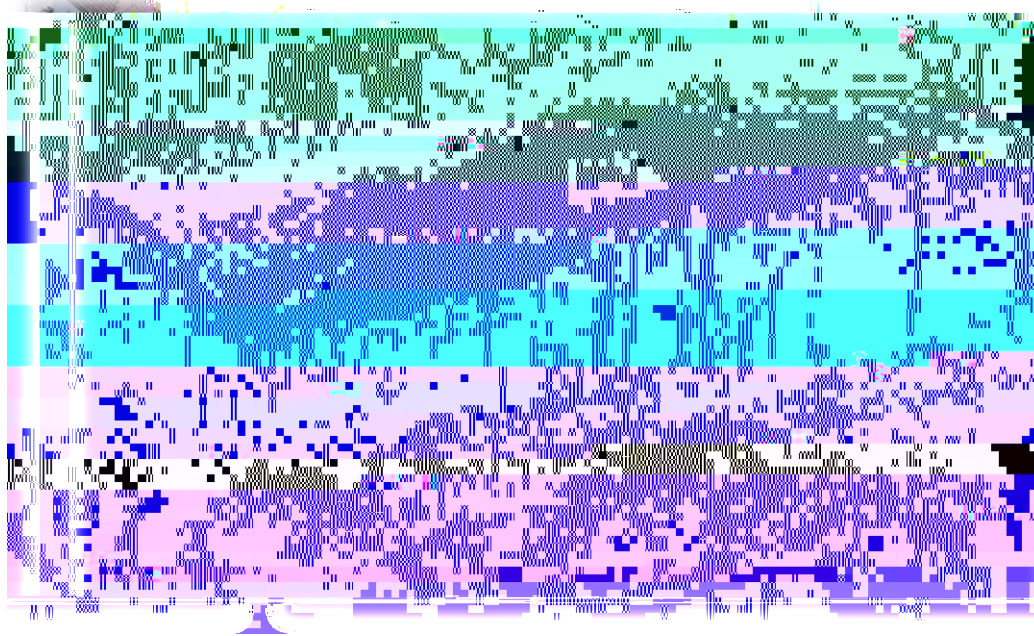
Difficult employment in high conversion efficiency power systems (e.g. gas turbines and reciprocating engines).

TurbodenORC characteristics (such





Thanks for your attention



Turboden HQ at a glance, Brescia, Italy

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Official YouTube Channel: <https://www.youtube.com/user/TurbodenItaly>

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