Autonomous Integrated Heliostat Field and Components:
Field deployment and Techno-economics

SETO CSP R&D Virtual Workshop Series
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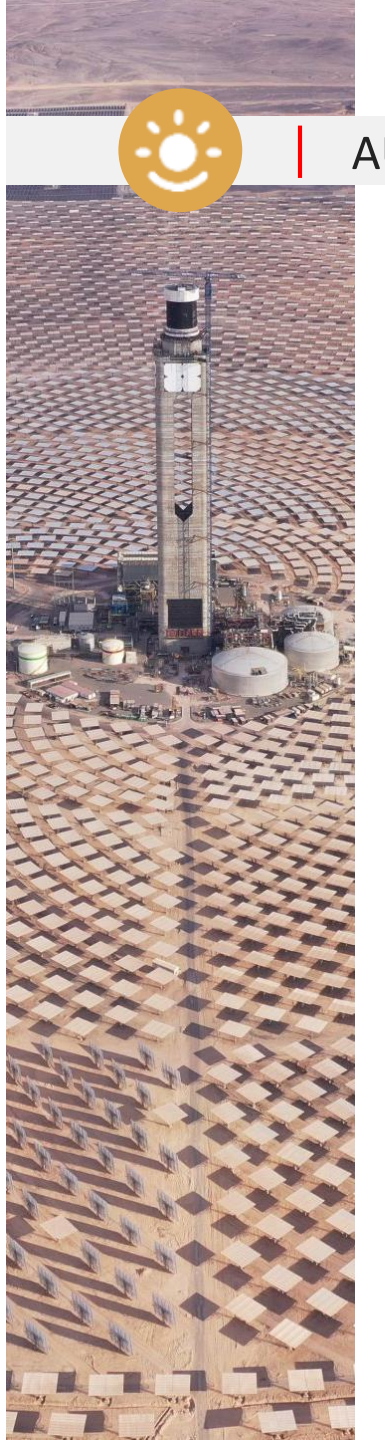


AUTONOMOUS HELIOSTAT FIELD DEPLOYMENT & TECHNO-ECONOMICS

BATTERY LIMITS AND LESSONS LEARNED

Correlations

- \- Autonomous heliostats —→ Medium-Small heliostats due to autonomy limitations
- \- Small heliostat —→ Higher number of foundations
- \+ Higher number of foundations + Autonomous Control System —→ Global minor civil works costs
- \+ Small heliostats —→ Higher optical quality —→ minimize slope error —→ minimize the solar field size under isoproduction
- \+ Small heliostats —→ minimize tracking error under wind loads —→ minimize the solar field size under isoproduction
- \+ High optical quality + specific aiming strategy —→ Spillage losses reduction
- \+ Smaller optimized solar field size —→ Minor total reflective surface + Higher optical quality

HIGHER OPTICAL EFFICIENCY OF THE SOLAR FIELD…..BUT….WHAT ABOUT THE COSTS AND ROBUSTNESS OF THE SOLUTION?

From manufacturing to installation

- From detailed design to prototype manufacturing
- From prototype to certification
- From certification to industrial serial process
- From industrial serial process to supply chain management
- From supply chain to solar field assembly
- From foundations to pilling process -- dependence on geotechnical conditions

Solar Field Optimization

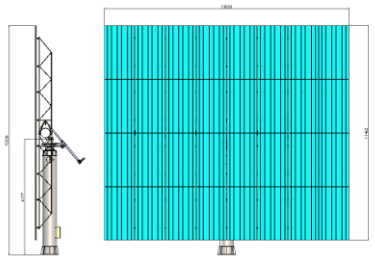
- Solar field layout optimization
- Aiming strategy optimization

Techno-economics

- From negotiation to serial contract: including manufacturing and logistics
- From single assembly to mass production and installation
- From theoretical operation to robustness and communication security

PHOTOn

ATH146



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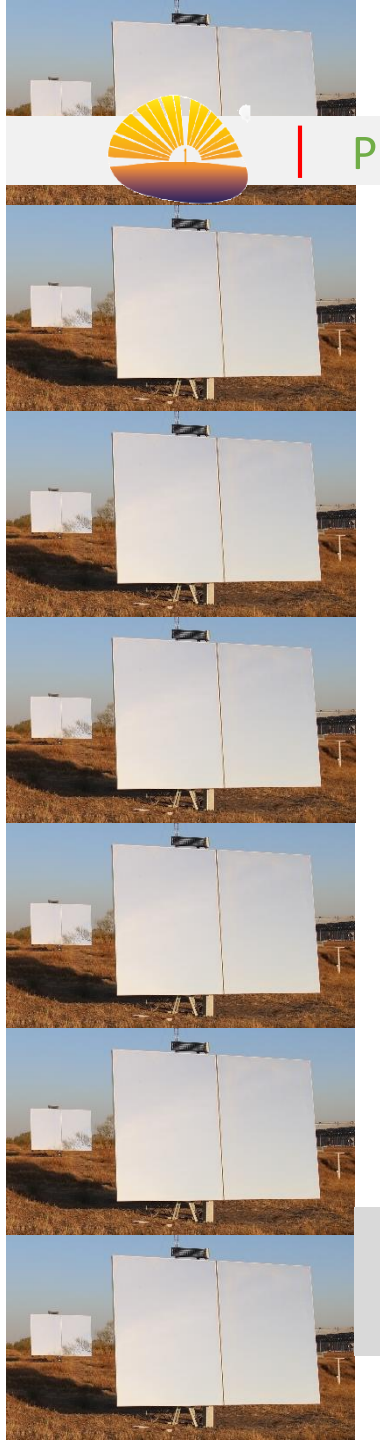

PHOTOn

KEY CONCEPTS

- Assembled Heliostat cost = 100 €/m²
- Bi-facet heliostat of 14.4 m² -- 7,2m² per facet which the largest facet of the world with spherical curvature
- Glass to Glass Sandwich panel facet design
- Auto-calibration System: one facet with solar sensor, being the facet master
- PV module external to the facet for autonomous purposes
- Minor civil works due to pilling process standardized in the PV-2V technology
- Accurate calibration among pilling due to Smart Dynamic Tracking Algorithm and Auto-calibration System

BENEFITS BEYOND STATE-OF-THE-ART

+ Optimized cost in mass production due to design, logistics and assembly cost balancing
+ Glass-to-glass sandwich panel facet —→ reduce canting operations and guaranty slope error of facets by manufacturing
+ Glass to Glass Sandwich panel facet —→ reduce slope error by temperature dependence during operation
+ Auto-calibration System + Dynamic Tracking algorithm —→ Minor tracking error and quick calibration of solar field
+ Optimized aiming strategy to reduce cosine factor losses —→ Heliostat reallocation and asymmetrical lay-outs
+ Optimized Solar Field —→ Minor total reflective surface —→ Minor maintenance and cleaning cost (10% OPEX REDUCTION)
+ Civil works cost due to Pilling process —→ 25% SOLAR FIELD CAPEX reduction in the worst geotechnical conditions
+ EPC cost reduction correlated to financial, contingency and margin costs —→ 15% OTHER COSTS REDUCTION

HIGHER OPTICAL EFFICIENCY OF THE SOLAR FIELD + MINOR CAPEX & OPEX = 15% LCOE REDUCTION

OPTICAL QUALITY COMPARISON

Parameter	Units	Big Heliostat 140-160 m²	Big Heliostat 40-60 m²	ATH 146 146 m²	PHOTON Heliostat 14.4 m²
Slope error	mrad	1.8	1.4	1.6	1
Slope Error (12m/s)	Mrad	2.0	1.6	1.8	1,2
ΔSlope error with ΔT	mrad/°C	0.04-0.05	0.04-0.05	0.02	0
Tracking Error	mrad	0.8	0.3	0.6	0.3

100 MW
Reference Plant

1.099.936m²
State-of-the-art

938.880m²
PHOTOn Solar Field

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