GEOTHERMAL THERMOELECTRIC GENERATOR FOR TIMANFAYA NATIONAL PARK

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ABSTRACT:

Despite being one of the largest renewable sources, geothermal energy is not widely utilized for electricity generation. In the case of shallow Hot Dry Rock (HDR) fields, thermoelectric generators can entail a sustainable alternative to Enhanced Geothermal Systems (EGS). The present work studies two configurations of thermoelectric generators for Timanfaya National Park (Spain), one of the most important Hot Dry Rock fields in the world, with temperatures of 500°C at only 3 meters deep. The first configuration includes biphasic thermosyphons as heat exchangers for both sides, leading to a completely passive thermoelectric generator. The second configuration uses fin dissipators as cold-side heat exchangers.

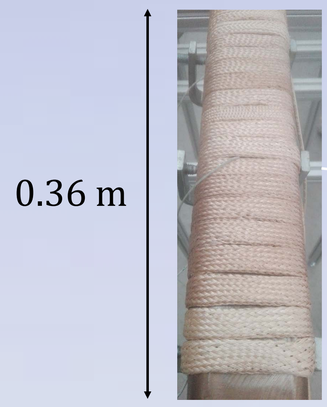
GEOTHERMAL THERMOELECTRIC GENERATOR (GTEG):

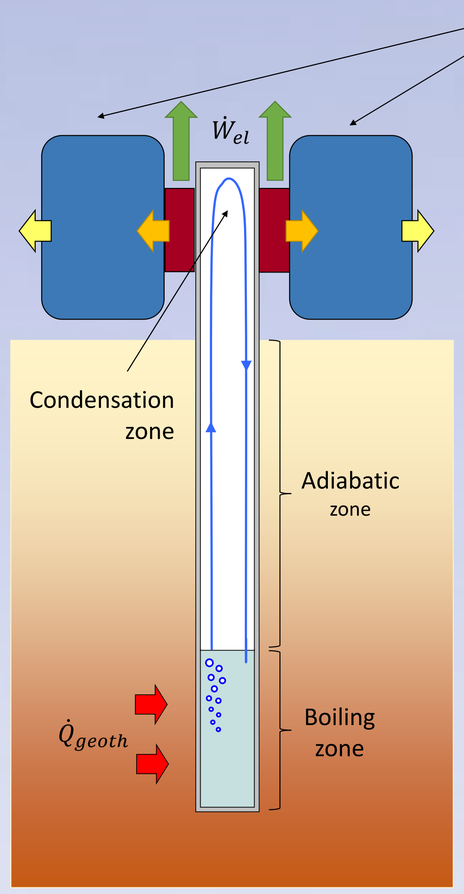
Hot-side Two Phase Closed Thermosyphon (TPCT):

Cross-section: 60 x 60 mm²
Thickness: 5 mm
Length:1 m
Material: AISI 304
Working fluid: water (0.36 m)

R = 0.13 K/W

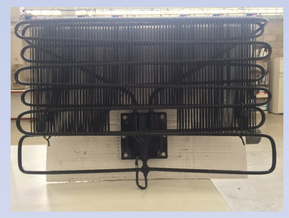
Rope heaters:



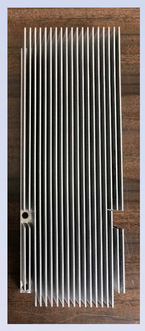


Cold-side heat exchangers:

1. Loop Thermosyphons (LT):
Evaporator: 50 x 50 mm²
Condenser:
Tube diameter: 6 mm
Length/level: 420 mm
Working fluid: water/ammonia



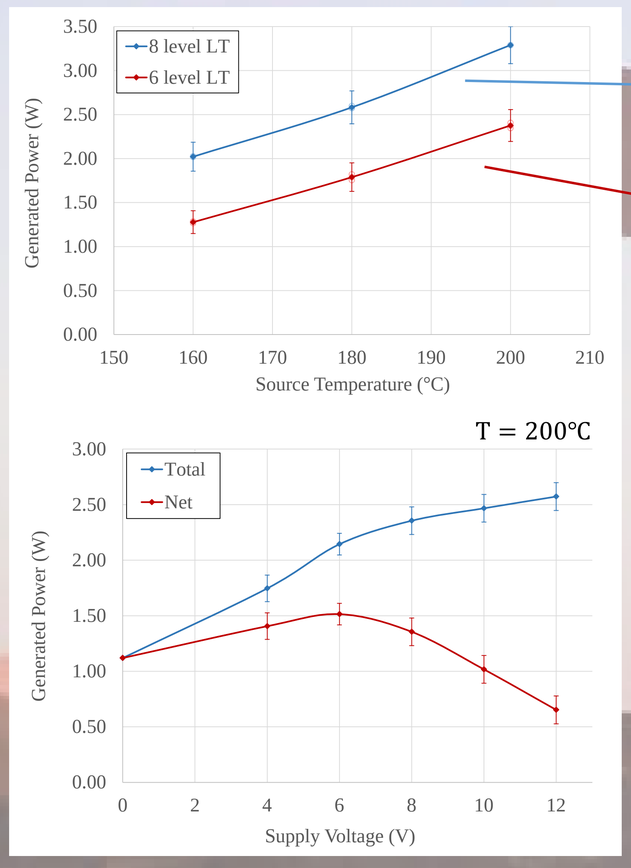
Heat flux (W)		20	40	60	100	140
R (K/W)	8 level LT	0.29	0.22	0.20	0.17	0.16
	6 level LT	0.40	0.33	0.29	0.26	0.24

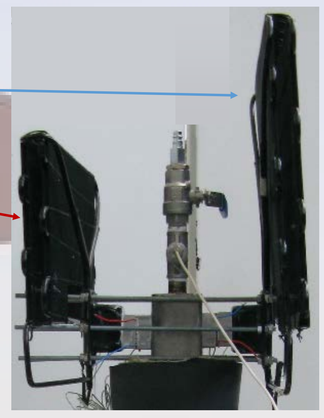


2. Fin dissipator (FD):
Base: 90 x 250 mm²
Fins: 39.5 x 1.5 mm²
Fin spacing: 4.8 mm
Brushless fan: 90 x 90 mm²

Fan voltage (V)	6	8	10	12
R (K/W)	0.27	0.29	0.32	0.38

MAX. POWER GENERATION PER MODULE:

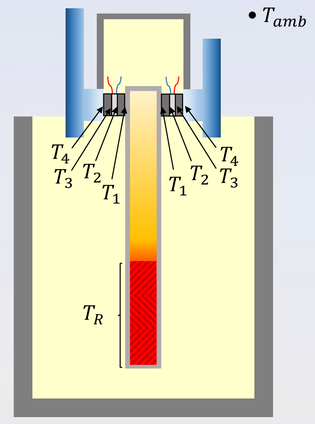


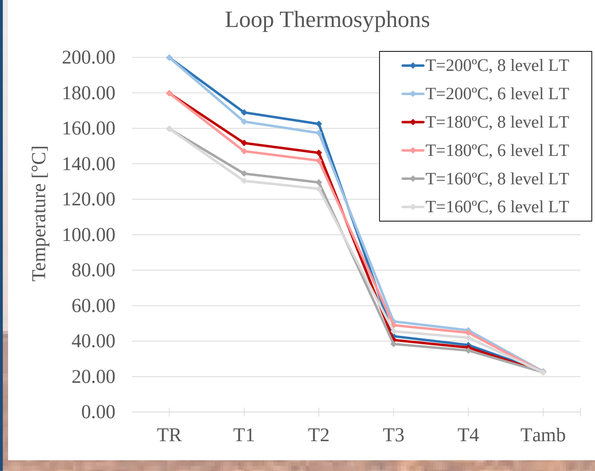


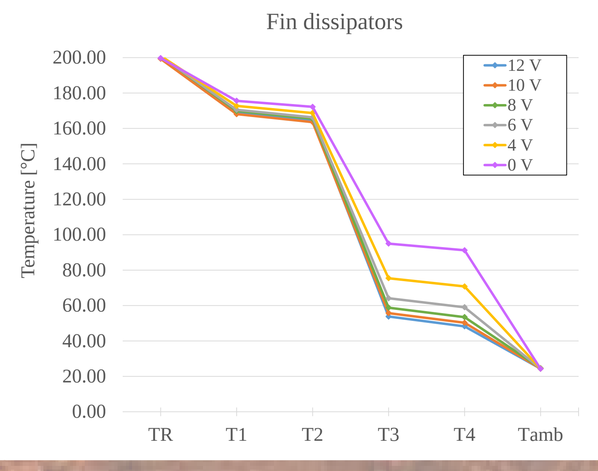
TEMPERATURE DISTRIBUTION:

Depicted points:

- TR: Source temperature (rope resistances)
- T1: Condesation zone. Hot-side TPCT
- T2: Hot face of the modules
- T3: Cold face of the modules
- T4: Cold side heat exchanger
- Tamb: Ambient temperature







CONCLUSIONS:

- ✓ **Two different Geothermal Thermoelectric Generators (GTEG) have been built and tested: one with biphasic thermosyphons as heat exchangers, and the other one including fin dissipators at the cold side.**
- ✓ **Biphasic thermosyphons lead to 3.3 W per module, 50% higher generation than fin dissipators due to their lower thermal resistance and especially due to their lack of auxiliary consumption.**
- ✓ **It is estimated that 100 kWe can be generated at Timanfaya National Park thanks to GTEGs with biphasic thermosyphons.**

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