

Critical Aspects in Engineering and Construction of a CSP Plant

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All Energy Australia



DEHQHU

Engineering and Construction for **Sustainability**

1. CSP Main Configurations

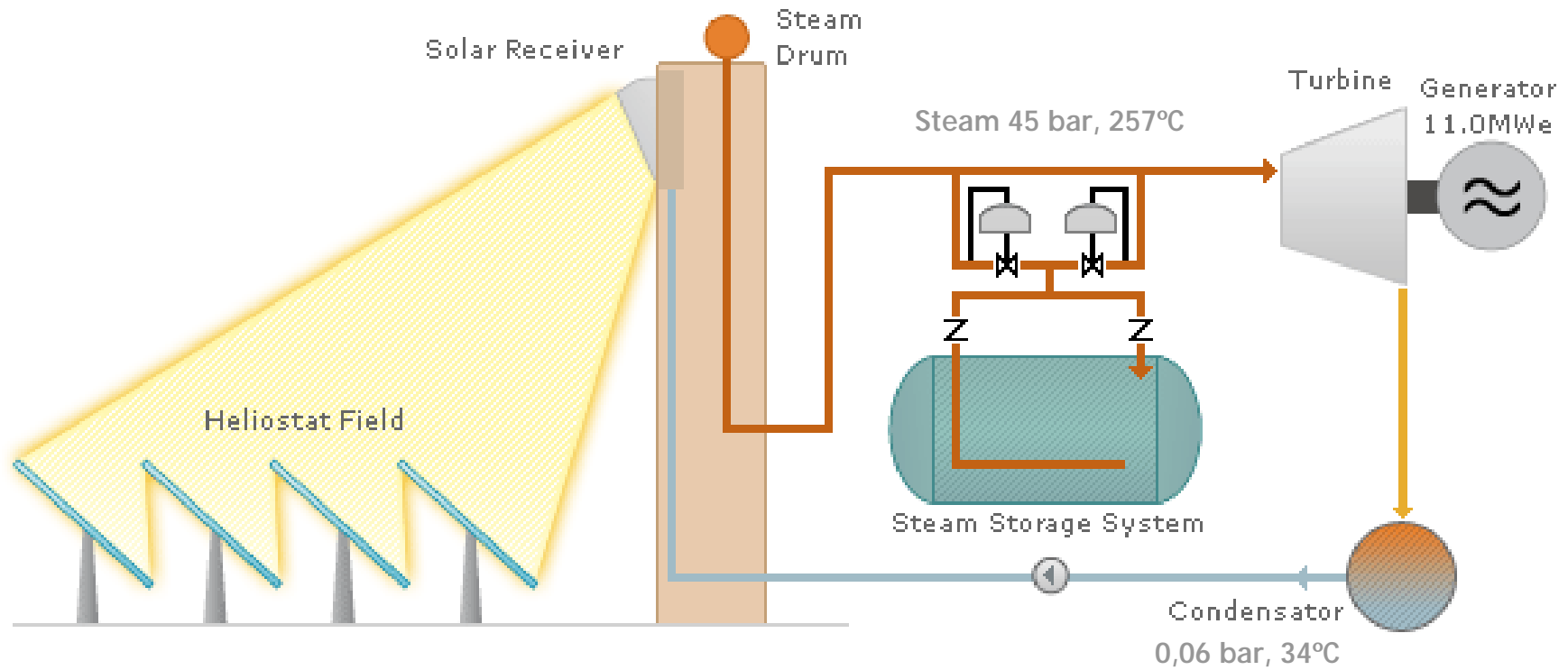
2. Abener Experiences in CSP

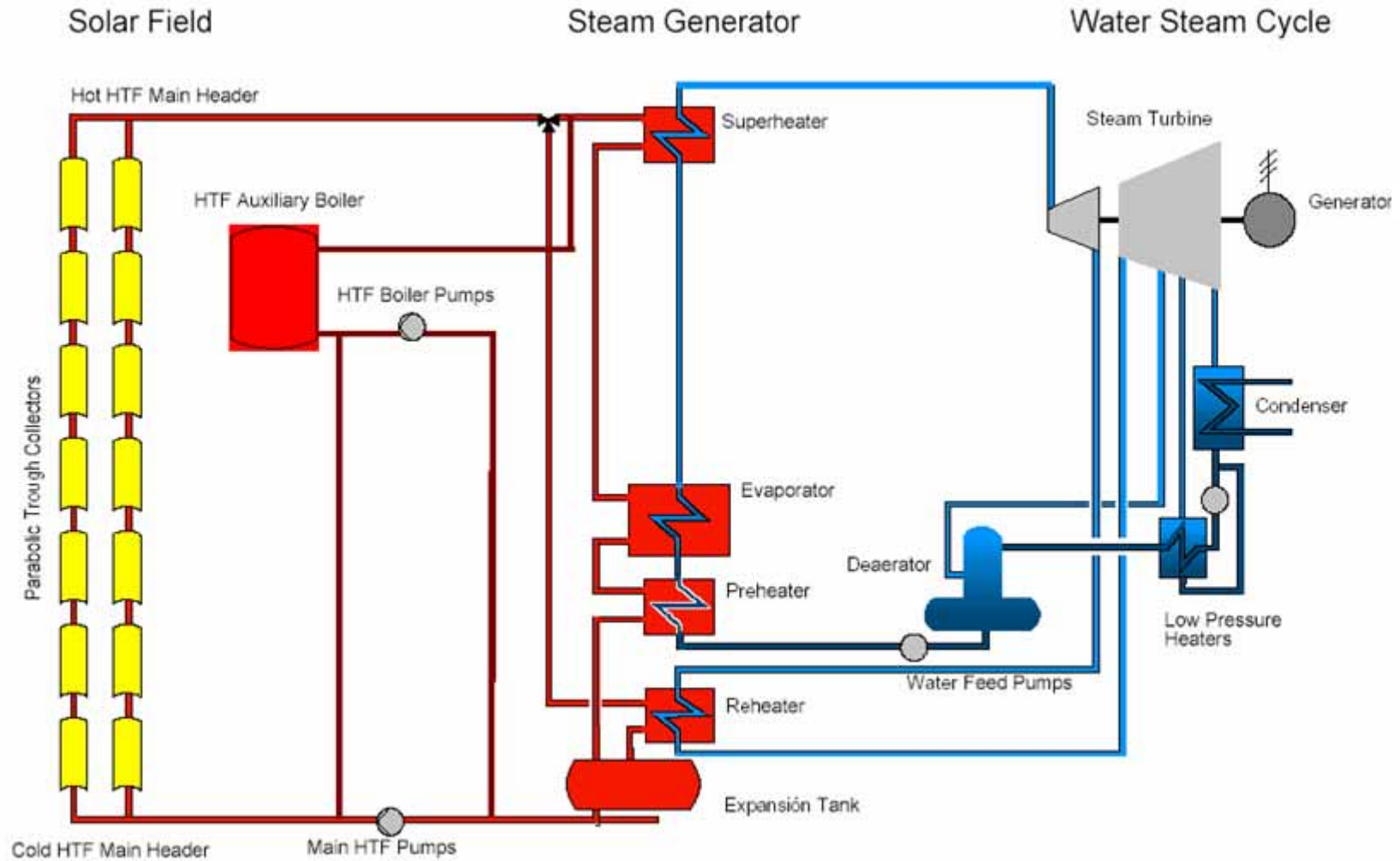
3. Critical Aspects in CSP Engineering/Design

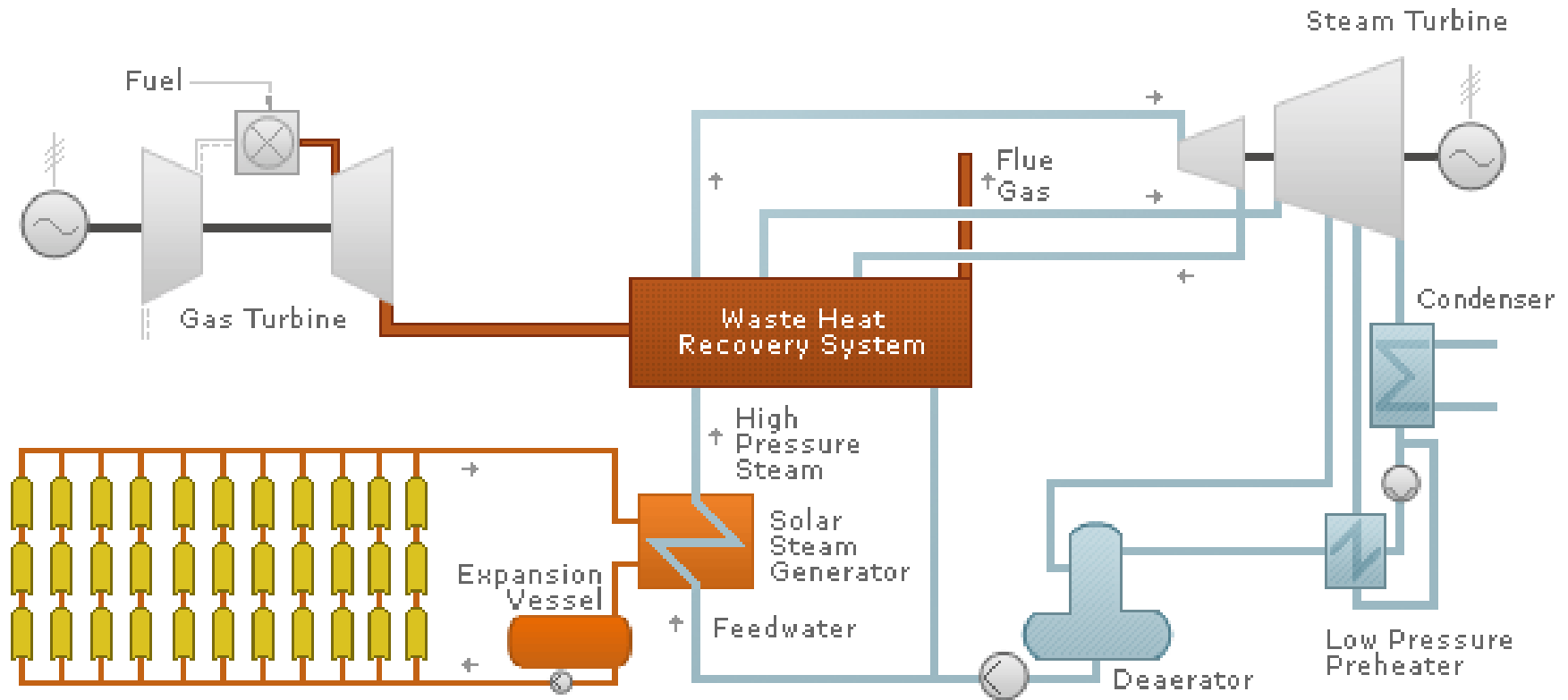
4. Critical Aspects in CSP Construction

5. Conclusions

1. CSP Main Configurations







2. Abener Experiences in CSP



Project Name	PS10	PS20
Net Power	11 MW	20 MW
No. of Heliostats	624	1255
Tower Height	114 mtr.	165 mtr.
Land Required	60 Hectares	90 Hectares
Solar Collector Area	74.880 m ²	150.600 m ²
Storage	Steam	Steam
Fluid	Saturated Steam	Saturated Steam
Water Steam Cycle (P,T)	45 bar, 257°C	45 bar, 257°C
ST Extractions	3	3



Project Name	
Net Power	50 MW
Loops	90
No. of Collectors	360
Land required	115 Hectares
Solar collector area	293.400 m ²
Storage	No
Fluids	Thermal Oil/Superheated Steam
Water Steam Cycle (P,T)	100 bar, 380°C
ST Extractions	5

Solnova 1 - 3 - 4

50 MW

90

360

115 Hectares

293.400 m²

No

Thermal Oil/Superheated Steam

100 bar, 380°C

5



Project Name	Ain Beni Mathar	Hassi R'Mel
Customer (Country)	ONE (Morocco)	SPP1 (Algeria)
Net Power – CC + Solar Field	450 + 20 MW	125 + 20 MW
Loops	56	56
Number of CCP	224	224
Required Land	62 ha CCPs	59 ha CCPs
Solar Collector Area	183.120 m ²	183.120 m ²
Storage	No	No
Fluid	Thermal Oil /Superheated Steam	Thermal Oil/Superheated Steam

3. Critical Aspects in CSP Engineering/Design



Objectives

General

- ¡Maximize Electricity Production!
- ¡Minimize Period for Commercial Operation!

Design/Construction

- ◆ Investment reduction.
- ◆ Efficiency optimization.
- ◆ Minimize self-consumption.
- ◆ Operational costs reduction.

Project Management

- ◆ Minimize construction risks.
- ◆ Assurance of Quality Control (assembly,...).
- ◆ Assurance of Delivery of Critical Equipment:
 - ◆ Reduced availability of manufacturers.
 - ◆ Schedule of deliveries.

Tower Technology I

Earthworks

Heliostat Foundation/Piling

Civil Works

Tower

Assembly Building

- ◆ Minimise levelling works.
- ◆ Optimise cost and timing.
- ◆ Access roads (installation and maintenance).

- ◆ High precision (focusing).

- ◆ Minimum height.
- ◆ Calibration target.
- ◆ Receiver structure, cavity, visor.
- ◆ Steam drum platform.
- ◆ Recirculation system.
- ◆ Deaerator system.
- ◆ Inside piping, pumping,...
- ◆ Maintenance facilities (lift, stairs, crane,...).
- ◆ Construction Material.
- ◆ Foundation.

- ◆ ¡Critical for assembly activity!
- ◆ Reduce global cost and timing.

Tower Technology II

Layout

Solar Block
Arrangement

- ◆ Heliostats configuration (rows definition).
- ◆ Optimise available land.
- ◆ Focus point (minimum tower height).
- ◆ Reduce shadows.

Power & Steam Blocks
Arrangement

- ◆ Electrical bus ducts.
- ◆ Minimise steam piping.
- ◆ Disturbances in mirrors (water from cooling system).

Equipment
Procurement

Heliostat

- ◆ Customized (reflection surface, curvature).
- ◆ Two-axis/individual tracking system.

Storage System

- ◆ Steam (time and load).

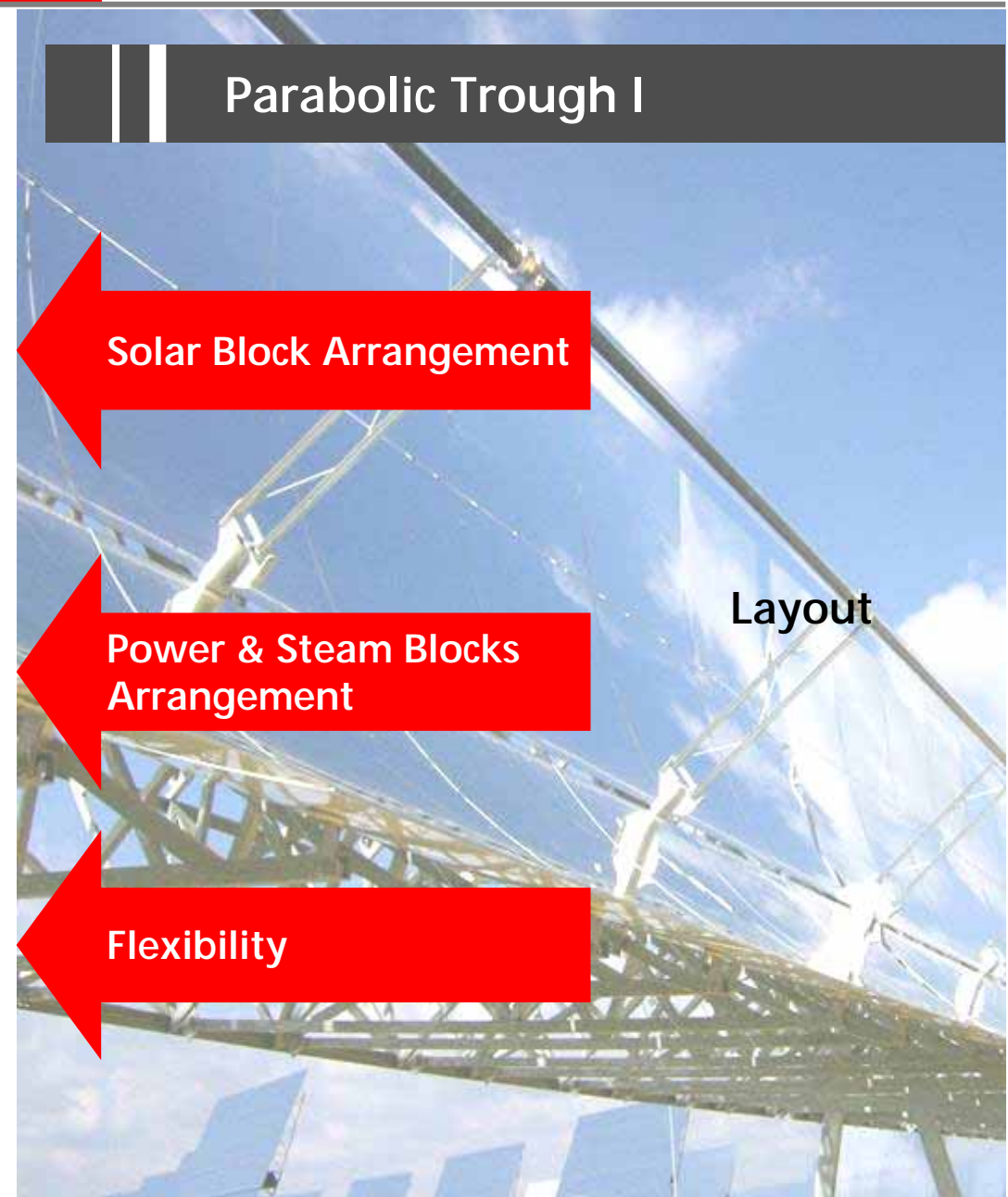
Control System

- ◆ Tracking (heliostat personalized monitoring)

Auxiliary Boiler

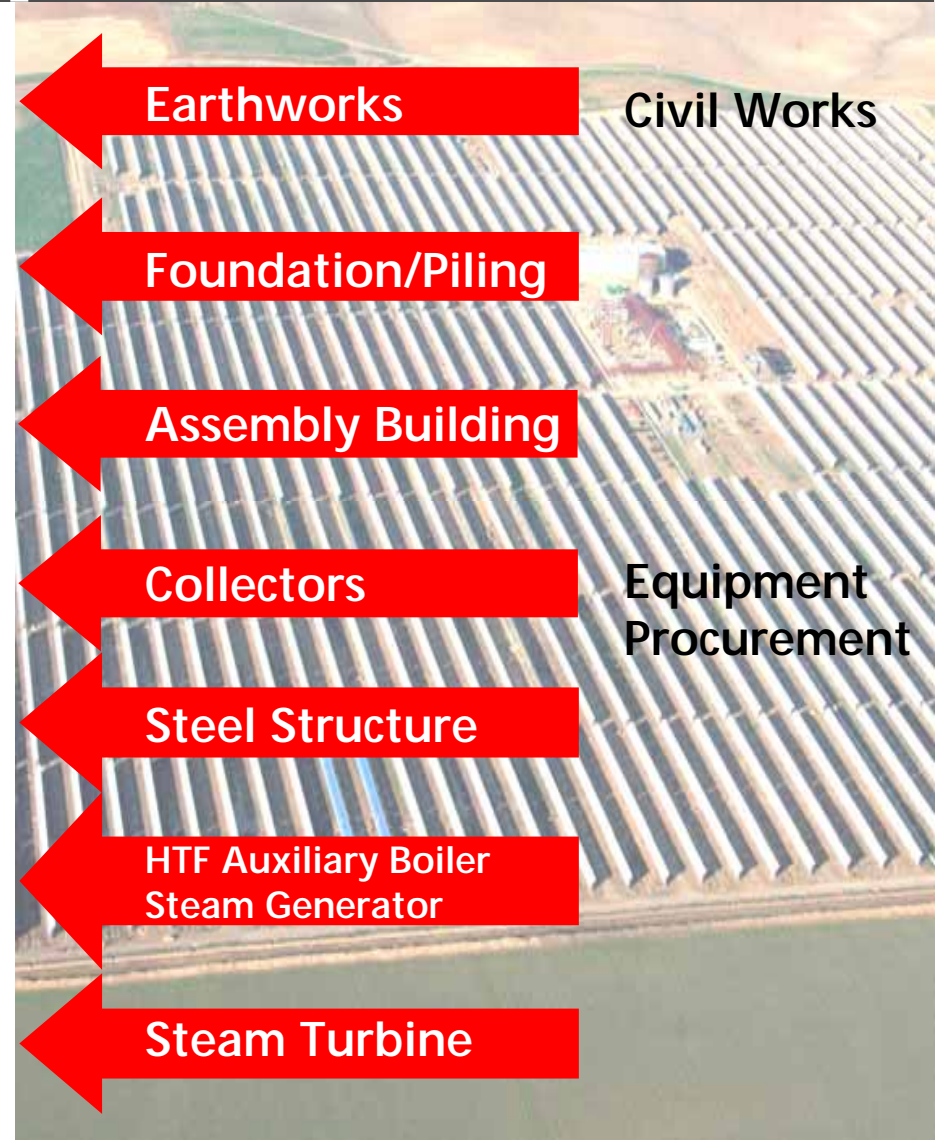
- ◆ NG/Saturated Steam (transient conditions and dispatchability).

- ◆ Minimise thermal loses.
 - ◆ Optimise available land.
 - ◆ HTF piping optimization.
 - ◆ Reduce insulation and pumping needs.
 - ◆ Arrangements for future expansions.
-
- ◆ Electrical bus ducts.
 - ◆ Low alloy steel piping.
 - ◆ Pumping (minimise pressure drop)
 - ◆ Disturbances in mirrors (water from cooling system).
-
- ◆ Implementation by phases (expansions, future options- storage,...-).
 - ◆ Reduce future investment costs.



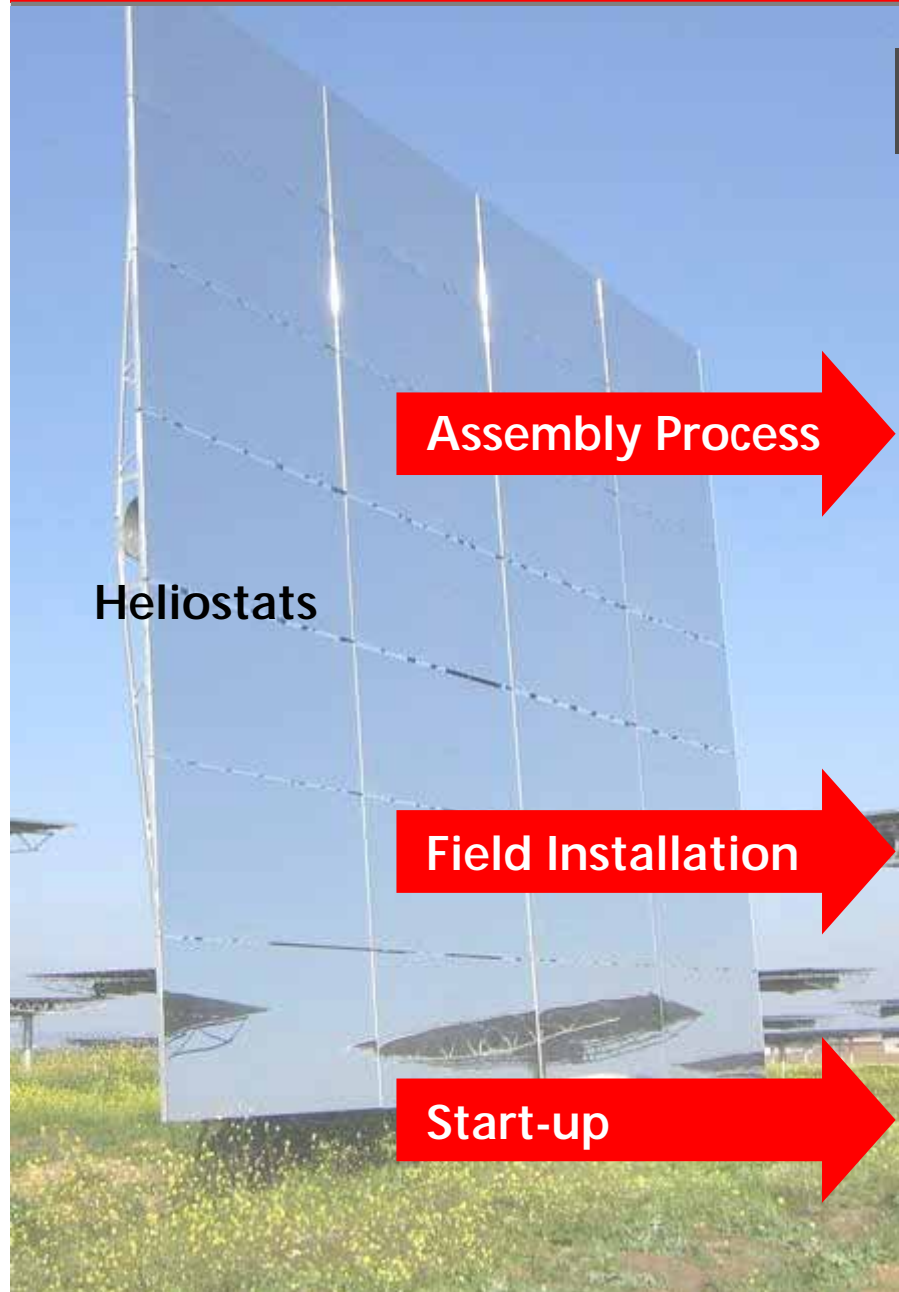
Parabolic Trough II

- ◆ Minimise levelling works.
- ◆ Customized (adapted to each specific position): boundary / inside collectors.
- ◆ ¡Critical for assembly activity!
- ◆ Reduce global cost and timing.
- ◆ Limited number of manufacturers (mirrors, tubes).
- ◆ Prevent freezing in cold weather conditions.
- ◆ Customized (adapted to each specific position).
- ◆ NG-HTF / HTF-Superheated steam (transient conditions and dispatchability).
- ◆ Long delivery period (> 50 MW).
- ◆ ISCC: Optimised net power (Solar + HRSG).
- ◆ ISCC: Optimisation production vs. NG consumption.



4. Critical Aspects in CSP Construction

Tower Technology I



- ◆ Time control (minimisation).
 - ◆ Quality control (testing before installation).
 - ◆ Production line (stocks, procedures,...).
 - ◆ Curving mirrors (adapted to focus –row-).
 - ◆ Curving heliostats (adapted to focus –row-).
 - ◆ Big amount of units (10 MW eq. >18.000 mirrors).
 - ◆ Critical manufacturing tolerances.
 - ◆ Minimize storage area.
-
- ◆ Field/assembly coordination.
 - ◆ High risk of breaking up.
 - ◆ Transport to the field (risky activity).
 - ◆ Heliostat: minimum unit for inst./removing.
 - ◆ Minimize route for installation.
-
- ◆ Long period (number of units).
 - ◆ Installation in advance of Power Block.

Tower Technology II

Civil Works

Heliostat Foundation
Piling

Tower

Mechanical
Works

Tower Equipment

Others

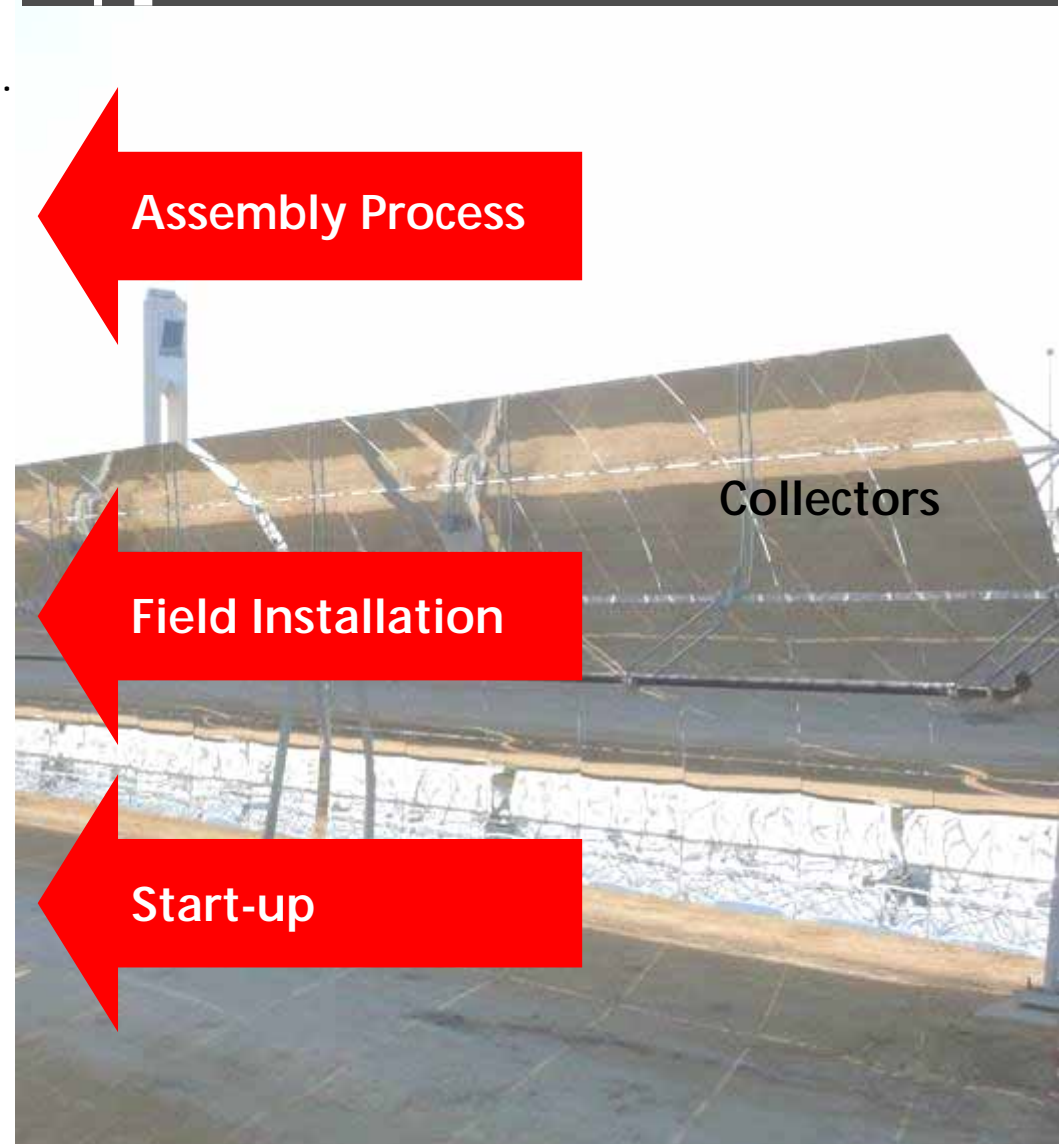
- ◆ Level calibration (verticality).
- ◆ Minimise length of internal roads.
- ◆ Singular building construction.
- ◆ Work on heights.
- ◆ Special cranes (>150 mtr.).
- ◆ Continuous pouring concrete.
- ◆ Security area.
- ◆ Specific local regulations.
- ◆ Work on heights
- ◆ Heavy equipment on the top (receiver).
- ◆ Permanent auxiliary equipment (crane, pumps,...).
- ◆ Pipe cleaning of water-steam cycle.
- ◆ General start-up adapted to the weather conditions.
- ◆ Algorithm for optimum solar tracking.

Parabolic Trough I

- ◆ Time control (minimisation).
- ◆ Quality control (testing before installation).
- ◆ Production line (stocks, procedures,...).
- ◆ Critical manufacturing tolerances.
- ◆ Big amount of units; for 50 MW
 - ◆ +120.000 mirrors.
 - ◆ + 54 Km. absorber tubes.
- ◆ Minimize storage area.

- ◆ Field/assembly coordination.
- ◆ High risk of breaking absorber tubes.
- ◆ Risk of vacuum losses in absorber tubes.
- ◆ Module is the minimum unit (12 modules = 1 collector).
- ◆ Minimize route for installation.

- ◆ Long period (number of units).
- ◆ Installation in advance of Power Block.

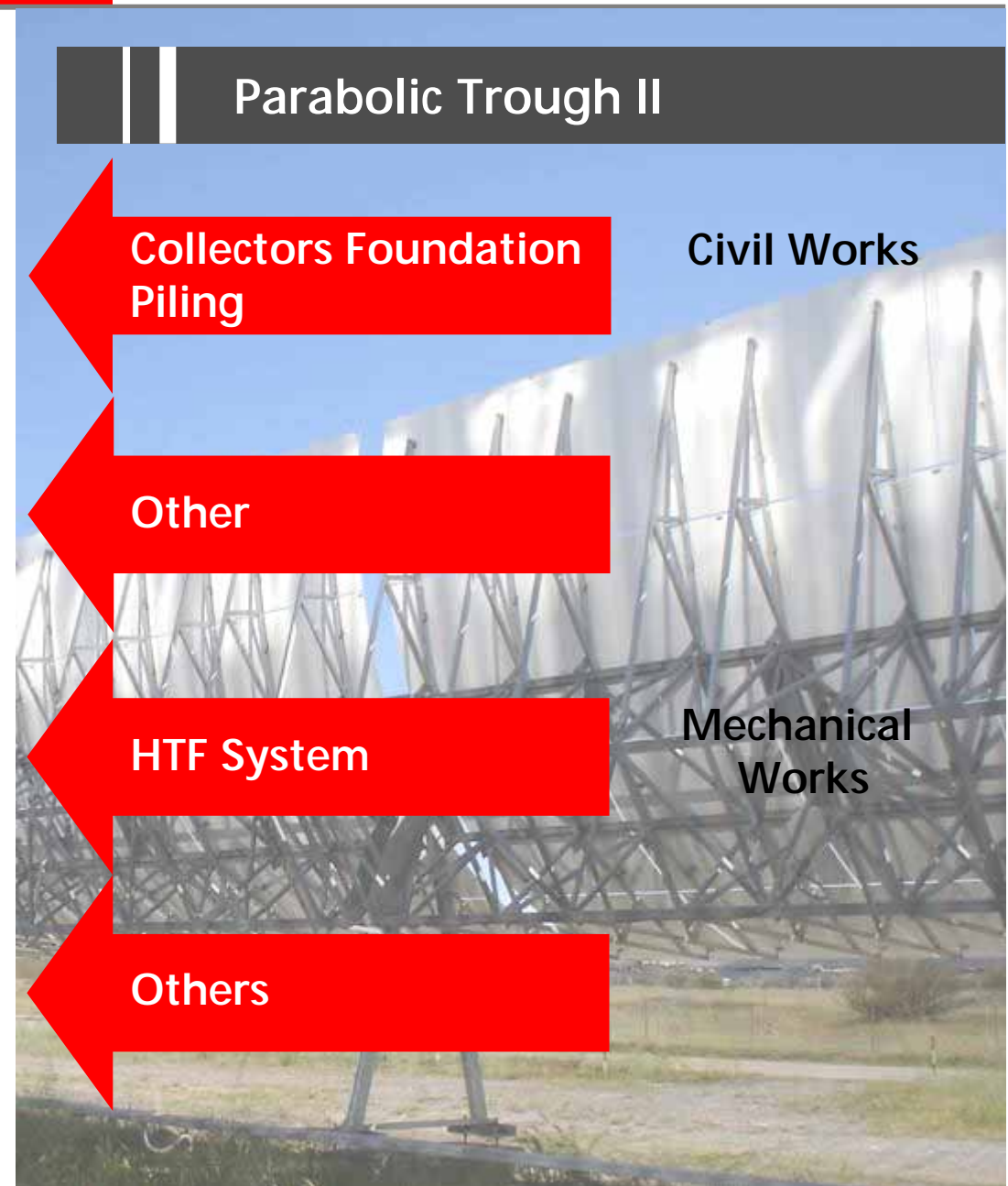


- ◆ Alignment (unit: 150 mtrs. length).
- ◆ Minimise length of internal roads.

- ◆ Reuse of assembly building.

- ◆ Avoidance of freezing:
 - ◆ Auxiliary boiler.
 - ◆ Continuous pumping (minimum flow).
 - ◆ Heat tracing.

- ◆ Pipe cleaning of water-steam cycle.
- ◆ General start-up adapted to the weather conditions.



5. Conclusions

General Objectives of an IPP Project

- ✓ Maximize Electricity Production
- ✓ Minimize Period for Commercial Operation

Investment Cost - Driving Parameters

- ✓ Significant reduction is needed for a long-term economic viability.
- ✓ Potentials:
 - Technology improvements and innovations (efficiency).
 - Reducing manufacturing costs (economies of scale).
 - Stronger O&M and production methods.
 - Thermal storage (higher output).
 - R&D approach (direct steam generation,...).

EPC - Driving Parameters

- ✓ Investment reduction, efficiency optimization and minimisation of self-consumption (Design and Construction).
- ✓ Minimize construction and assembly collectors/heliostats risks (Project Management).

EPC Contractor

- ✓ Expertise: diversified portfolio of projects (thermal solar).
- ✓ Strong and specialized design and engineering capabilities.
- ✓ Relevant R&D activity (technology testing, improvement, cooperation with scientist institutions,...).

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Thanks for your attention!

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