UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

SOLAR THERMAL ENERGY RESEARCH GROUP

An introduction to the Stellenbosch UNiversity Solar POwer Thermodynamic (SUNSPOT) cycle

Emeritus professor Detlev G. Kröger,
D.Sc. Eng (multi), D. Eng h.c. (multi), LFASME

18 July 2013

Fakulteit Ingenieurswese
•
Faculty of Engineering

SOLAR THERMAL ENERGY
RESEARCH GROUP

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

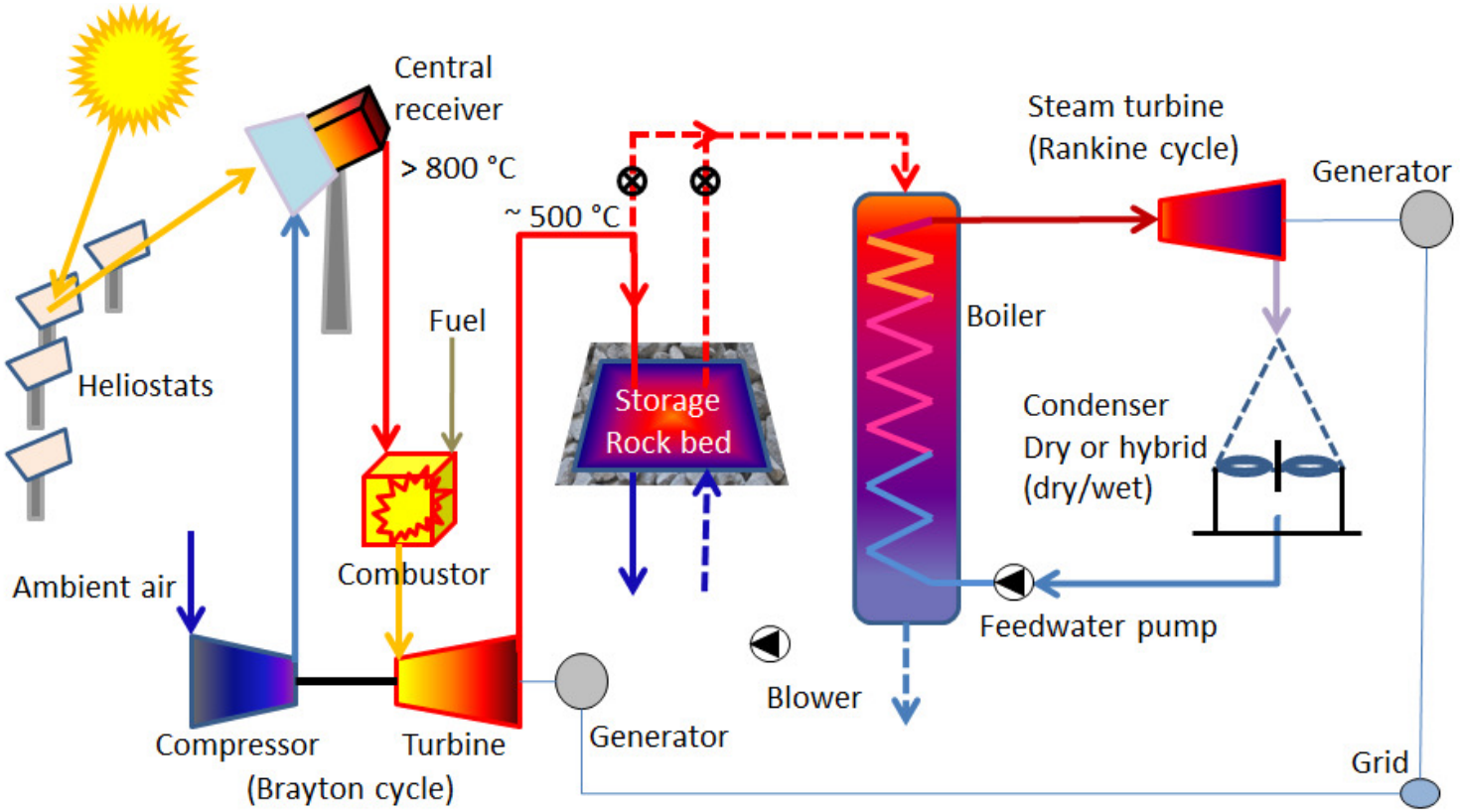

Figure 1: The SUNSPOT cycle

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

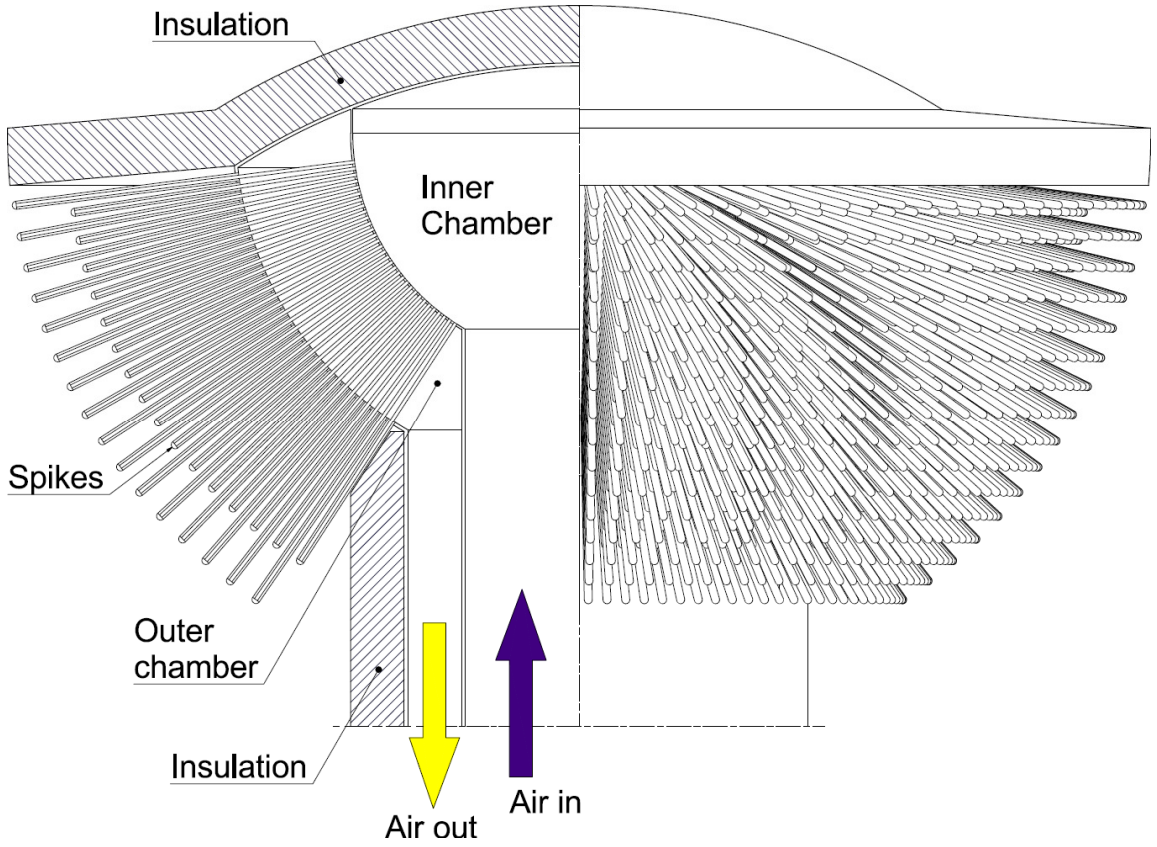

Figure 2: **S**piky **C**entral **R**eceiver **A**ir **P**re-heater (**SCRAP**) Concentric spherical surface chamber (left half in section)

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

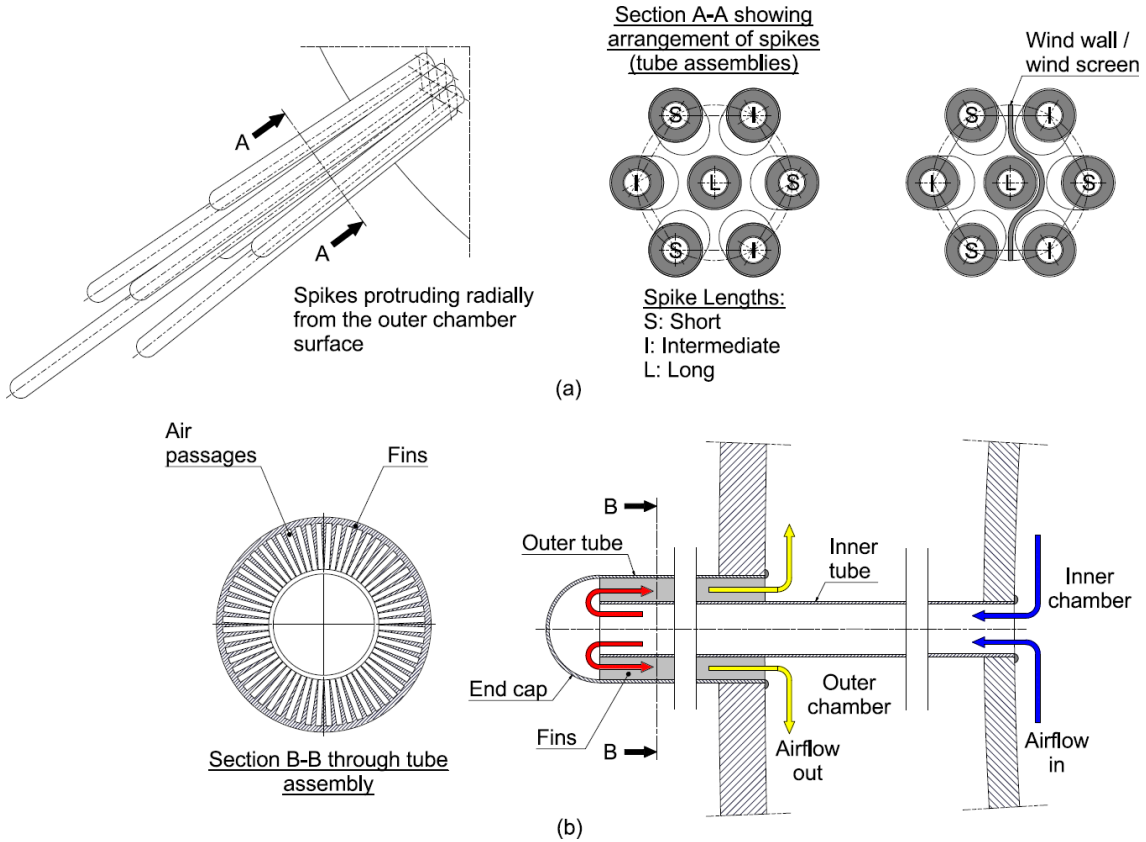

Figure 3: SCRAP tube assembly (spike) details: (a) tube arrangement, (b) tube geometry

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

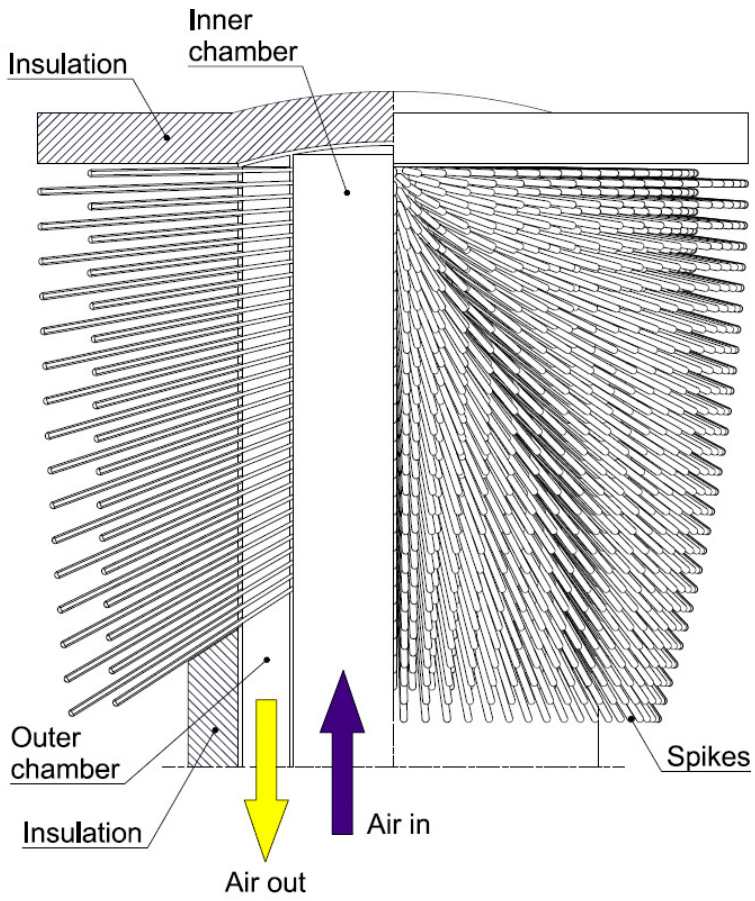

Figure 4 : Concentric cylindrical surface spiky air pre-heater (left half in section)

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

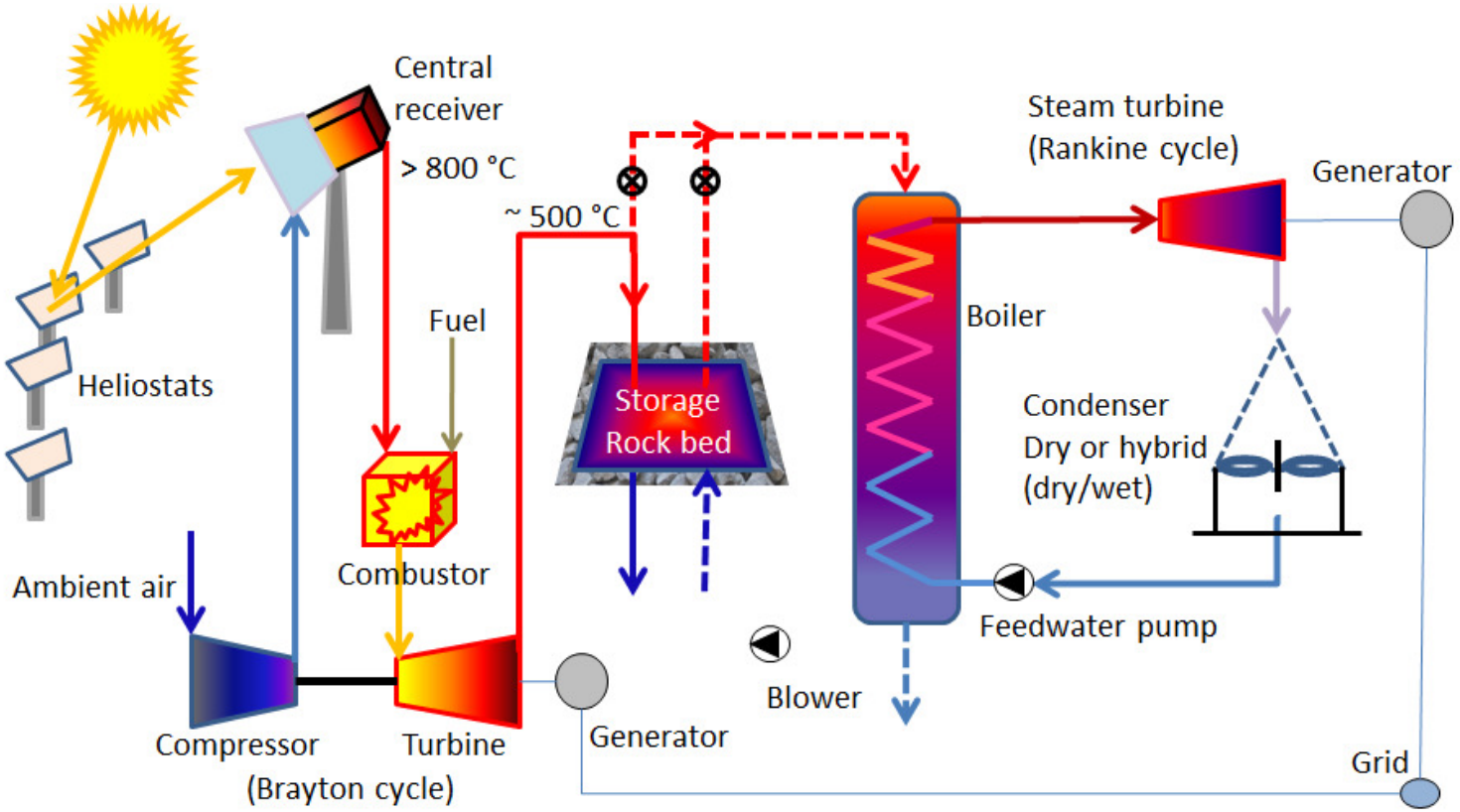

Figure 5: The SUNSPOT cycle

SOLAR THERMAL ENERGY
RESEARCH GROUP

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

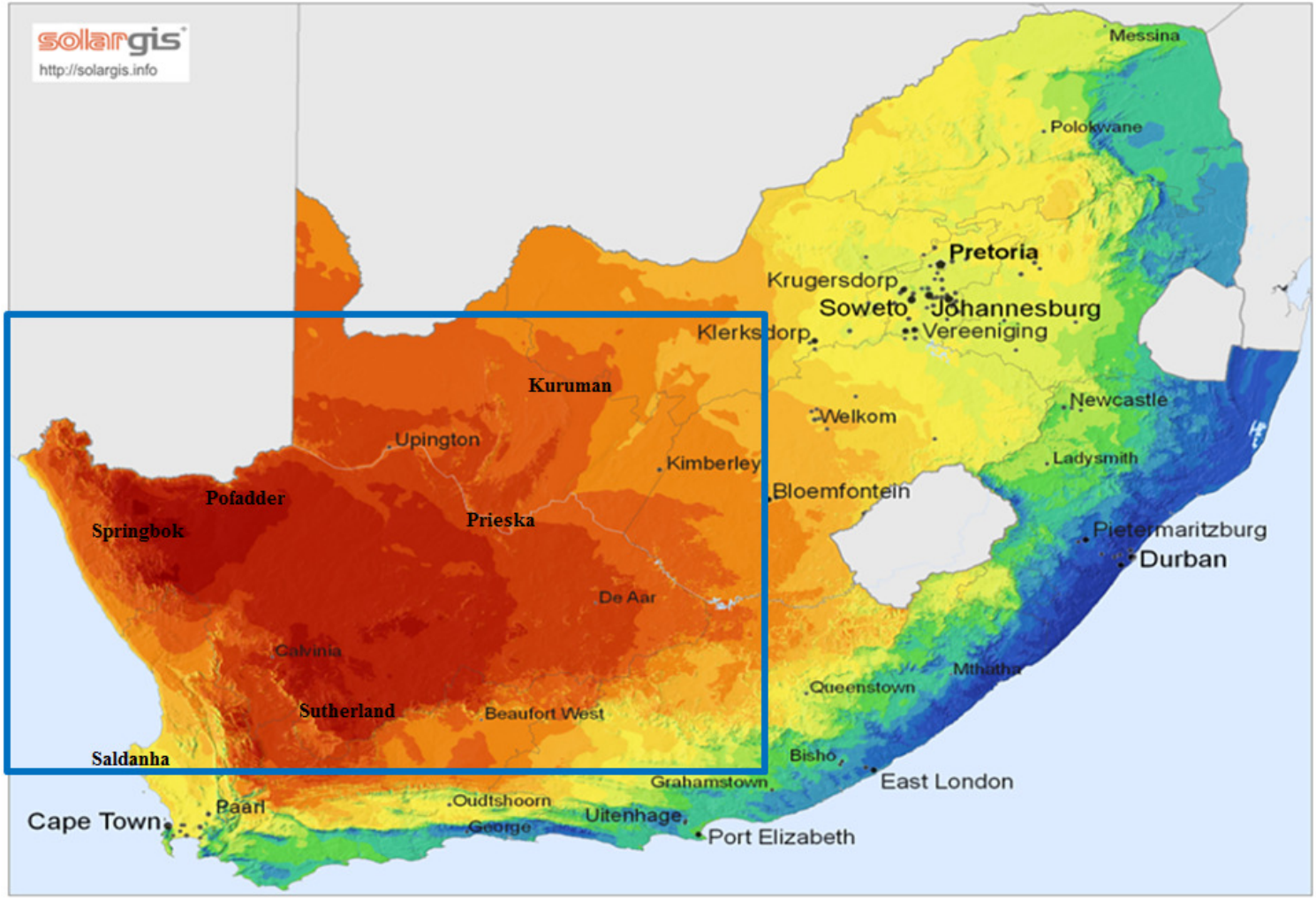

Figure 6: Annual direct normal solar radiation in South Africa

SOLAR THERMAL ENERGY RESEARCH GROUP

Figure 7: Dolerite rock formation near Calvinia

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

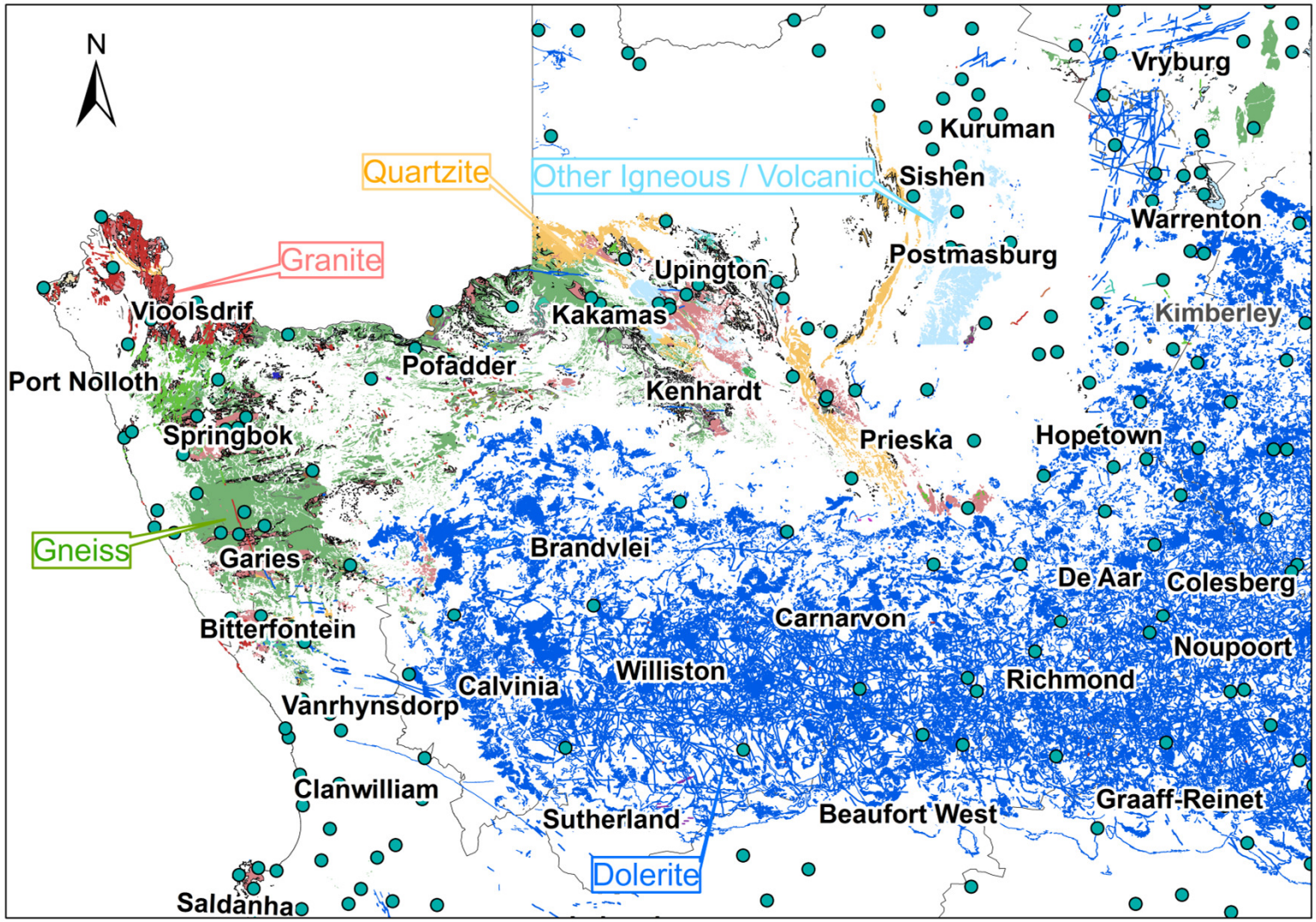

Figure 8: Rock type distribution in the Northern Cape region
(based on South African Council for Geosciences data)

SOLAR THERMAL ENERGY RESEARCH GROUP

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

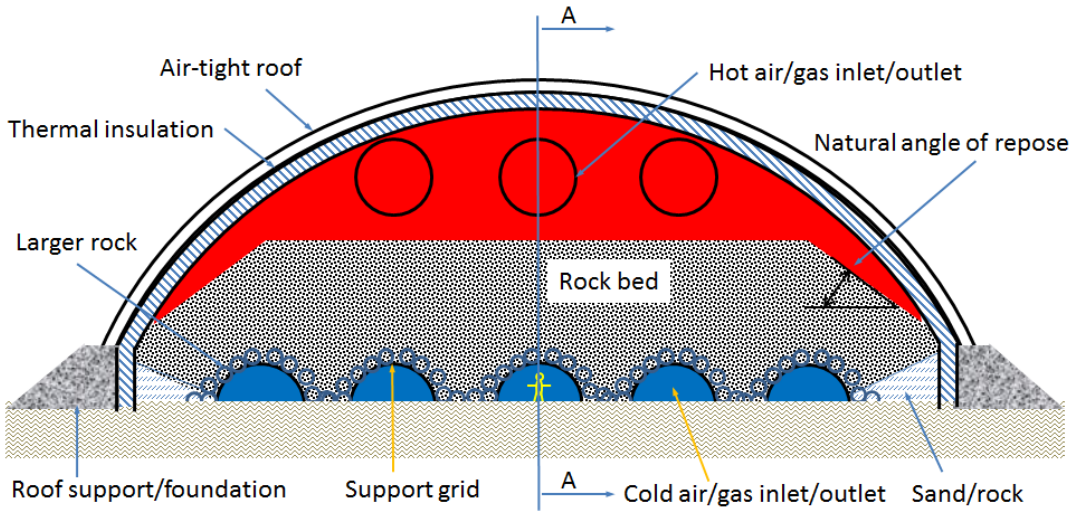

Figure 9a: Packed rock bed thermal storage

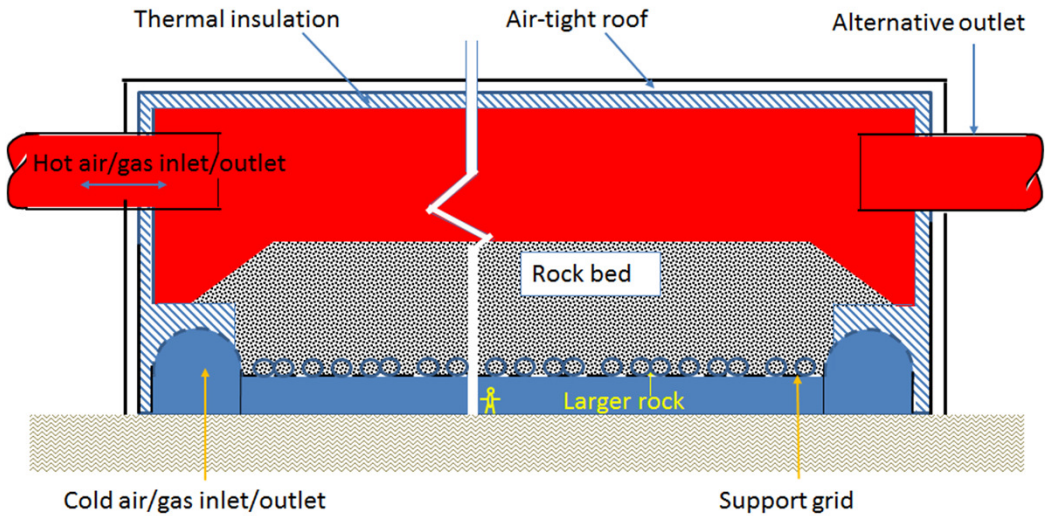

Figure 9b: Section on A-A

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

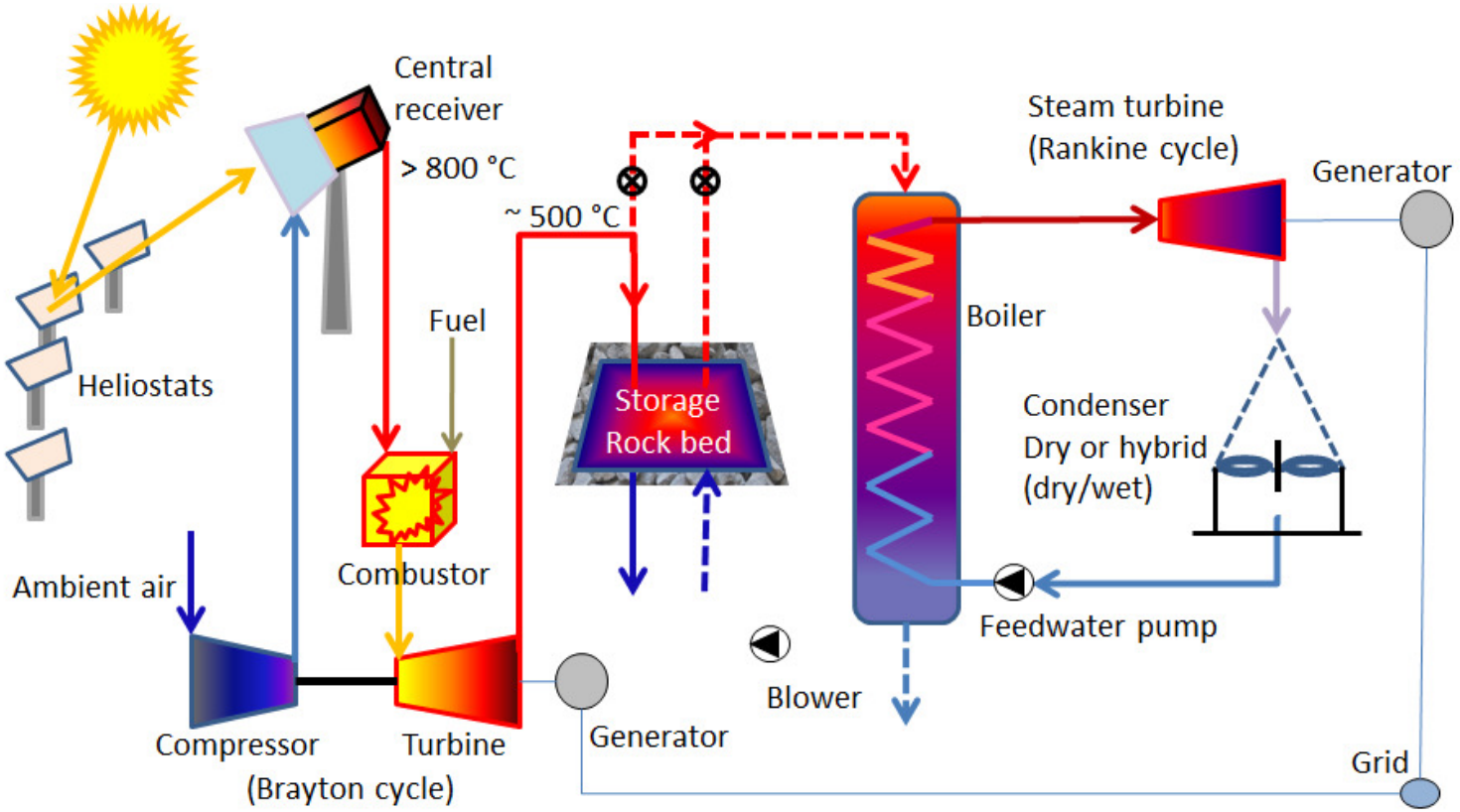

Figure 10: The SUNSPOT cycle

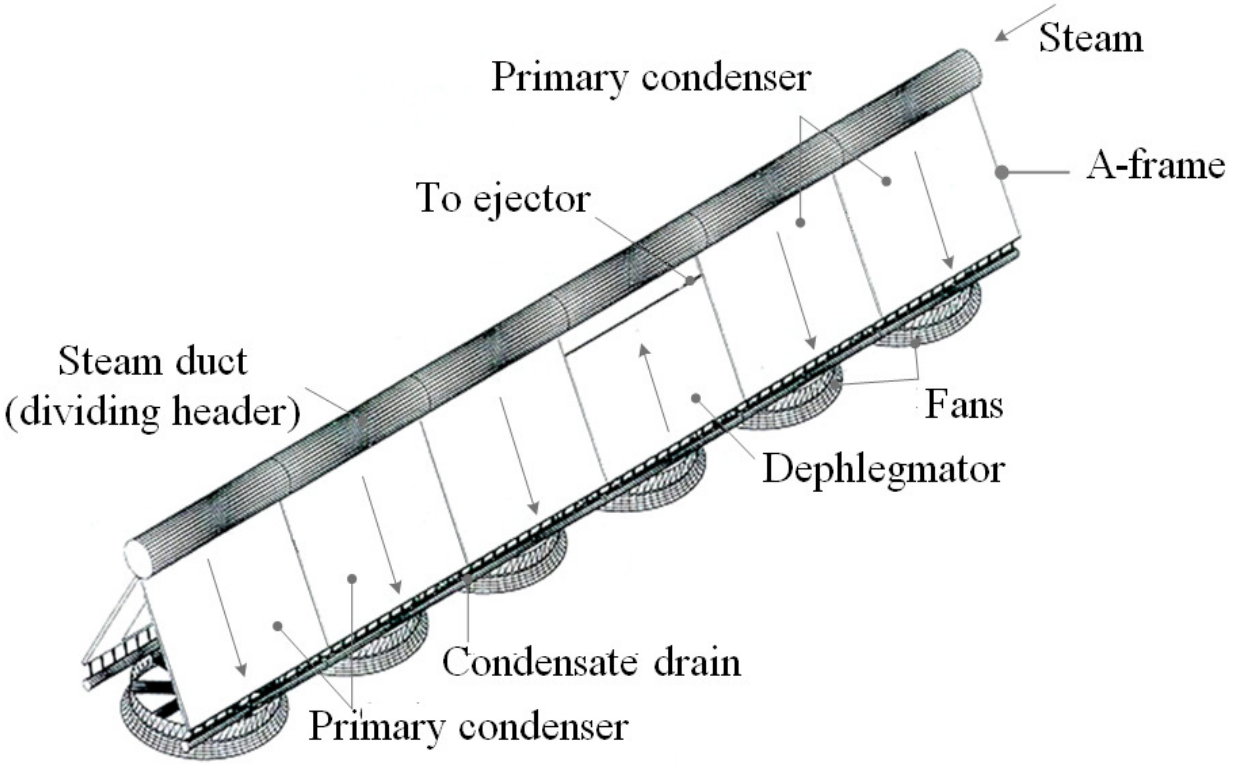

Figure 11: Air-cooled steam condenser street

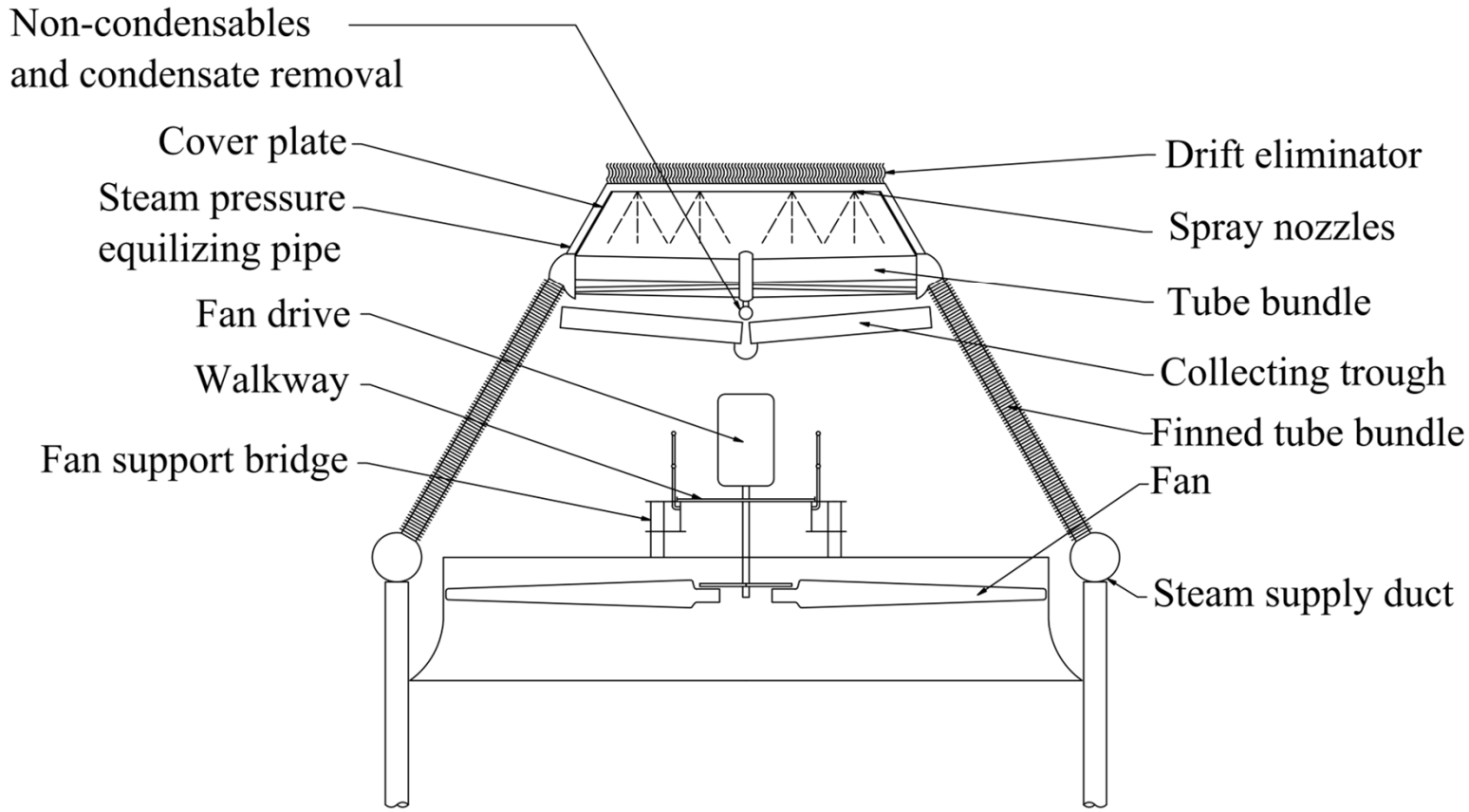

Figure 12: Hybrid (dry/wet) dephlegmator

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

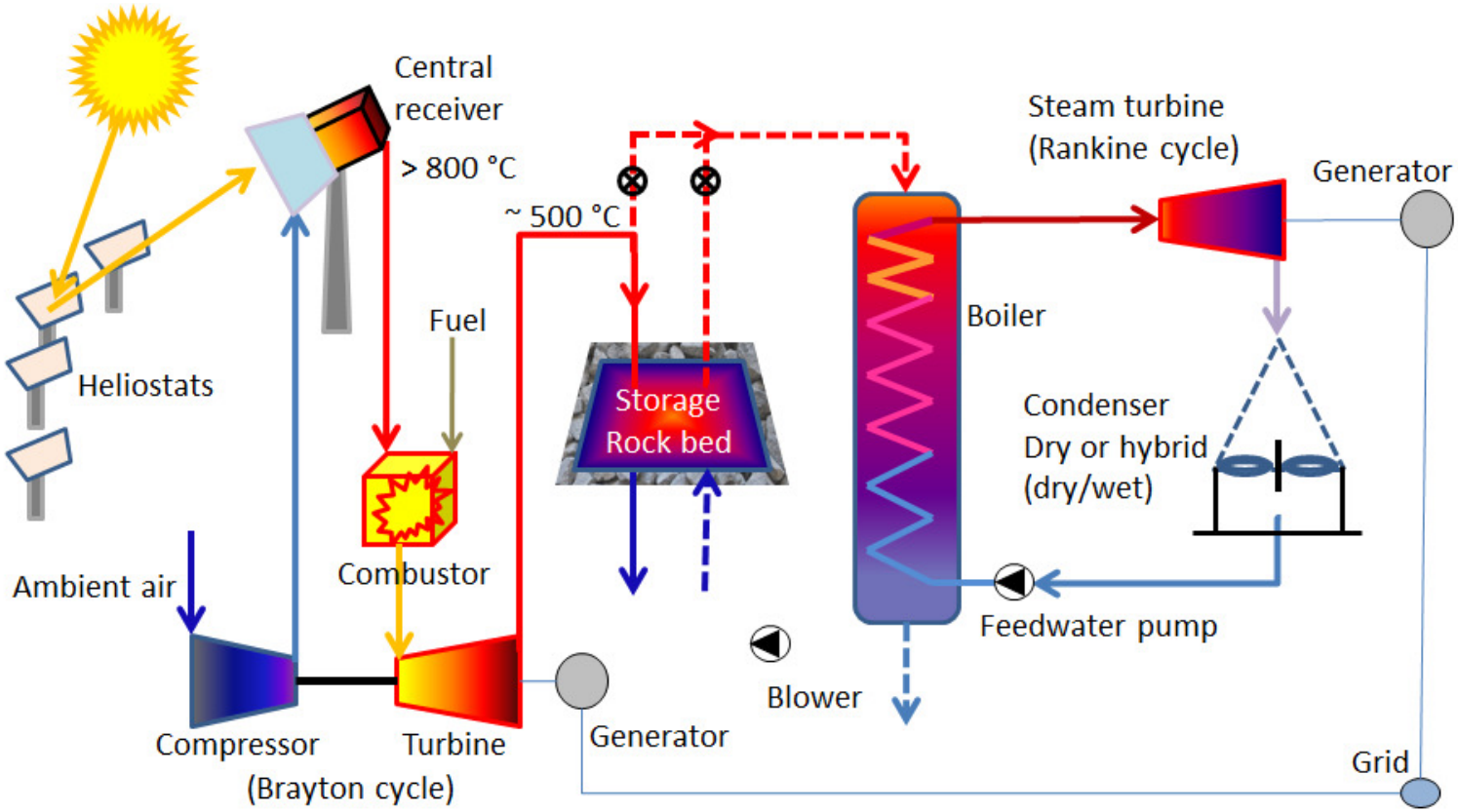

Figure 13: The SUNSPOT cycle

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

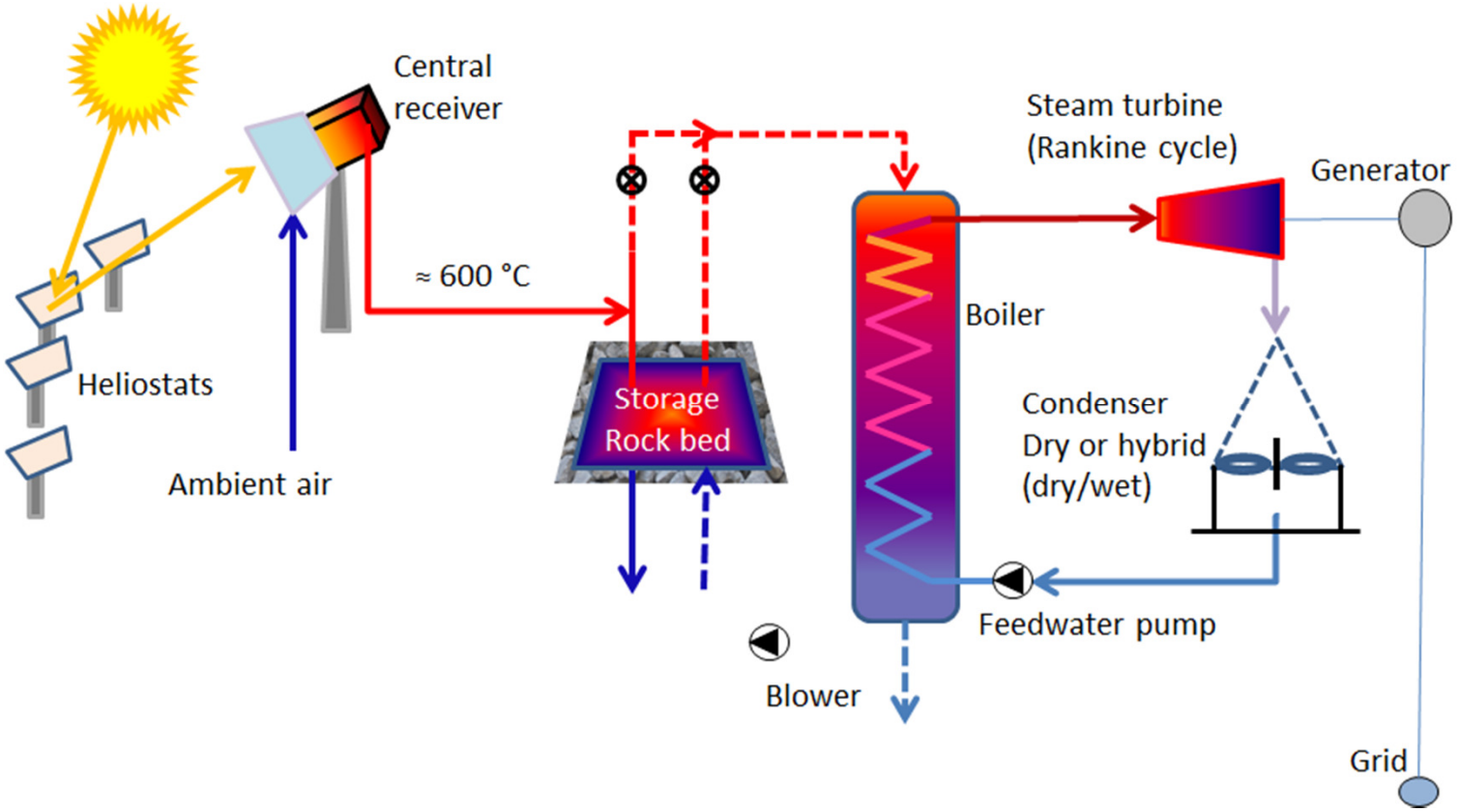

Figure 14: Cycle for peak demand periods

Figure 15: Volume of rock needed for thermal storage

ΔT = 500 °C; 100 m x 100 m x 500 m; ρ = 2700 kg/m^3, so m = 14 x 10^9 kg

An introduction to the **S**tellenbosch **UN**iversity **S**olar **PO**wer **T**hermodynamic (SUNSPOT) cycle

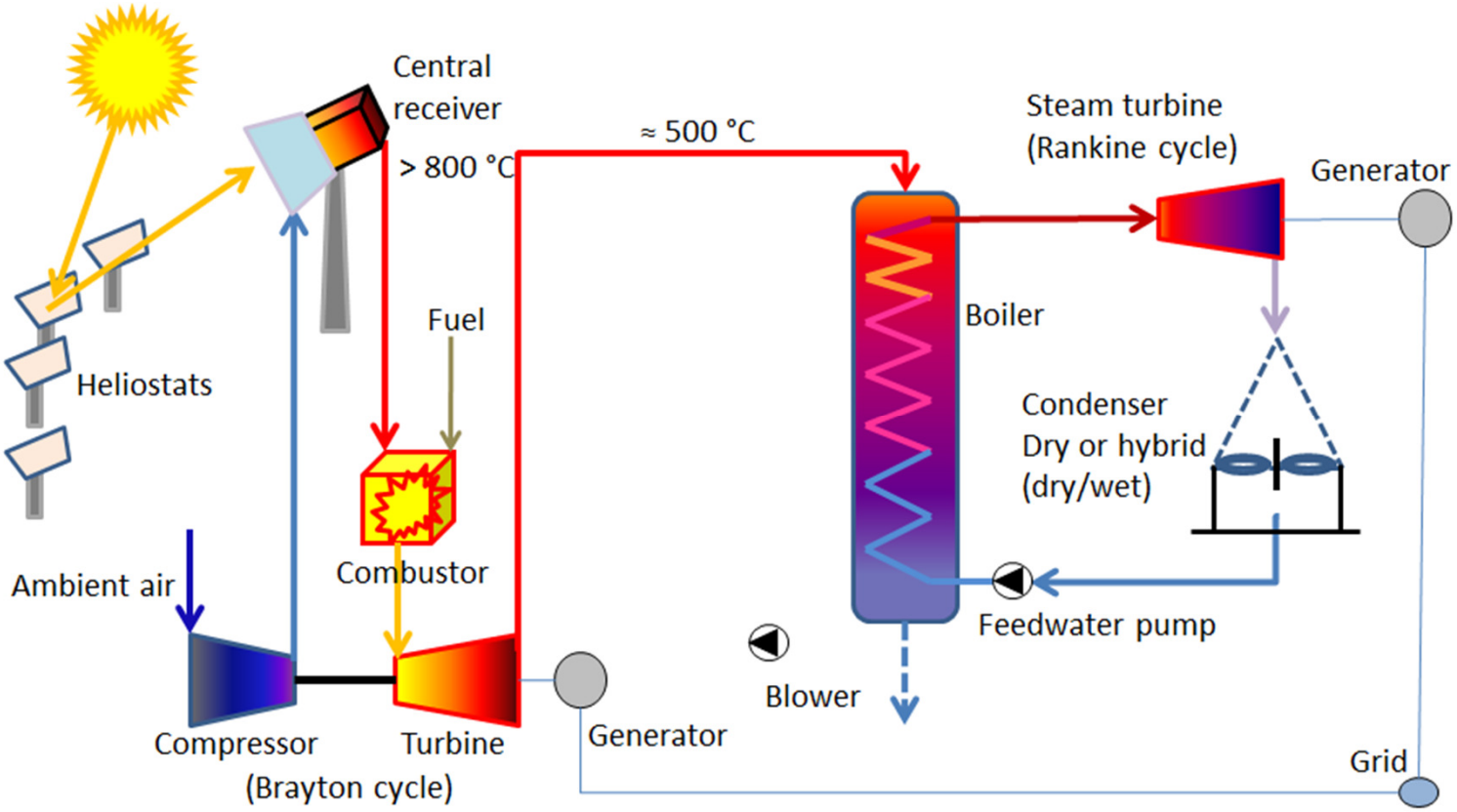

Figure 16: Cycle for maximum efficiency

SOLAR THERMAL ENERGY
RESEARCH GROUP