

Concentrating solar power research at CSIR

Thomas Roos

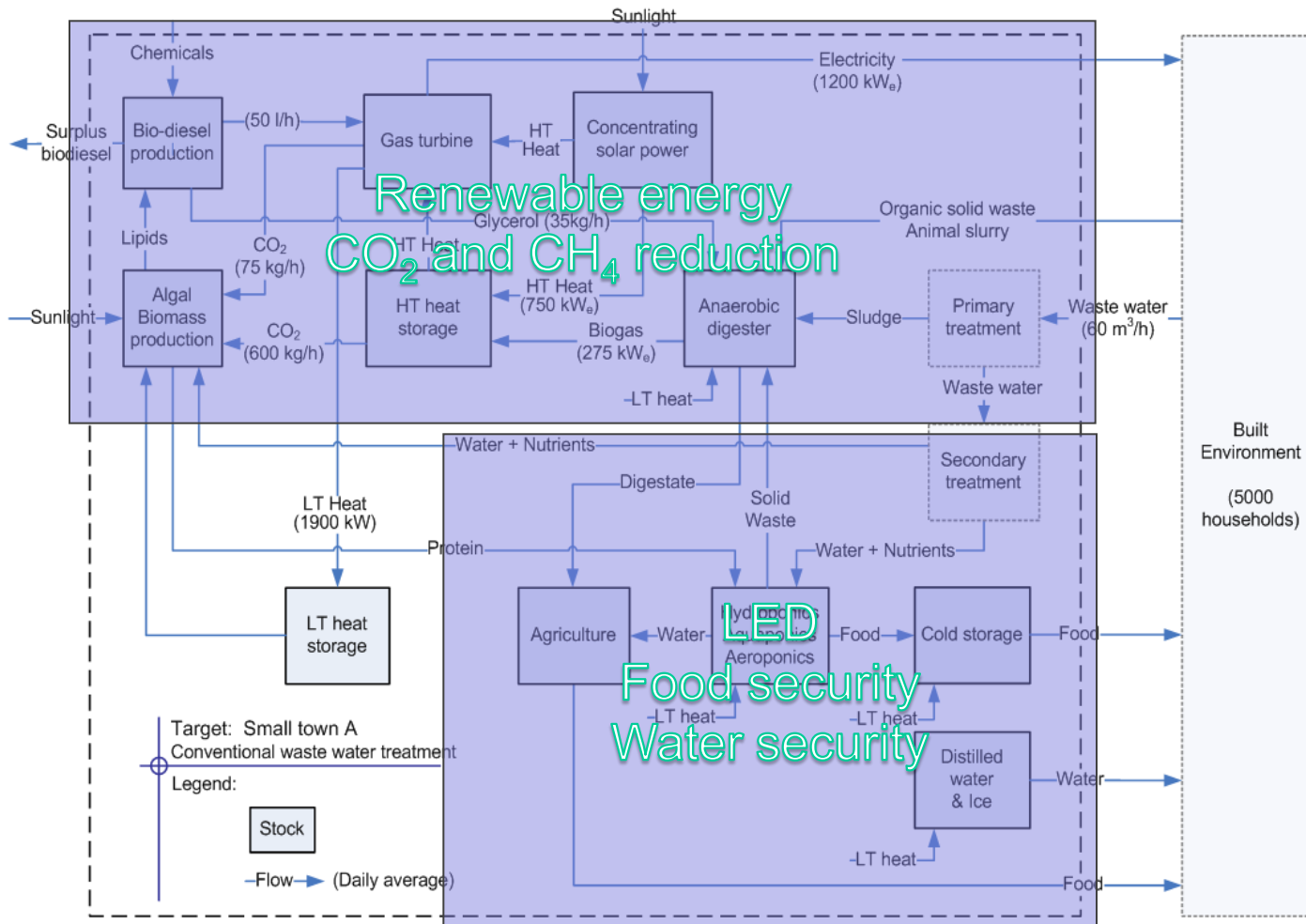
Overview

- **Background**
- **CSP components and value propositions**
- **Progress from 2009 to date**
 - Gas turbine
 - Heliostat field layout
 - Tower and thermal storage
 - Heliostat
- **Way forward**
 - Updated context

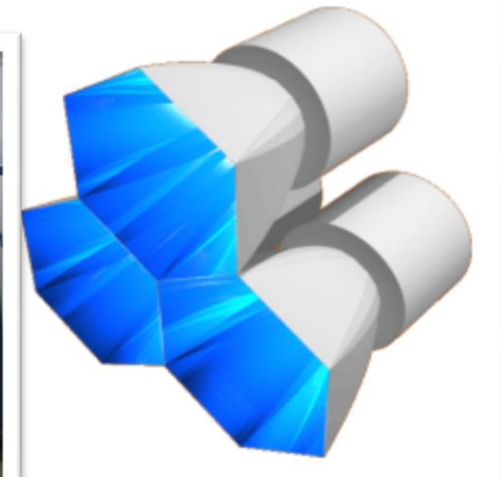
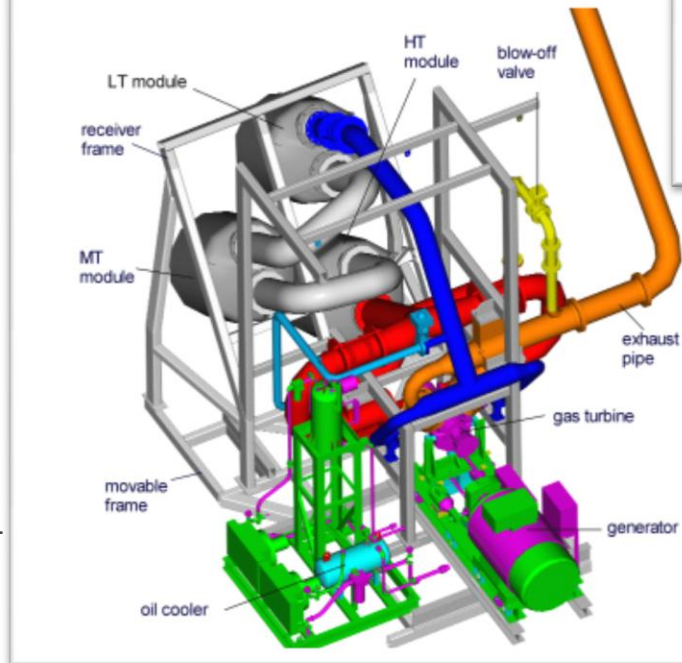
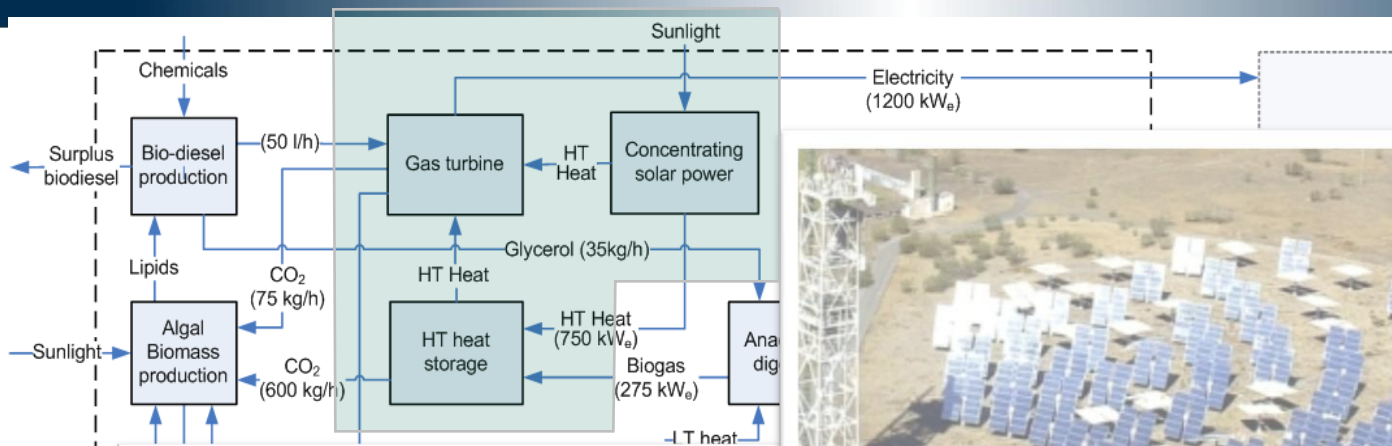
Background

- **National context: latter half of 2007**
 - Energy security: Eskom capacity problems just emerging
 - Energy access: SHS and mini-grids showing institutional rather than technical difficulties
 - Climate change: LTMS just completed, changes required to reduce SA CO₂ emissions
 - No renewable incentives
 - Service delivery: Sewage infrastructural and maintenance problems evident particularly in smaller towns
- **IRIP project**
 - Integrated Research Infrastructure Platform
 - Sewage + sunshine → electricity, fuel and food
 - Presented to and approved by CSIR Executive

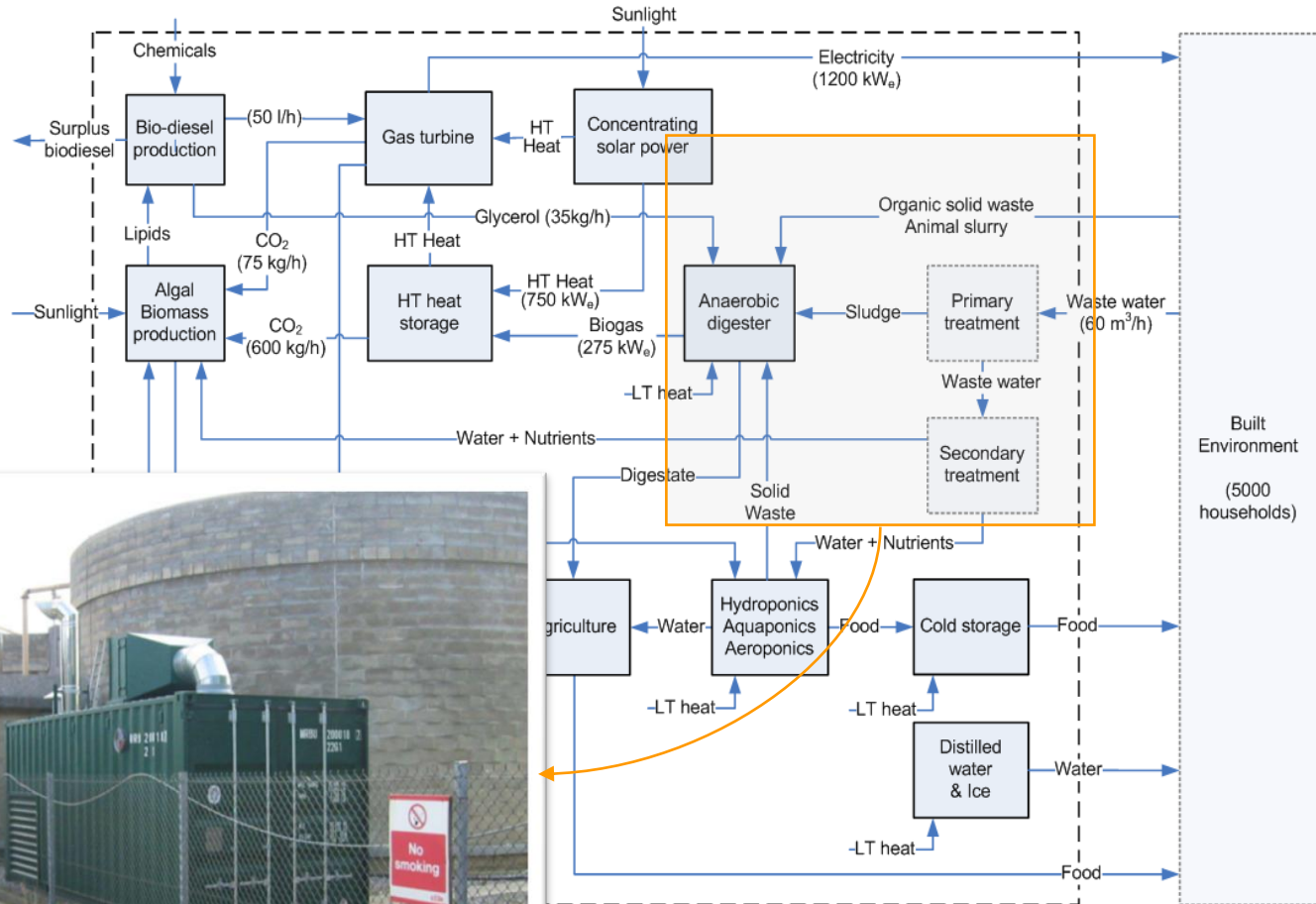
What is IRIP?



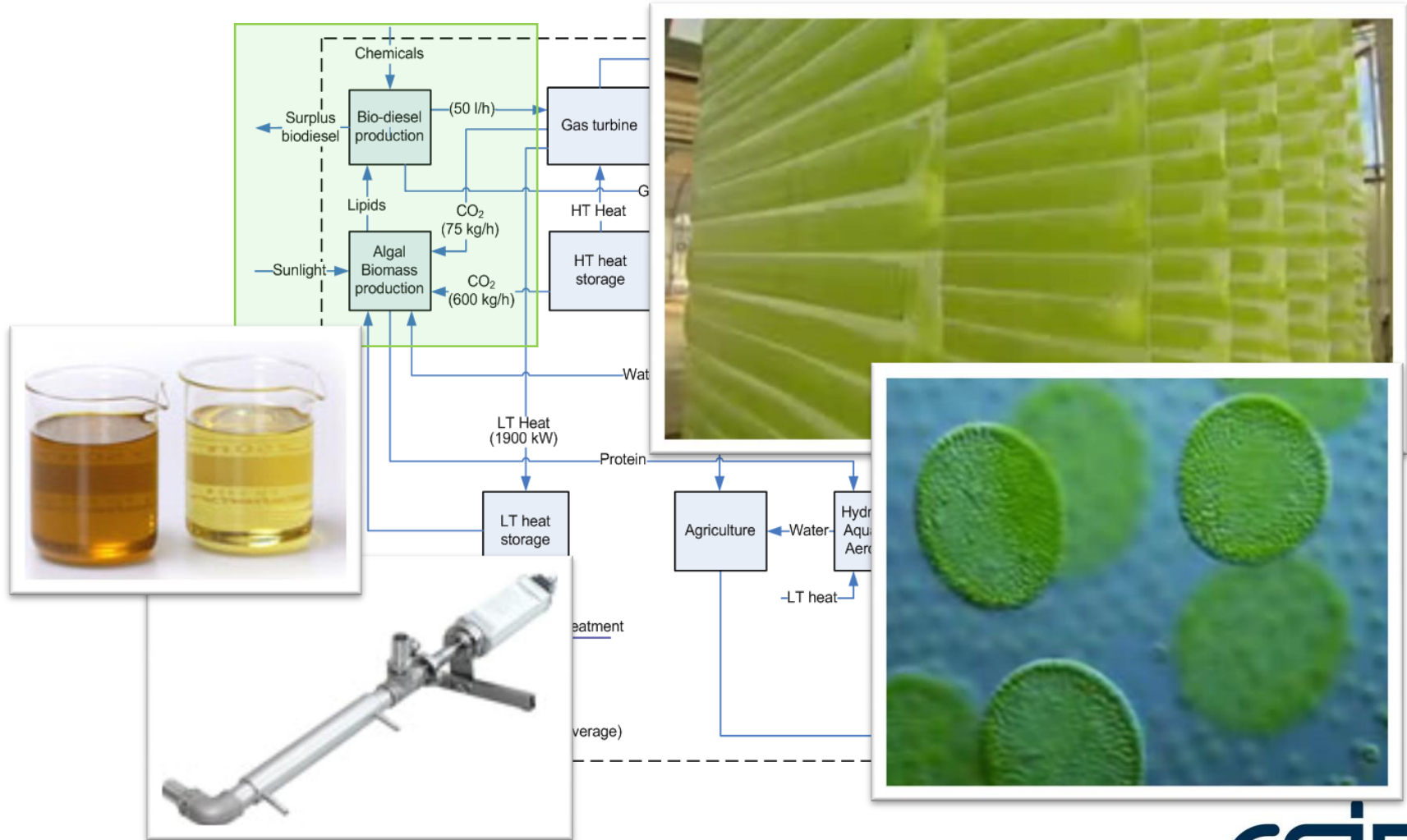
Concentrating Solar portion of IRIP



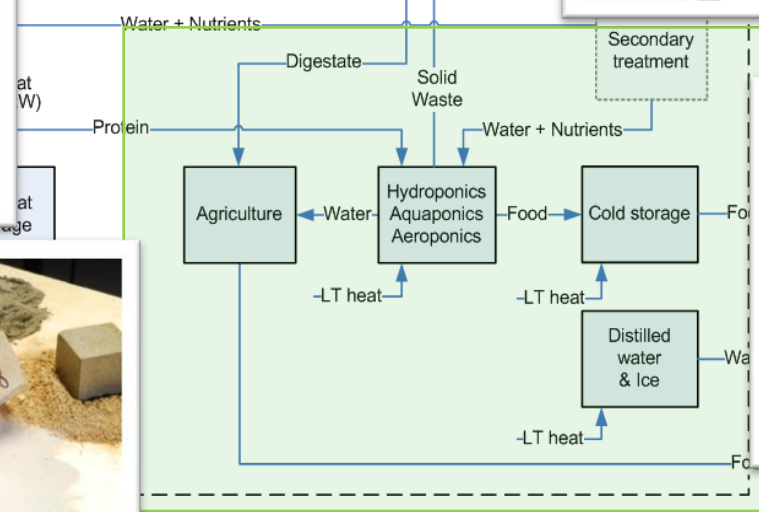
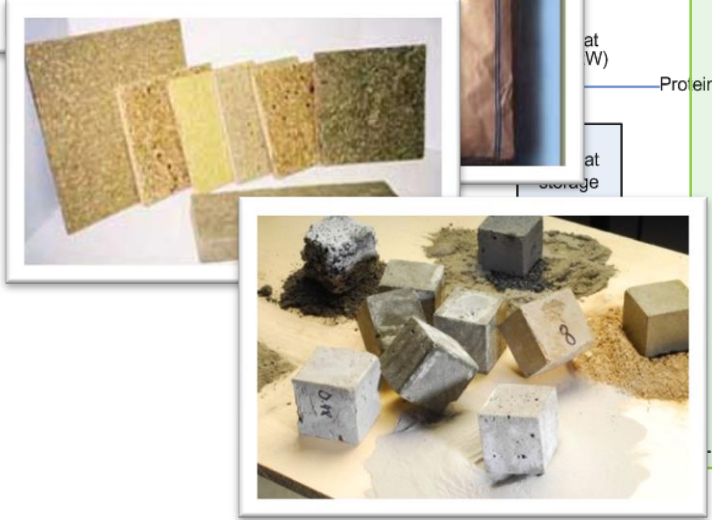
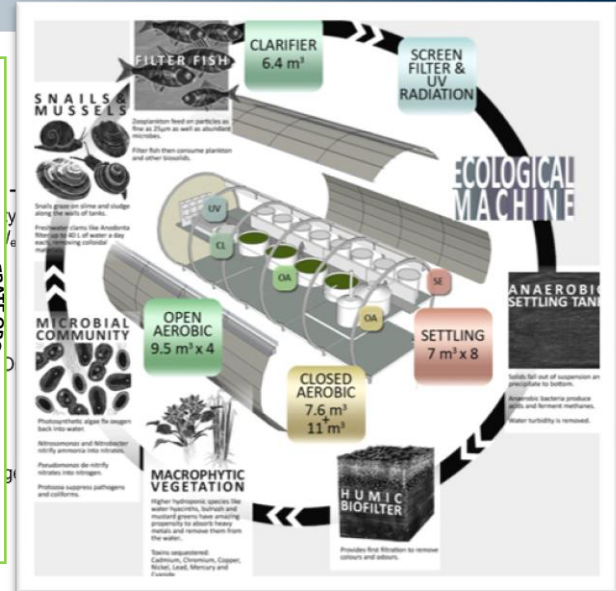
IRIP: Sewage to biogas



IRIP: algal biomass



IRIP: Local Economic Development



IRIP: evolution

- **Initially**

- scale version of full installation planned at CSIR:
 - CSP, sewage, biogas, biodiesel, fish
- CSIR seed funding, bulk of funding intended from DST/EU

- **But:**

- DST/EU could only fund application, not R&D (so no CSP)
- Tshwane and CSIR facilities vetoed sewage onsite in 2009

- **So, split into two:**

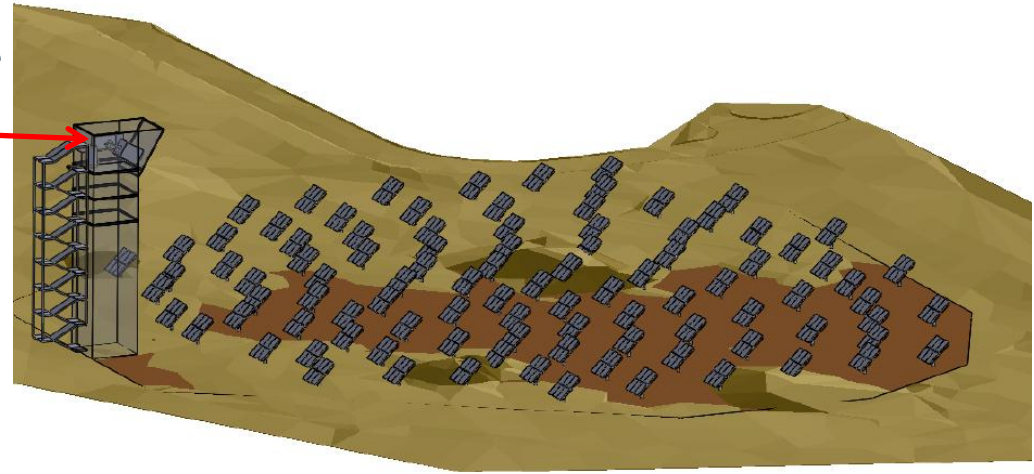
- “Wet works”: moved off-site to sewage works (DST funding application ongoing)
- CSP: to be developed in onsite research facility (Provisionally CSIR-funded)

IRIP: CSP components & value propositions

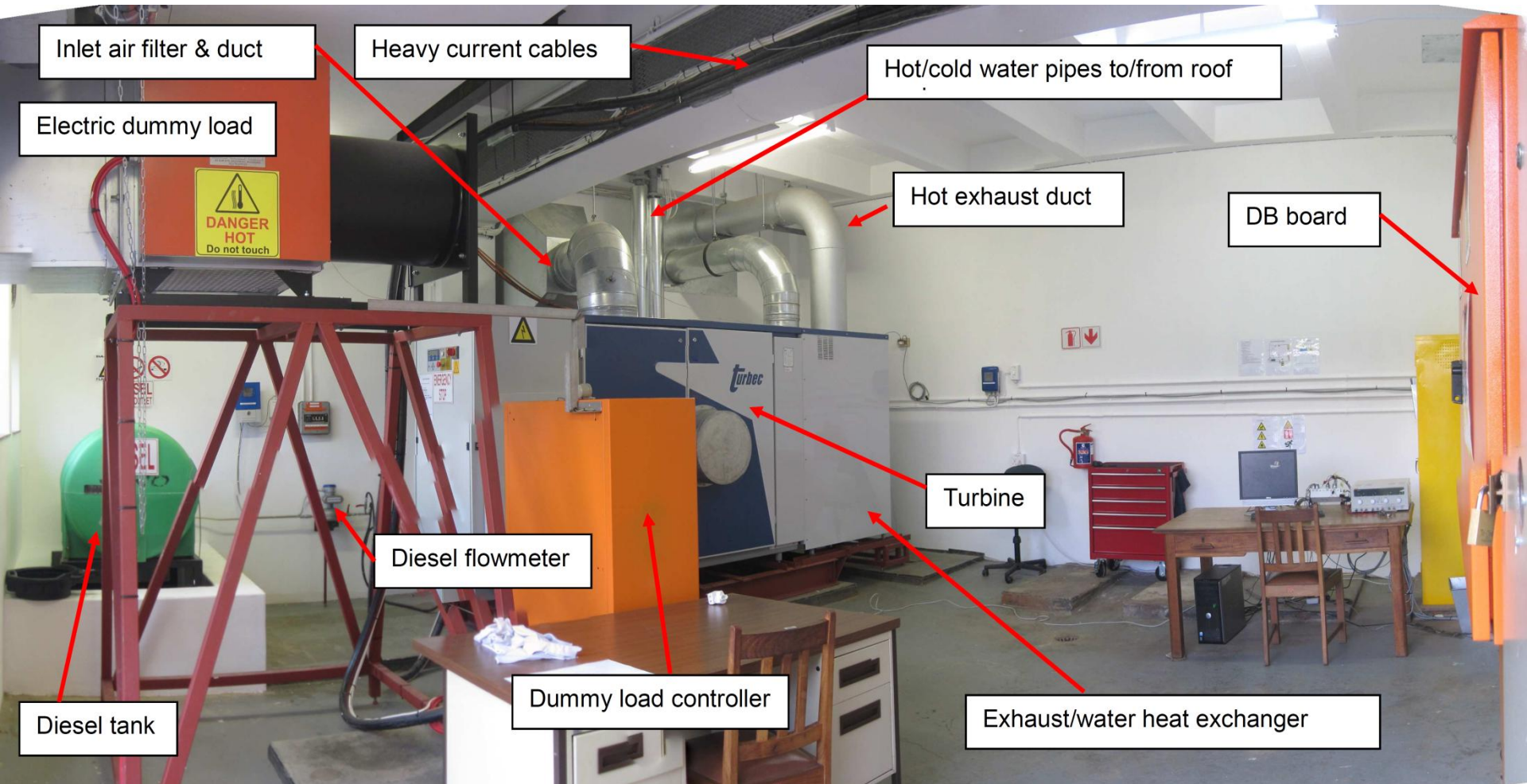
Item	Objective	Value proposition
Gas turbine	Source COTS, install, commission	Lower capital cost, waterless, higher total efficiency (CC operation) so lower cost/kWh
Heliostat	Design, develop, implement target-aligned (TA)	Higher optical efficiency, hence fewer needed
Heliostat field	Commission layout design, develop heliostat and field control system, build	Thermal energy for 1) Turbine 2) Al smelting 3) H ₂ & thermochemistry
Thermal storage	Develop pressurised packed bed storage 1) sensible heat 2) latent heat	Extends solar-only capacity factor Reduces fuel use in hybrid mode LH reduces volume, mass and ΔP
Tower	Develop requirements, commercial contract build	Elevates receivers for better optical efficiency, houses turbine & storage
Receiver	800 C FP7: source, install Develop HT receiver	High efficiency and low ΔP Single step: 600 C to T_{target}

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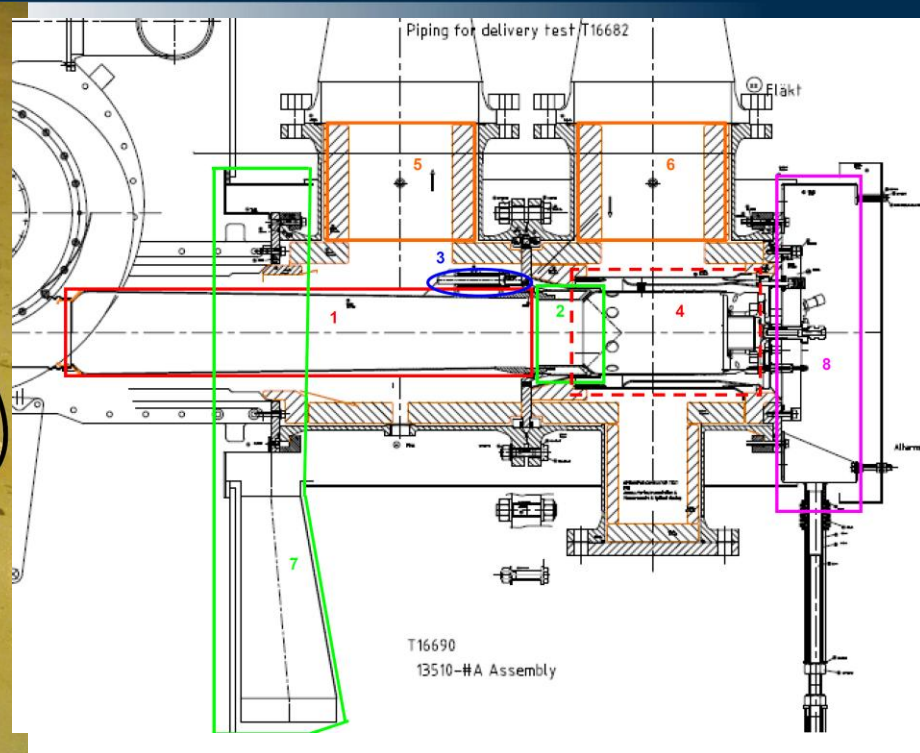
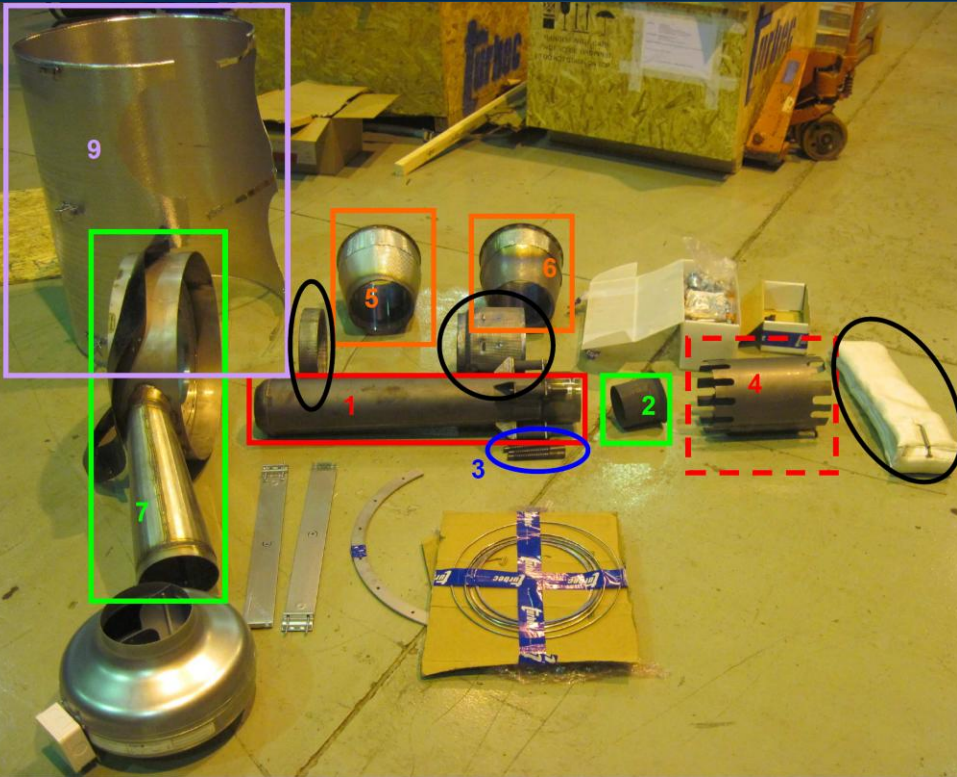
Gas turbine



Gas turbine

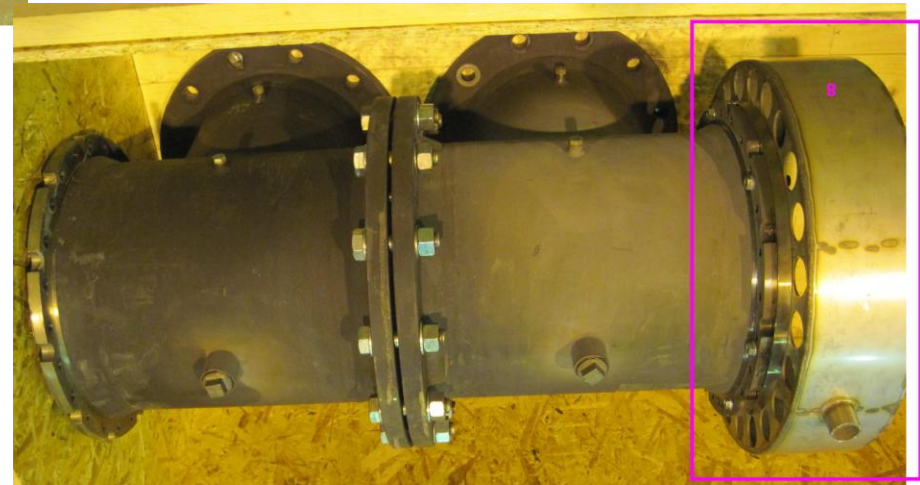


Gas turbine



Also supplied:

- Hot air kit: high temperature “plumbing” to attach receiver to turbine
- 4 software packages



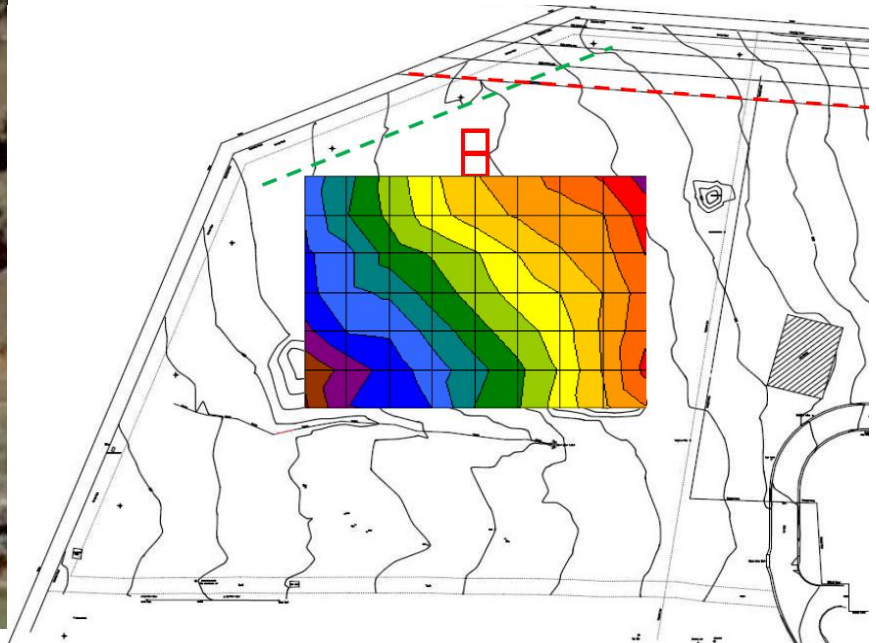
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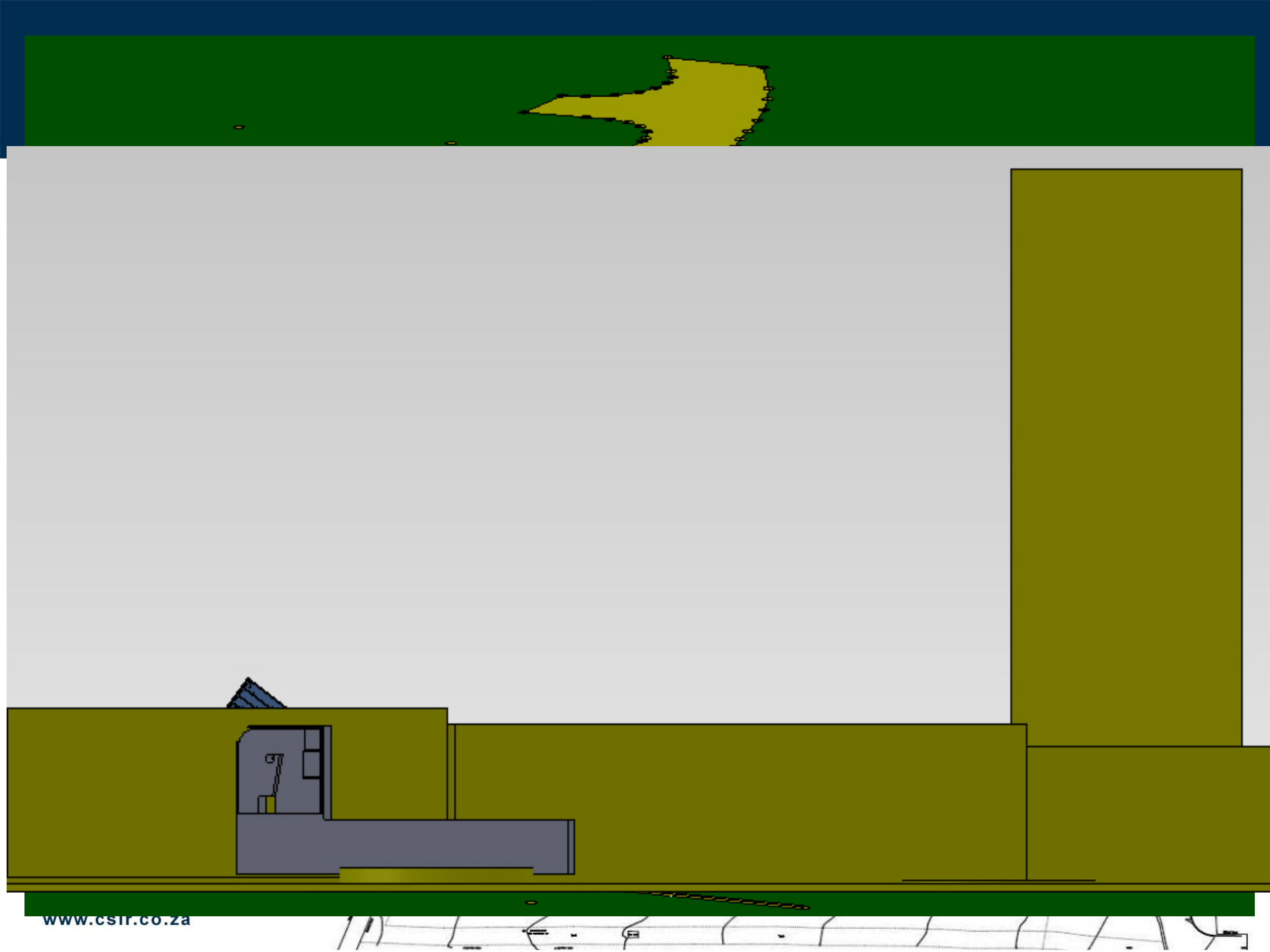


Heliostat field layout

- **Site chosen: NW corner of CSIR**

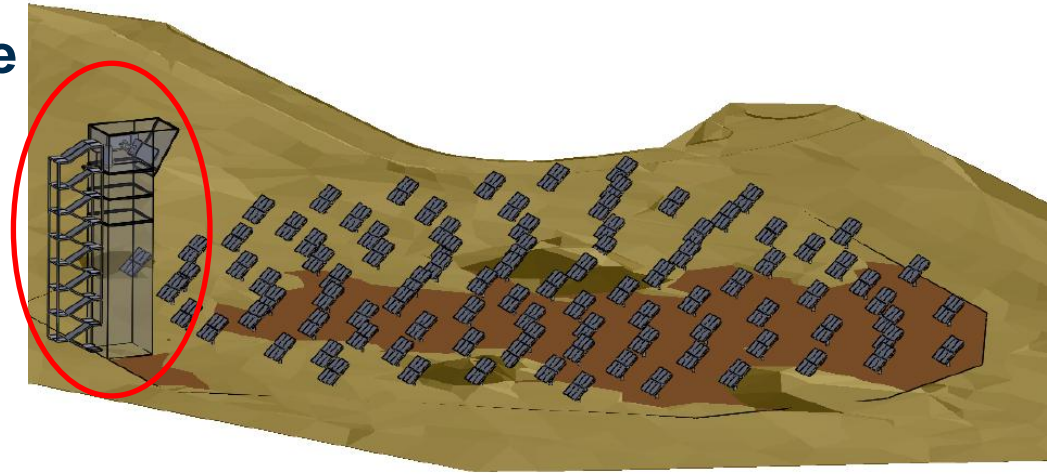


- **DLR commissioned to design field**
- **Tshwane height limitation on tower: 19m, or motivation with detailed plans**



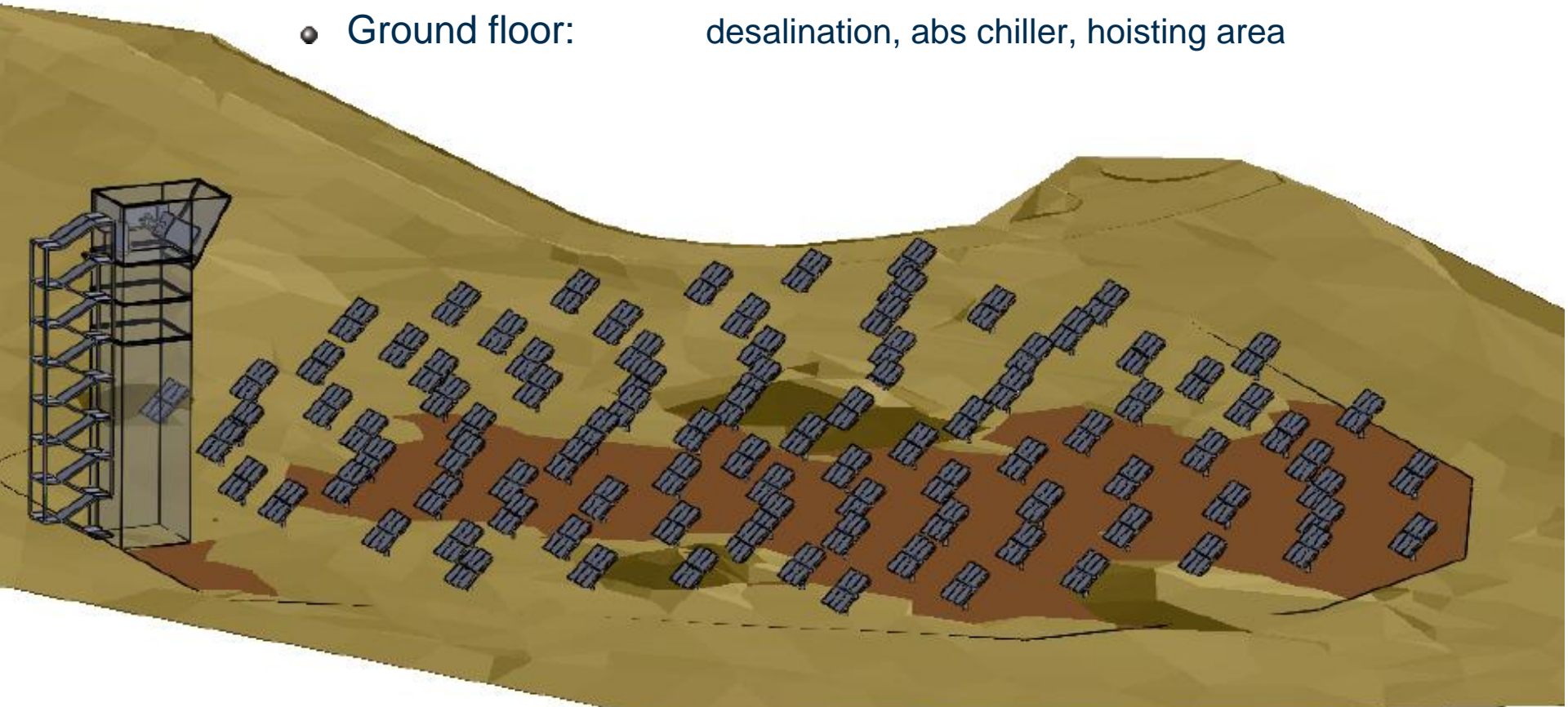
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Tower and storage

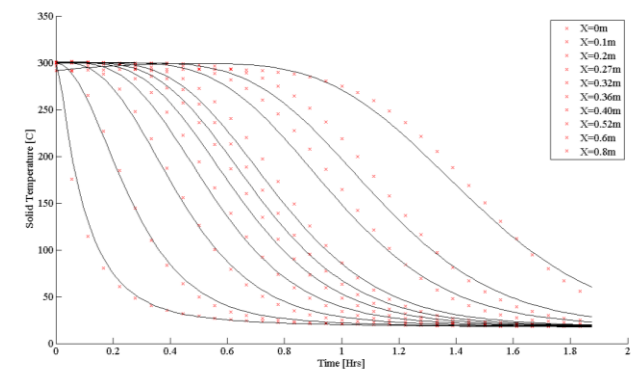
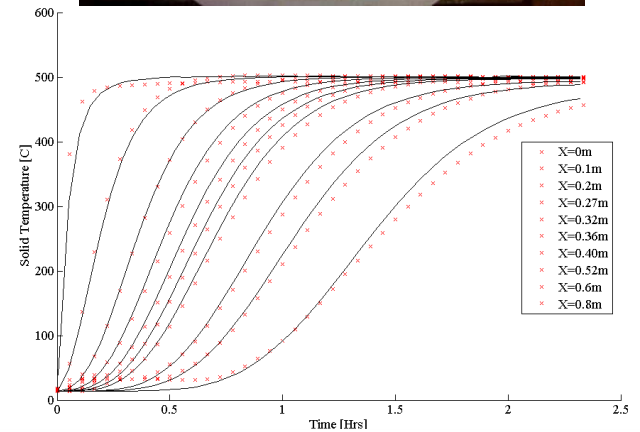
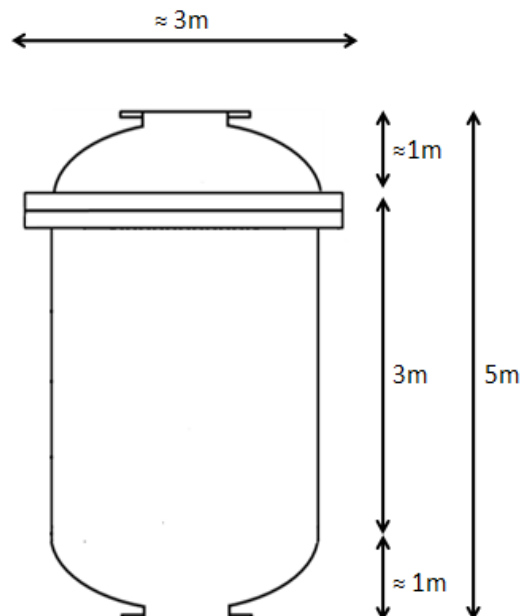
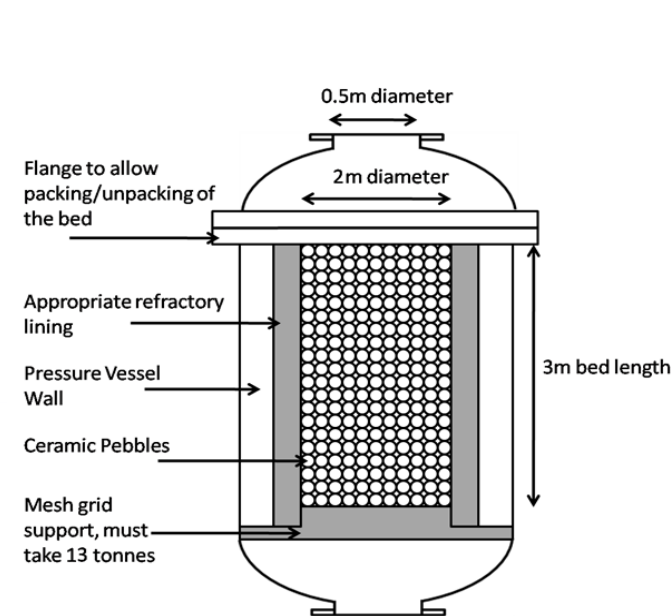
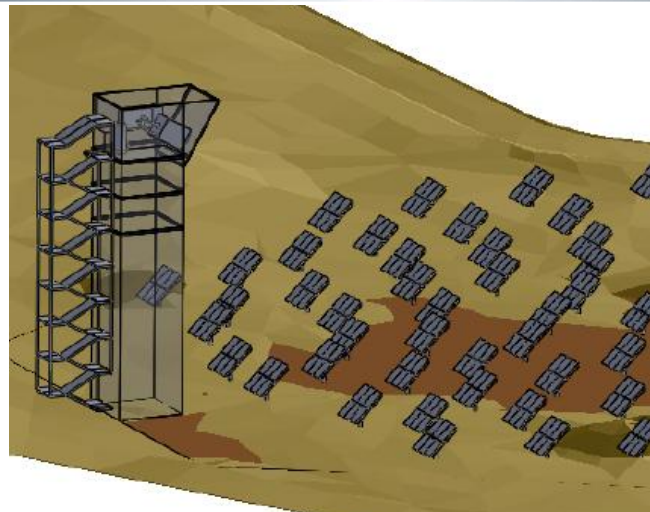
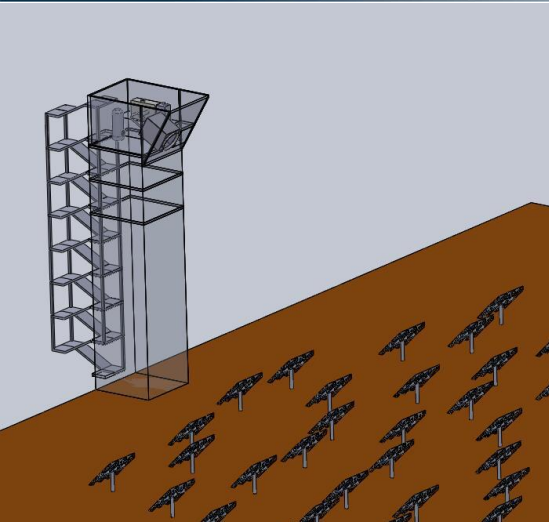
- **Original concept: multiple laboratory storeys**
 - Power generation (top)
 - Thermo-chemistry (middle)
 - Student / industry (bottom)
 - Ground floor: desalination, abs chiller, hoisting area



Tower and storage

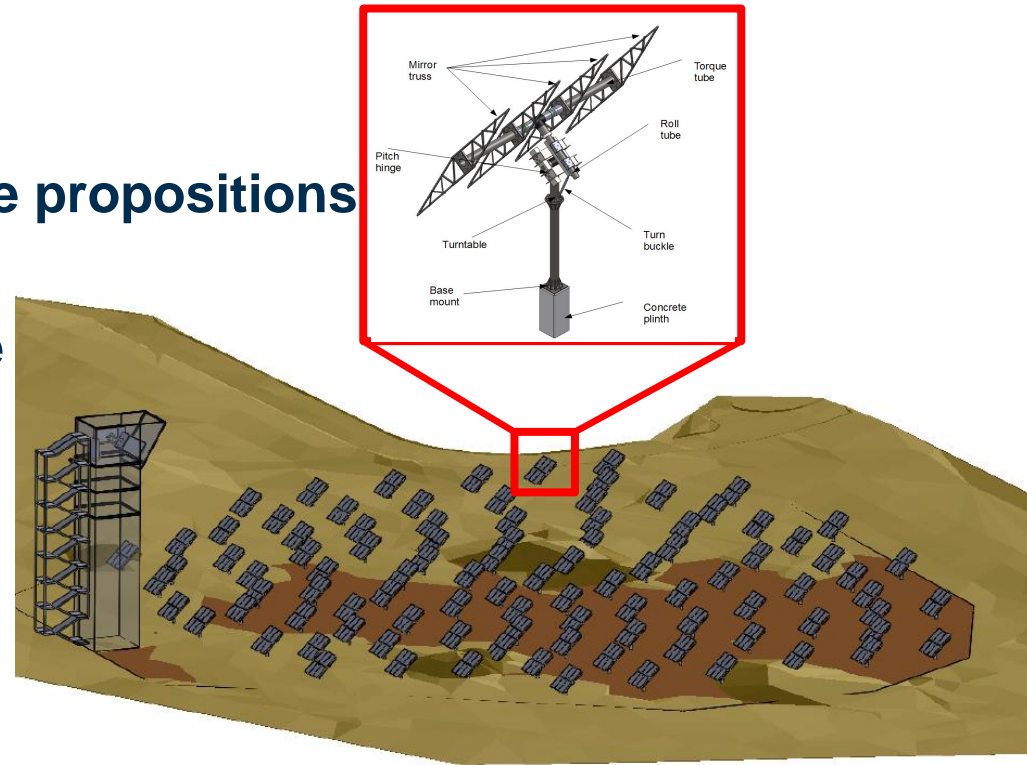
- **Tower requirements review, due to**
 - Visit to PSA
 - No personnel in tower while the heliostat field is operational
 - All research experiments are controlled from the ground
 - Removes the human safety requirement
 - Large installations by commercial mobile crane, removes heavy-duty crane requirement.
 - Thermal storage requirements
 - The storage subsystem will be placed in the tower
 - Thus, mass and volume of storage are needed for the tower structural design

Tower and storage



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Heliostat design



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Current Context: mid 2012

● Government departments

- DWEA/DIRCO (COP15, COP17), DoF (carbon tax): CO₂ is on the table
- DoE/NERSA (IRP → REBID), DTI (IPAP, Green Jobs) : CSP has a market
- DST: Solar CoC study (2010, 2012), SETRM Workshop held Monday 18 June
- SANEDI (DoE) / TIA (DST): Investigating a centralised national CSP research facility
- DoD: SAAF engaging CSIR about wind farms & radar, and CSP & pilot safety, IR missiles
- DEA: Green Fund – R800 million!

● Parastatals & listed companies

- Eskom: 100MW CSP tower plant: EOI's for EPC services being assessed
- Abengoa: 50MW CSP tower plant
- Sasol: Performing FEED with BrightSource for tower CSP plant

Thank you for your attention