www.csiro.au

Geothermal Energy

Prof. Klaus Regenauer-Lieb, Prof. Hui Tong Chua, Dr. Frank Horowitz, Dr. Donald Payne and others

Collaborative project (WAGCOE, Direct Energy, GT Power, various Universities) with CSIRO as Centre Agent

CSIRO

Overview

Increasing the footprint + risk

The Challenge

- Hundreds of MW Renewable Power for 50 years +

The Potential of a Geothermal Base Load Solution

i. Geothermal Cooling the antennas: Ground source heat pumps < 1 MW_{th} ✔

ii. Waste Heat from Generator for Cooling: Absorption Chillers <100 M_{th}

iii. Geothermal Cooling for the Pawsey Centre: Sorption Chillers <10 MW_{th} ✔

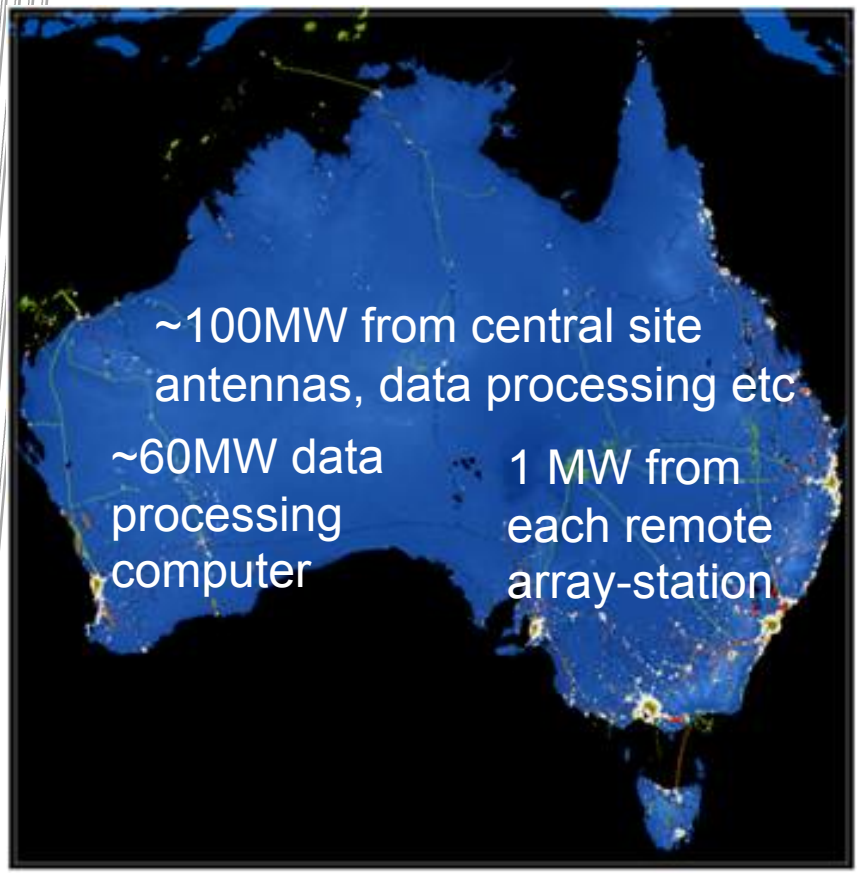
iv. Geothermal Electricity and Cooling for the SKA Supercomputer <100 $Mw_{el,th}$

v. Geothermal Electricity and Cooling for the Central site <100 $M_{el,th}$

✔ : ongoing funded through the EIF bid

CSIRO

The Challenge: Power for 50 years+ & The Tyranny of distances

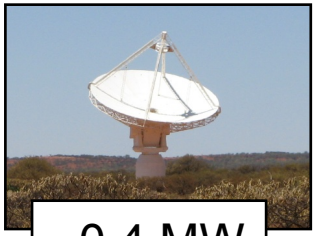


Remoteness of Power + Water infrastructure

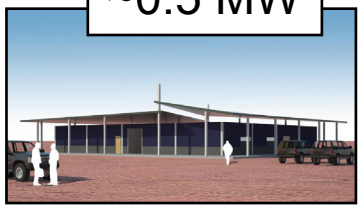
CSIRO

ASKAP as an energy pathfinder for SKA

- **Energy requirement**



~0.4 MW



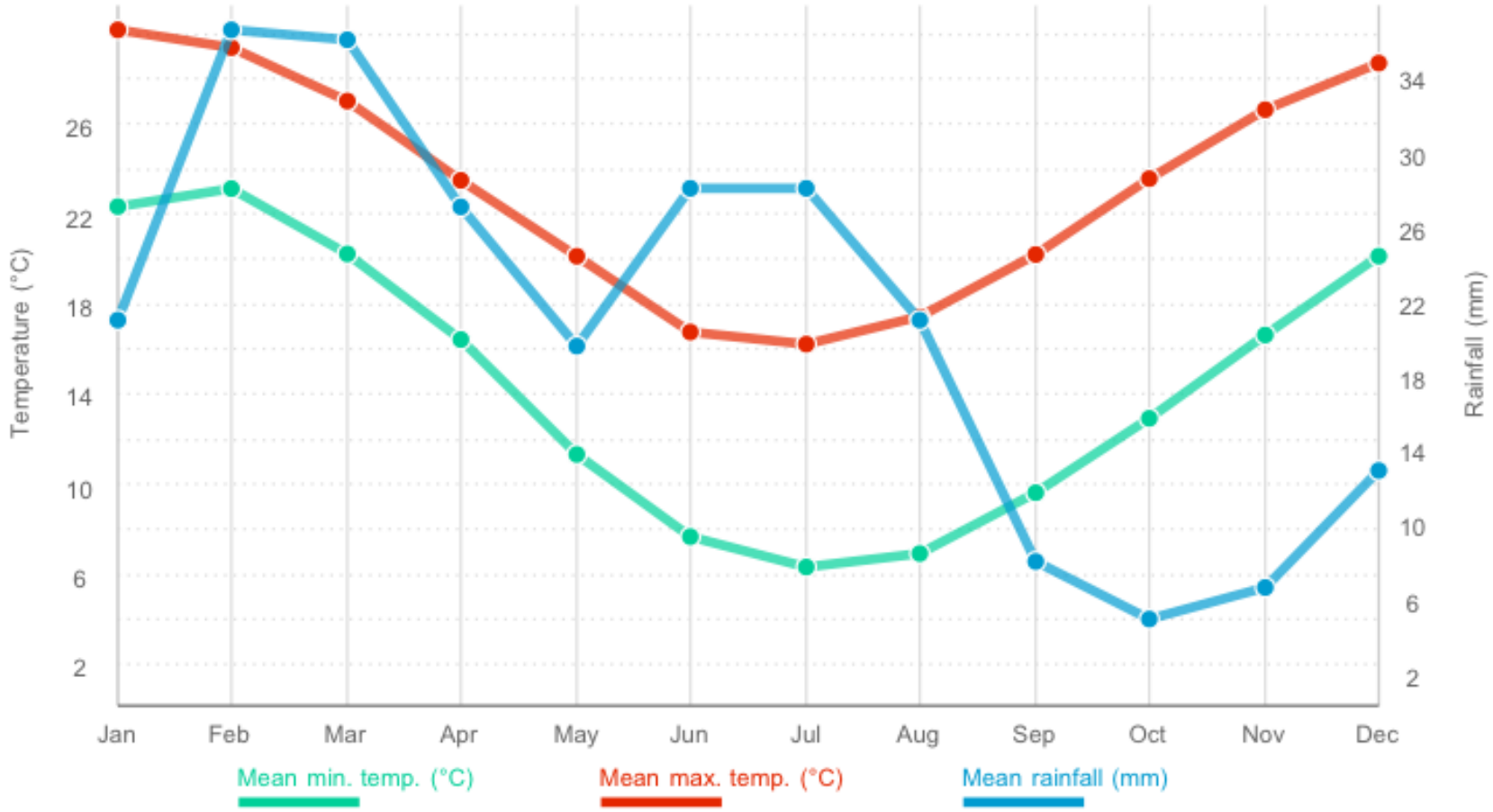
~0.5 MW

Cooling requirement in Perth ~3 MW_{th}

- **Off-grid at MRO**
- **RFI compliance**

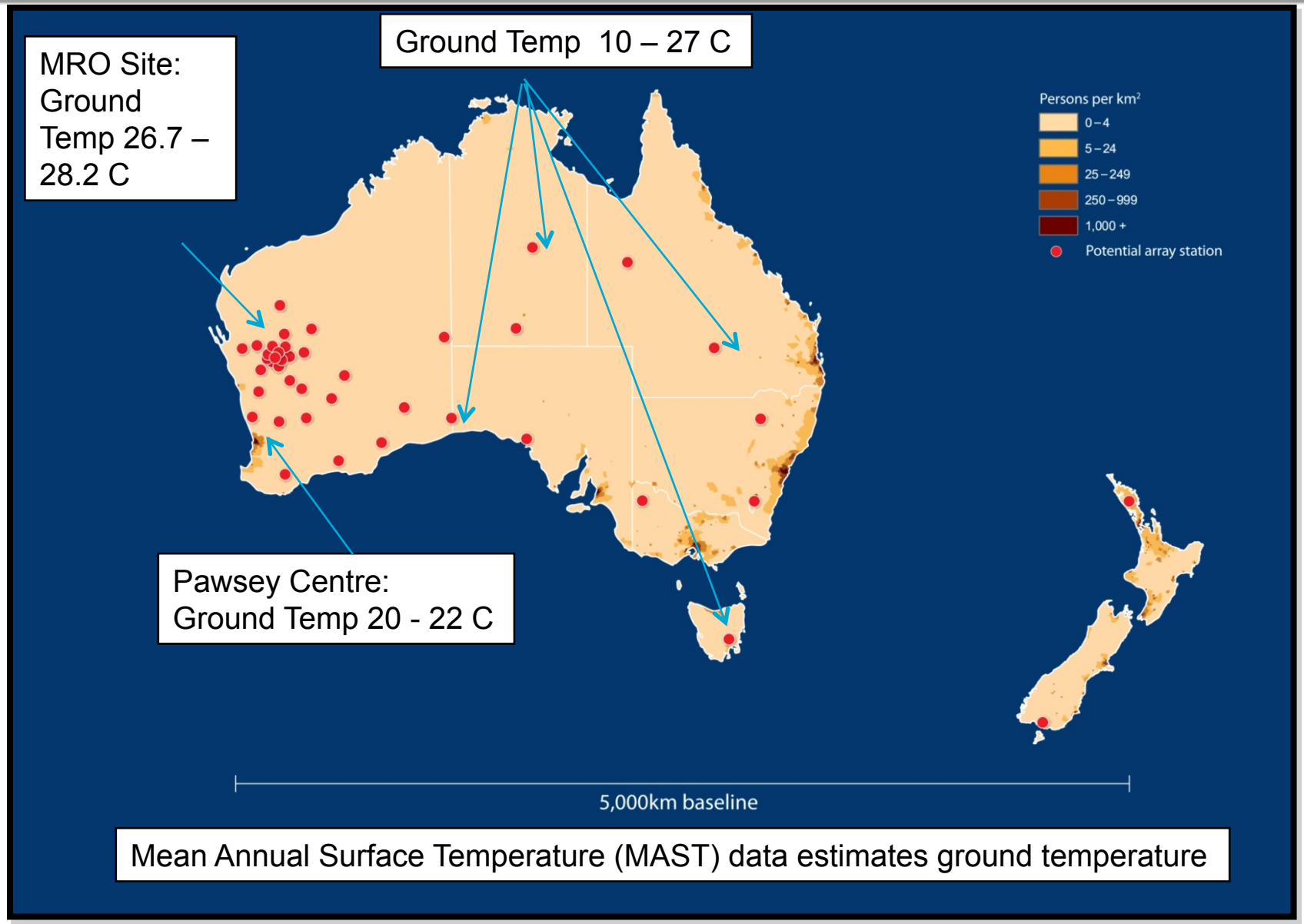
CSIRO

Climate Data Murchison Regional Observatory (MRO)



MRO (26.9167°S, 116.606°E, 331m AMSL)
Hottest this year 42.9°
Long term average 30.6°

i. Geothermal Cooling GSHPs for SKA ✔

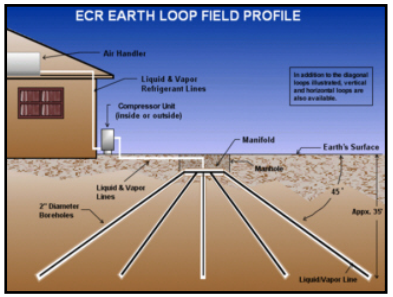


i. Geothermal Cooling: GSHP ✔

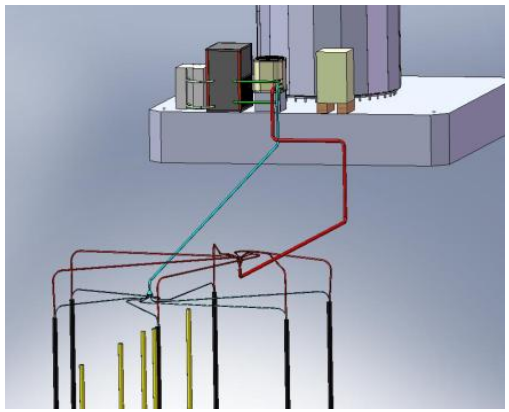
- Murchison Radio-astronomy Observatory site: GSHP

- **GSHP demonstration at MRO site #29**
  - Ground temp = 27 C, Ambient to 45 – 50 C
  - Temp difference 18 – 23 C

- **Direct heat geoexchange cooling**
  - copper/coolant ground loops 6 x 30m depth
  - Prototype at CASS headquarters Marsfield
  - Prototype at MRO, 12 months testing with success



- **Ground Temperature Monitoring**



CSIRO

ii. Waste Heat from Generator for Cooling: Absorption Chillers <100 M_{th}

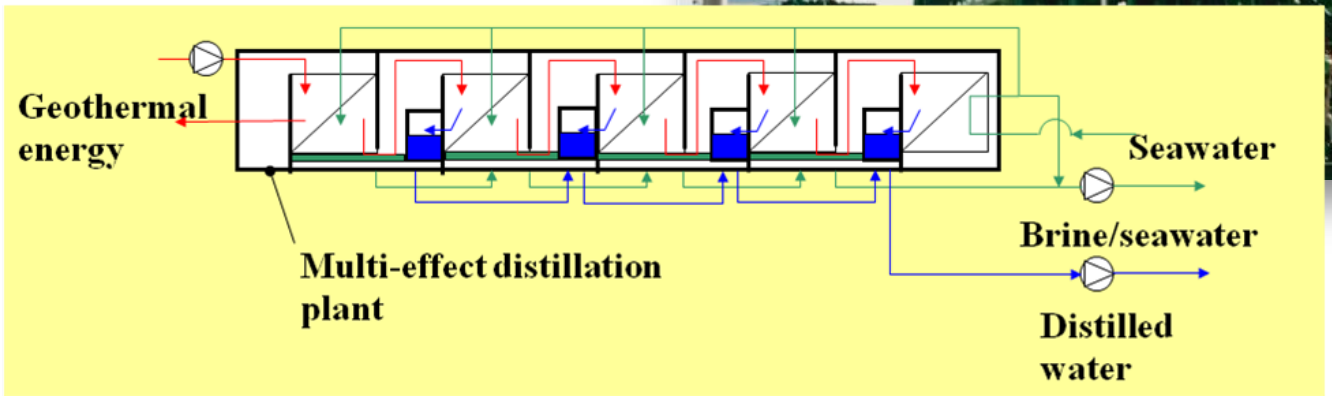
AIR COOLED AMMONIA WATER CHILLER
could harvest waste heat
From thermally driven Generator at 170°C and cool with a COP of 0.67

Tolerates 45°C Air temperature

there is a 85% ratio of cooling to electrical power output

CSIRO

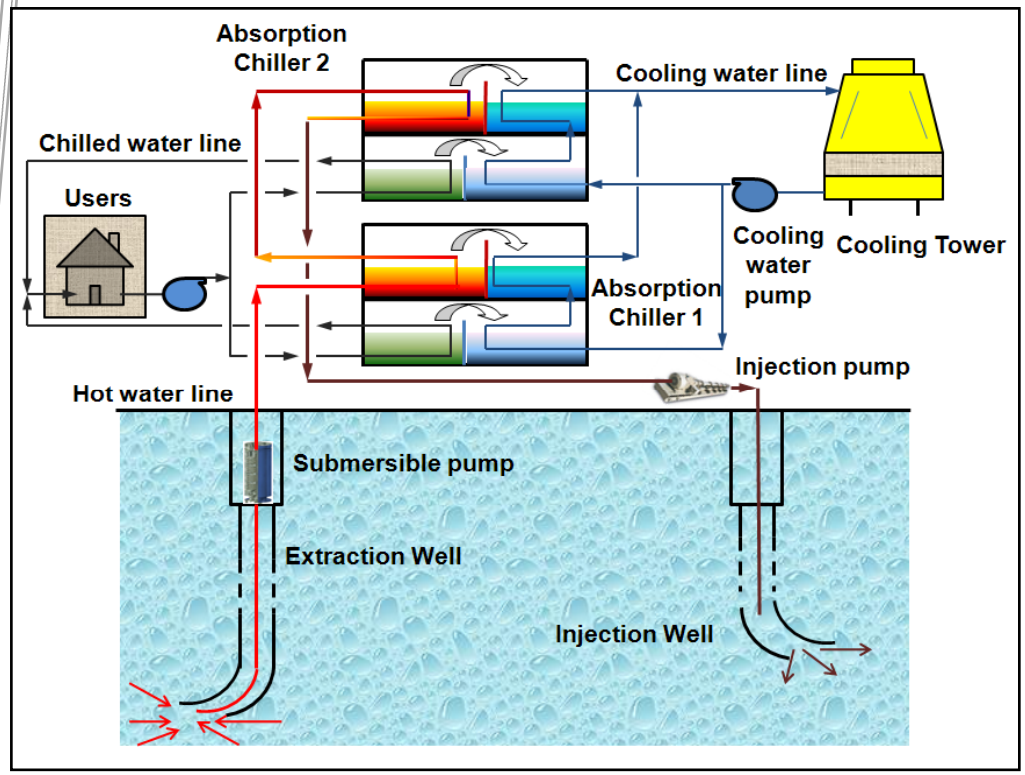
ii. Cascaded heat from sorption chiller into Turning Heat into Fresh water at 70°C

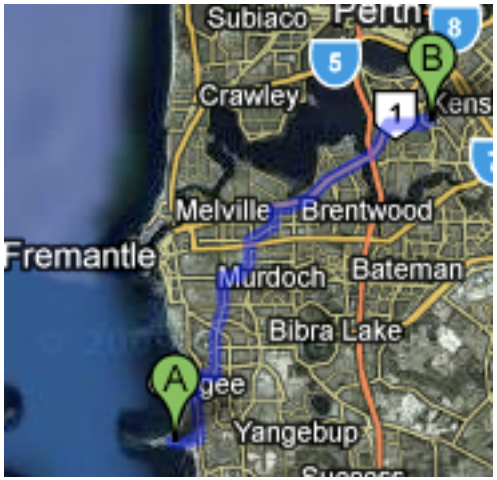


WAGCoE developed a design with 30% higher yield, We have been awarded a research grant by the National CoE for Desalination to develop this technology

iii. Geothermal Cooling for the Pawsey Centre: Sorption Chillers <10 MW_{th} ✔

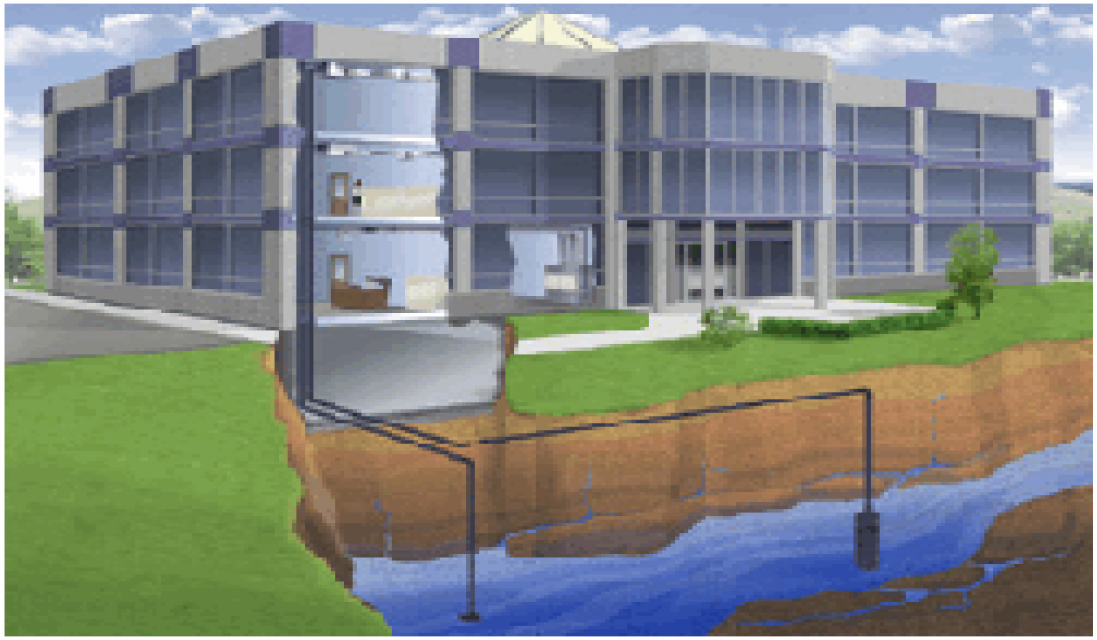
Cockburn 1 oil well; drilled in 1967
to a total depth of 3054 m confirms required temperature and permeability





iii. Geothermal Cooling for the Pawsey Centre: Cooling Tower Replacement <10 MW_{th} ✔

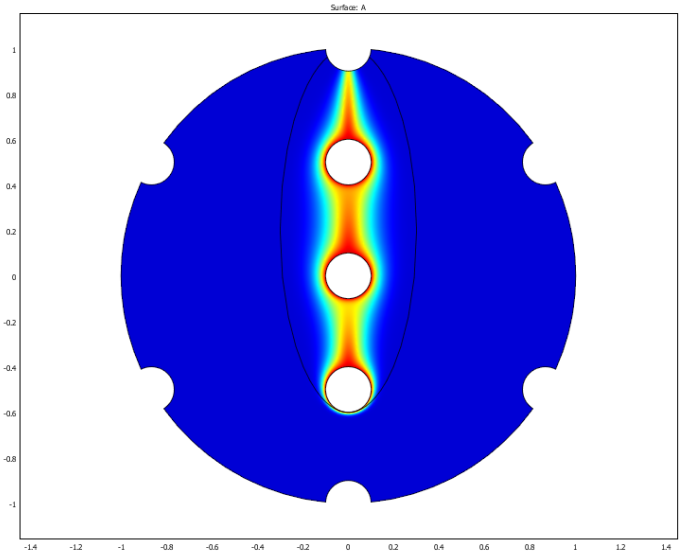
Replacing the cooling tower through Aquifer thermal storage



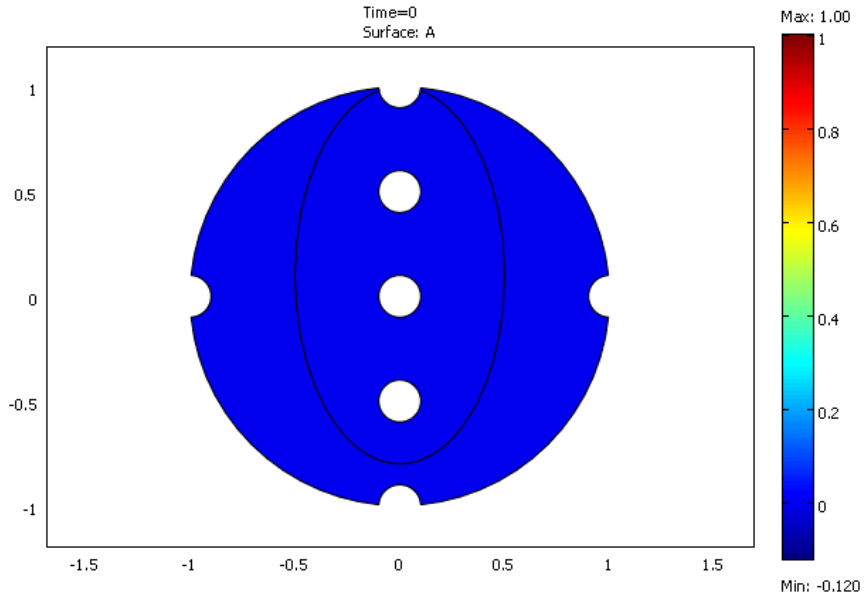
iii. Cooling tower replacement: Underground Mixer

- **Patent "Subsurface Process Optimisation via Flow Manipulation" (DCC ref 30753459)**

Steady flow



Chaotic flow

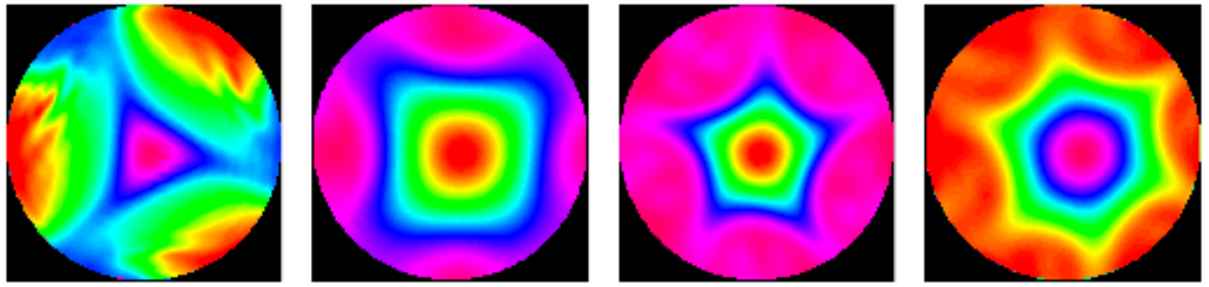


Metcalfe et al. 2009 (collaboration with WAGCoE)

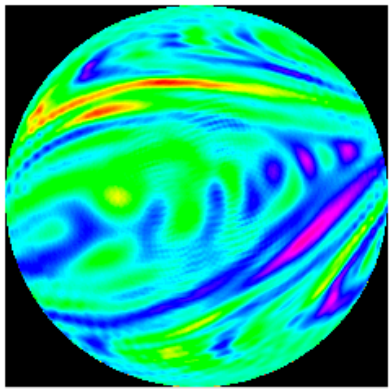
CSIRO Materials Science & Engineering Applied Fluid Chaos Group

iii. Cooling Tower Replacement: Underground Mixer

- **Suboptimal locked in strange Eigenmodes**

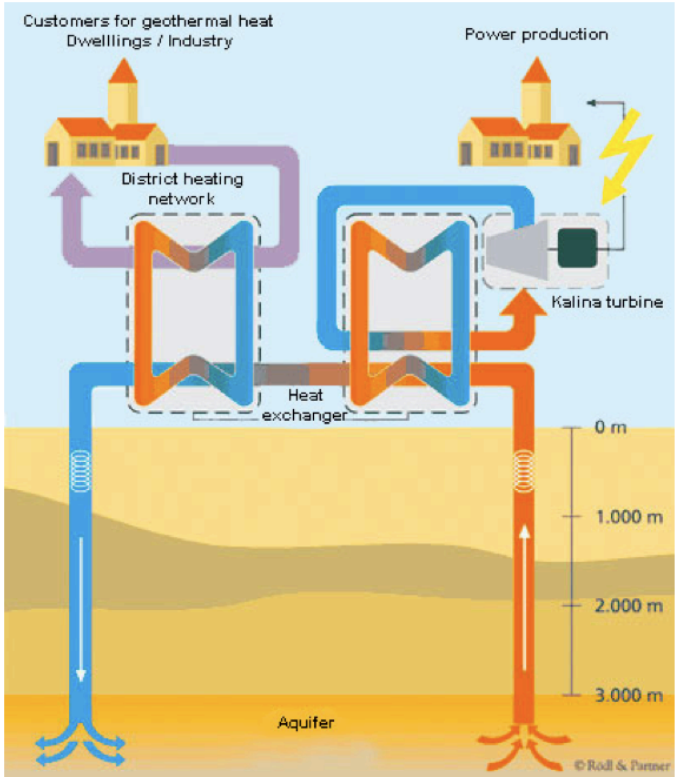


- **Optimal strange Eigenmode**



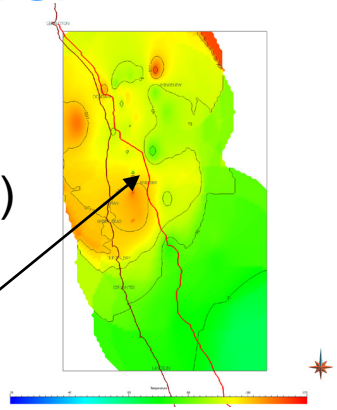
Lester et al. 2010

iv. Geothermal Electricity and Cooling for the SKA Supercomputer <100 $Mw_{el,th}$



- Hot AQUIFER Example
  - Unterhaching, Germany
  - 125° C
  - 3.300 m Deep Well
  - 3.36 MW (electric)
  - 40 MW (thermal)
  - 2007 district heating
  - 2008 power

Pilot study identified high temperatures (120°C @ 2 km depth) near the high speed Geraldton-Perth transmission link

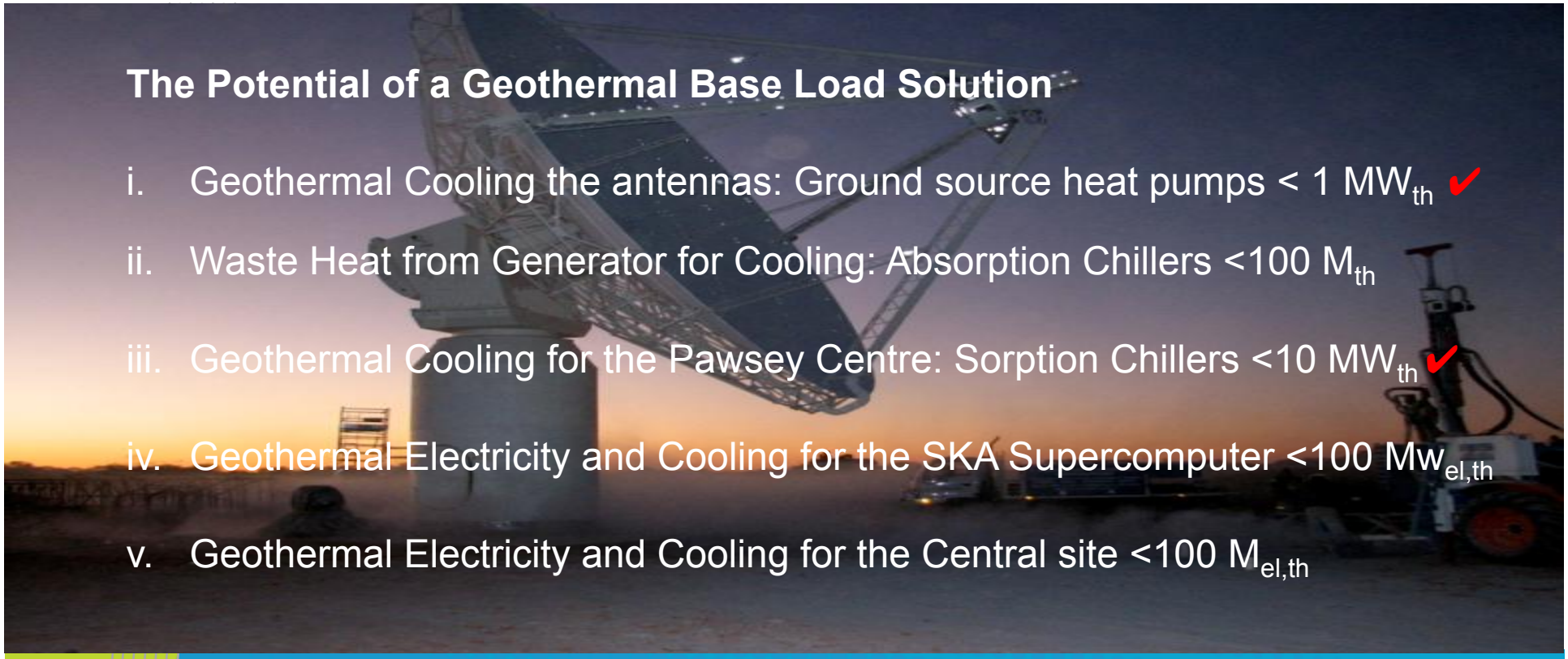


CSIRO

v. Geothermal Electricity and Cooling for the Central site <100 $M_{el,th}$

Potential for an EGS power station on the deep crustal Meeberrie fault
Such a project would be similar to a Geodynamics Cooper basin project

CSIRO



The Potential of a Geothermal Base Load Solution

i. Geothermal Cooling the antennas: Ground source heat pumps < 1 MW_{th} ✔

ii. Waste Heat from Generator for Cooling: Absorption Chillers <100 M_{th}

iii. Geothermal Cooling for the Pawsey Centre: Sorption Chillers <10 MW_{th} ✔

iv. Geothermal Electricity and Cooling for the SKA Supercomputer <100 $Mw_{el,th}$

v. Geothermal Electricity and Cooling for the Central site <100 $M_{el,th}$

www.csiro.au

Thank you

Prof. Klaus Regenauer-Lieb

Phone: +61 8 6436 8693
Email: klaus.regenauer-lieb@csiro.au

Contact Us
Phone: 1300 363 400 or +61 3 9545 2176
Email: enquiries@csiro.au Web: www.csiro.au

CSIRO