The 'Australia’s Future Energy Resources' project:
Investigating the energy resources potential in central Australia

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Project Objectives

Evaluating the resource potential for Australia’s future energy requirements

Petroleum systems ➔ GAS  (OIL)
Deep groundwater ➔ GREEN HYDROGEN
Petroleum systems + CCS ➔ BLUE HYDROGEN
CO2-Enhanced Oil Recovery ➔ OIL

Where?
A set of variably stacked basins:

Central Australian basins
Eromanga, Simpson, west Cooper, Pedirka, Warburton

May progress to other basins identified for EFTF
Why?

✓ Aligns with the technology investment roadmap goals
✓ Identifies new resources to support a future low carbon economy

Why Central Australian basins?

- System of stacked basins provides access to a large variety of resource commodities in a regionally confined space
- Target area is close to existing infrastructure and may be crossed by a new gas pipeline
- Boundaries of selected basins overlap NT, QLD and SA borders
What? The four project modules:

Module 1: Resource Assessments
- Well failure analysis
- Play fairway mapping
- Prospective resources (“yet-to-find”)

Module 2: Hydrogen
- Natural hydrogen occurrence
- Hydrogen storage
- Hydrogen Economic Fairways Tool

Module 3: CO2-enhanced oil recovery in residual oil zones
- Evaluation of depleted hydrocarbon fields
- Identification of palaeo-oil columns
- Assessment of CO₂ storage potential

Module 4: Basin Inventory
- Gap analysis – geological knowledge
- Recommendations for future work
- Evaluation of petroleum systems, including source rock characteristics

AFER project is carried out in collaboration with SA DEM and NTGS
Project outcomes

Outputs

• Publication of comprehensive geoscientific report(s)
  • Basin analyses (tectonic evolution, petroleum geology, distribution of resources)
  • Resource assessments compliant with international standards
  • Quantification of the potential resource base under a variety of economic scenarios

• Updated data-bases and major additions to GA-data portal

Outcomes

• Multiple precompetitive data-sets and information will stimulate industry activity in this sparsely explored region

• Project will provide a thorough understanding of the resource occurrences in a crustal section that spans from the early Paleozoic to the Neogene

Impacts

• Major contribution to the unlocking of new energy resources using innovative technologies

• Project will contribute to Australia’s energy security
Seismic reprocessing

- Existing 15,000 line km across 190,000km²
- No 3D seismic surveys acquired outside Cooper Basin

Reprocessing Phase 1:
- 2,000 line km in SA
- Data now publically available

Reprocessing Phase 2:
- 1,750 line km, including 650 line km in NT
- Additional infill and well ties
- Data release expected by mid-2022

- Aim to better define structures and key stratigraphic packages
- Needed for regional mapping of play intervals
- Insight into older (Paleozoic) section?
Late Cretaceous (non-marine)

Early Cretaceous (marine)

Early Jurassic – Early Cretaceous (non-marine)

Permian (non-marine)
Play-based resource assessment workflow

Gap Analysis (Q2-Q3 2021)

Well Failure Analysis
Q3 2021 – Q4 2022

Basin Analysis/Petroleum Systems Studies
Q1-Q2 2022

Conventional Resource Assessments
Q2-3 2022

Unconventional & Other Resource Assessments
Q3 2022 – Q4 2024

2. Dry Valid Trap Tests

Reservoir
Seal
Trap Presence
Charge

Play ‘x’ CRS Map
Defining “plays”

- Common regional chronostratigraphic framework established to define play intervals
- Plays based on reservoir and seal pairs and associated sequence stratigraphic surfaces
- Each play being assessed for conventional and unconventional hydrocarbon potential and carbon capture and storage (CCS) opportunities
- Framework in
  - Mesozoic: 9 Plays (published APPEA)
  - Permo-Triassic: 8 Plays
Post Drill Analysis

- Post Drill Analysis (PDA) being conducted on 36 conventional petroleum wells and 7 coal bed methane wells.
- PDA provides systematic approach is to evaluate discrete play intervals and trapping mechanisms.
- Player software by GIS-Pax™ being used to evaluate the presence and effectiveness for the main conventional petroleum systems’ play elements of reservoir, seal, trap and charge.
- Methodology to assess conventional hydrocarbons has been modified to assess the elements and criteria essential for unconventional petroleum resources and CCS potential.
CO2-enhanced oil recovery and geological storage

**CO2-EOR+ in Australia: achieving low-emissions oil and unlocking residual oil resources**

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<table>
<thead>
<tr>
<th>Description</th>
<th>Net utilisation tCO₂/bbl oil</th>
<th>Net negative?</th>
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<tr>
<td>“Average” CO₂ EOR</td>
<td>0.3 - 0.5</td>
<td>No</td>
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<tr>
<td>“Good” CO₂ EOR (minimum CO₂)</td>
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<tr>
<td>Maximum storage EOR+</td>
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</table>
CO$_2$-EOR and residual oil zones (ROZ)

Permian Basin - Seminole field example

100% oil  0% oil  

(after Sanguinito et al., 2020)

(after Trentham et al. 2015)
A new resource for Australia?

Identify ROZ

Calibrate and predict

Technical and economic feasibility

Kalinowski et al., 2022 (in press)

Seyyedi and Sohrabi, 2020

Hydrogen production (HEFT)
Where are we looking?

‘Mature’ provinces e.g. Cooper-Eromanga

‘Frontier’ regions?

Pedirka

Amadeus

(from Hall et al., 2019)

(from Cotton et al., 2007)

(from NTGS, 2017)
Hydrogen

Location map showing exploration well, mine and groundwater samples with measurable concentrations of H₂ (mol%)

- H₂-rich natural gases identified as early as 1917 (Yorke Peninsula; Kangaroo Island, SA)
- GA lab identified ~1000 natural gases from 470 wells that penetrated Neoarchean to Cenozoic reservoir rocks with detectable H₂ levels of up to 91.9 mol%.
- Gases with elevated H₂ contents a mixture of deep inorganic sources and decomposed organic matter at high maturities.
- Opportunity to discover natural H₂ in areas previously not targeted by petroleum exploration.

H₂ concentration (mol%)

- ≤0.001
- >0.01
- >0.1
- >1
- >10

from: Boreham et al, 2021; https://doi.org/10.1071/AJ20044
Hydrogen

• Naturally occurring hydrogen can be trapped within or below evaporite accumulations (perfect seal)

• Salt can act as buffer preventing reservoir breaching during prolonged tectonic activity

• Evaporites widely distributed across many sedimentary basins in Australia

• Salt accumulations provide excellent hydrogen storage potential (caverns)

• Important consideration for establishing hydrogen production centres

from: Boreham et al, 2021; https://doi.org/10.1071/AJ20044
Summary and outlook

• AFER is a multidisciplinary project assessing the energy resources potential of underexplored, data-poor regions in onshore Australia

• Close cooperation with State/Territory Geological Surveys and where possible with industry, essential for achieving results

• Innovative approach to utilisation of existing data

• Results/data to be published in stages

• Outcome of project will demonstrate untapped resource potential and inform government and industry decision makers about economically feasible and environmentally sustainable development opportunities