

# Santos CCUS – Cooper/Eromanga Basin CO<sub>2</sub>-EOR

Global CCS Institute Asia Pacific Forum

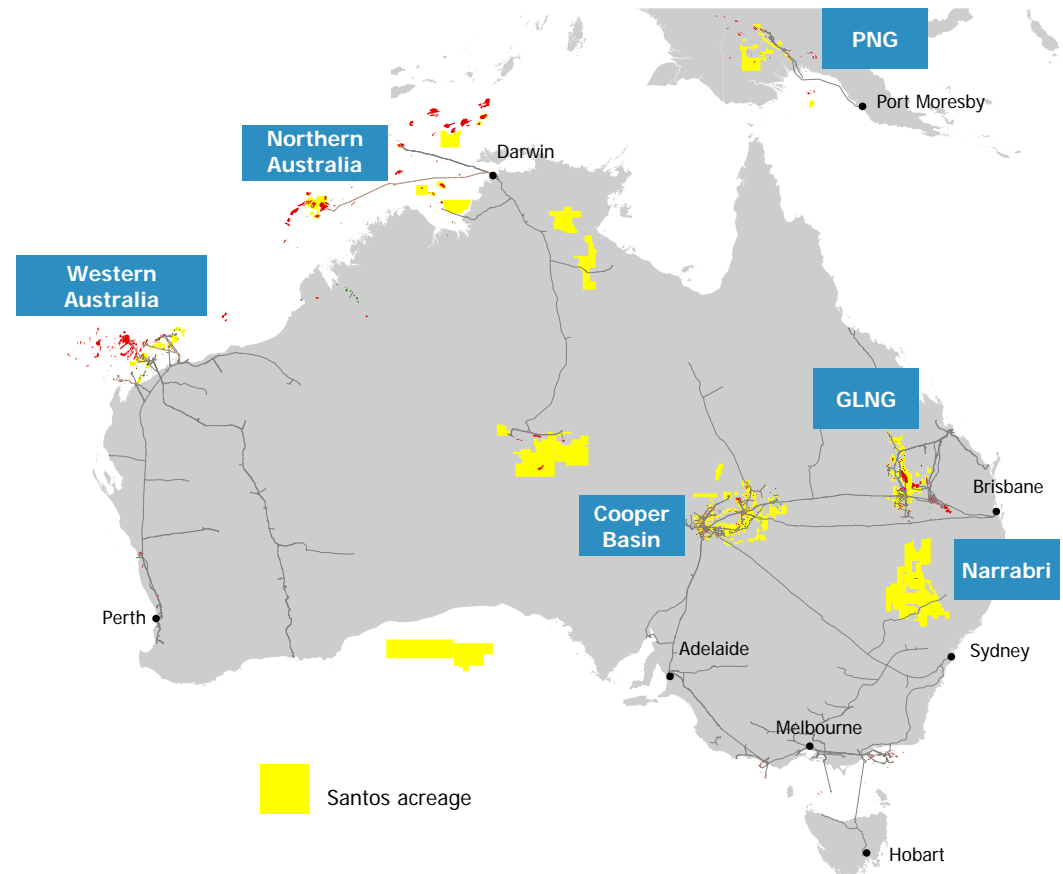
31 May 2019

**Santos**



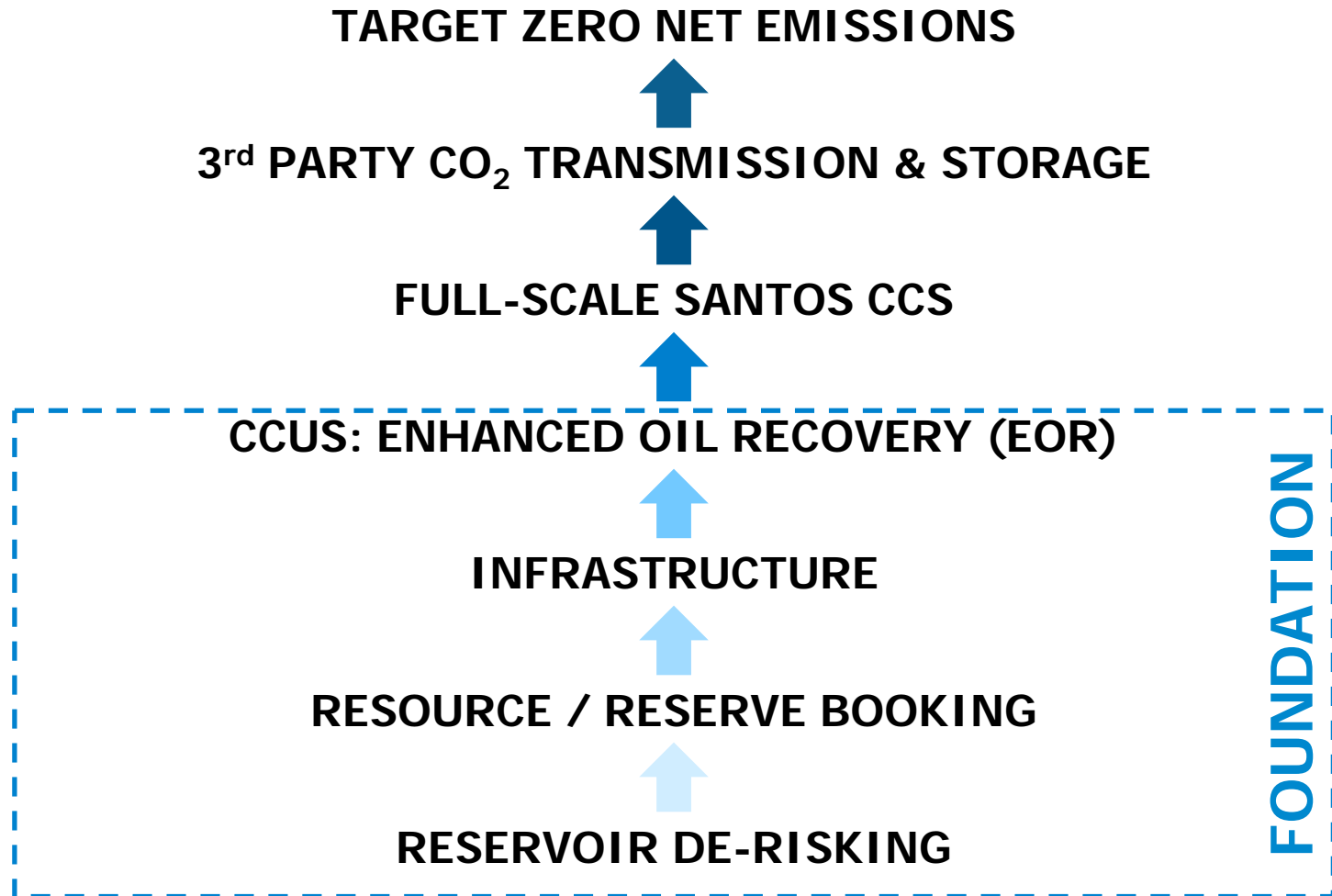
Operating since 1954, one of Australia's leading natural gas exploration and production companies

- + Five core long-life natural gas assets
  - + LNG: PNG LNG, GLNG and Darwin LNG
  - + Domestic gas and liquids: Cooper Basin and Western Australia
  - + Narrabri Gas Project under independent development approval process
- + 2019 production guidance of 71-78 mmbbl
- + Australia's lowest cost onshore producer
  - + All assets free cash flow positive at <US\$40/bbl
- + Over 2,000 employees



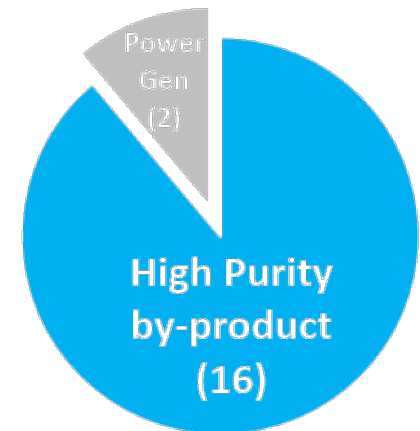
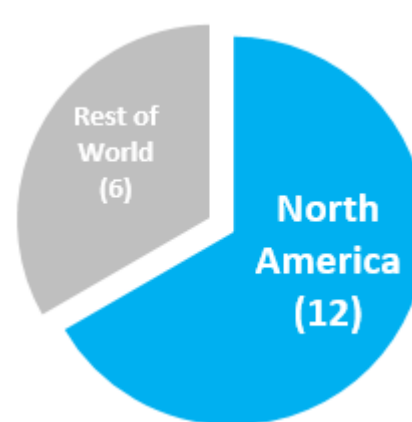
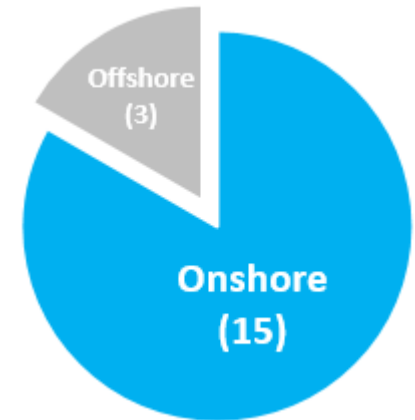
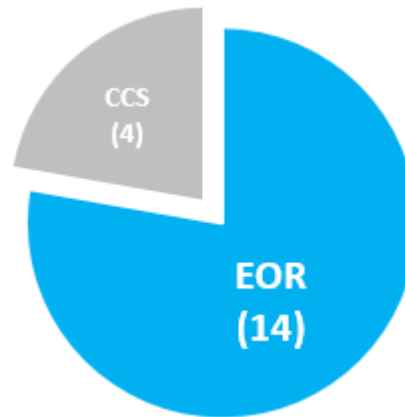
Five core long-life natural gas assets

Large scale CCS of Santos & 3<sup>rd</sup> Party CO<sub>2</sub> provides a pathway to a zero emissions future



## Global CCS Projects

- + 18 large-scale (>0.4 Mtpa) Carbon Capture projects presently in operation worldwide
  - Majority use CO<sub>2</sub> for EOR
  - Primary market is North America
  - Predominantly onshore, utilising CO<sub>2</sub> from high purity by-product
  - Capture capacity ranges from 0.5 – 8.4 Mtpa (Santos Moomba Gas Plant ~ 2.3 Mtpa)



Santos' Cooper/Eromanga Basin asset is well positioned to develop CCS with EOR (CCUS)



## Global CCS Projects (particularly USA):

- ✓ Onshore Operations
- ✓ EOR Focus
- ✓ Oil field practices well accepted by community & regulator
- ✓ Tax/Royalty Fiscal Regime
- ✓ Natural & Industrial CO<sub>2</sub> Sources
- ✓ Established and extensive CO<sub>2</sub> capture & transmission infrastructure
- ✓ Suitable reservoirs

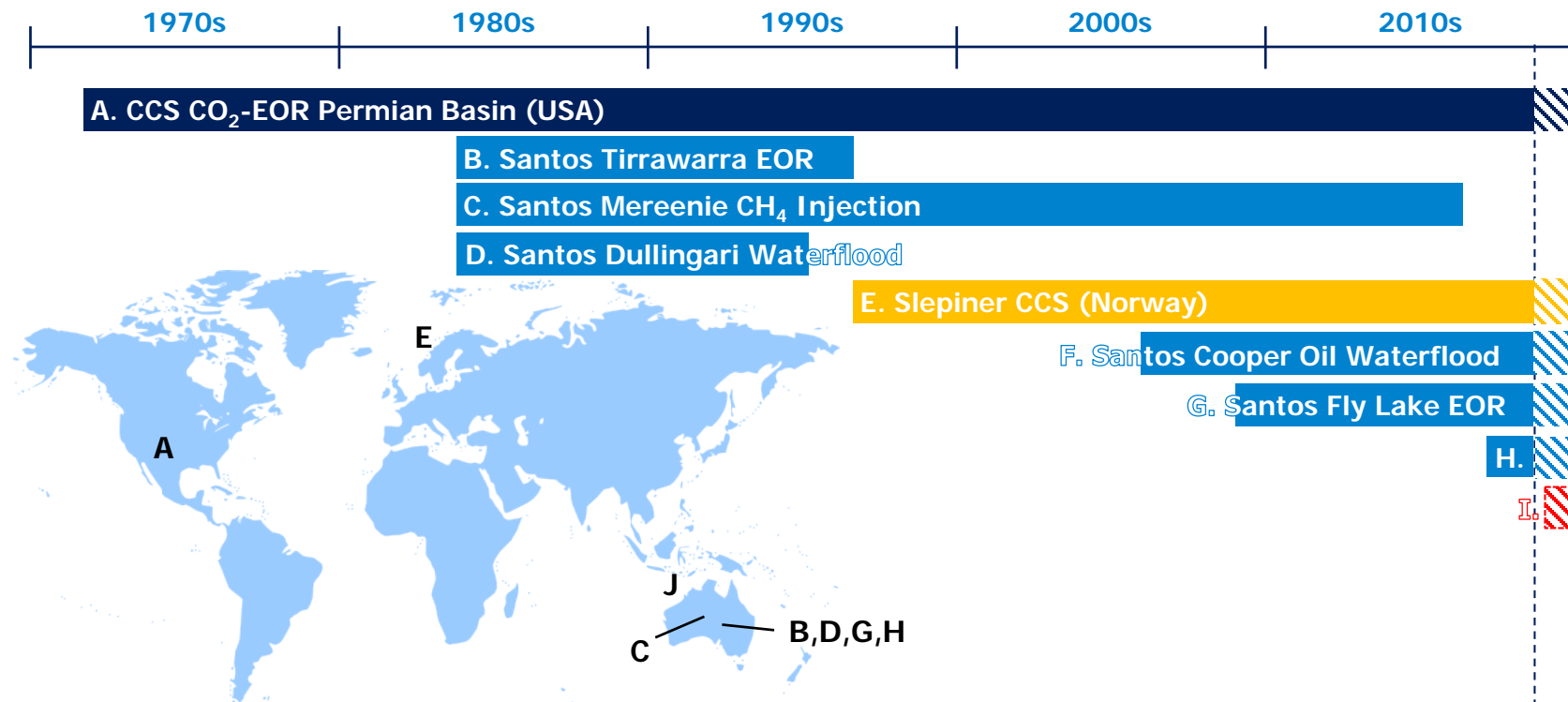


## Santos Cooper/Eromanga Basin Operations:

- ✓ Onshore Operations
- ✓ Mature Oil Fields (EOR target)
- ✓ Oil field practices well accepted by community & regulator
- ✓ Tax/Royalty Fiscal Regime
- ✓ Industrial CO<sub>2</sub> source – Moomba Gas Plant
- Existing CO<sub>2</sub> separation facilities at Moomba Gas Plant. Requirement to establish capture & transmission infrastructure
- Assessing suitable reservoirs

# Carbon Capture, Utilisation and Storage History

Santos EOR History in relation to Australian and global milestones



- A. World first use of CCS for CO<sub>2</sub> miscible flood in SACROC formation, Permian Basin USA, 1972.
- B. Santos first volatile oil EOR project – ethane injection for recovery of condensate, ~ 7 MMstb incremental production.
- C. Santos use of methane injection for pressure support in Mereenie oil field, ~2.3 MMstb cumulative production.
- D. Santos implementation of waterflood in the Dullingari field for secondary recovery. ~3.5 MMstb incremental production.
- E. World first CCS for geological storage – implemented in Sleipner gas field, North Sea – driven by Norwegian tax on CO<sub>2</sub> emissions. Also world’s first offshore CCS.
- F. Santos further implementation of waterflood in the Eromanga Basin for secondary recovery – Mulberry, Endeavour, Talgeberry, Gimboola, Cranstoun, Merrimelia, Charo. ~3.5 MMstb incremental production.
- G. Santos Fly Lake EOR – methane injection for recovery of volatile oils, ~0.9 MMstb incremental production. Recent operation limited by gas availability.
- H. Formation of Santos Energy Solutions Team, renewed focus on CCUS EOR opportunity.
- I. **Target – 2019 Santos CO<sub>2</sub> injection pilot (Single Well Injection Test)**

# Key Learnings From The US

CO<sub>2</sub> EOR is a long established and scalable base oil-field business driven by economics and reservoir characteristics rather than new technologies

CORE ENERGY, LLC



## LEARNINGS

- + CO<sub>2</sub> business is normal oil-field practice ✓
- + Significant STO advantage with both CO<sub>2</sub> source & targets ✓
- + CO<sub>2</sub> EOR can be phased, scaled & replicated development (Core Energy) ✓
- + Key metric US\$2/Mcf CO<sub>2</sub> delivered at pressure to field ✓
- + Compression requirements (major CAPEX/OPEX driver)
- + Key to appraisal activities is asking right questions – injection test to assess residual saturation, core flooding to estimate recovery
- + Greatest uncertainty for STO is suitability of reservoirs – project driven by subsurface workflow **PRIMARY FOCUS**

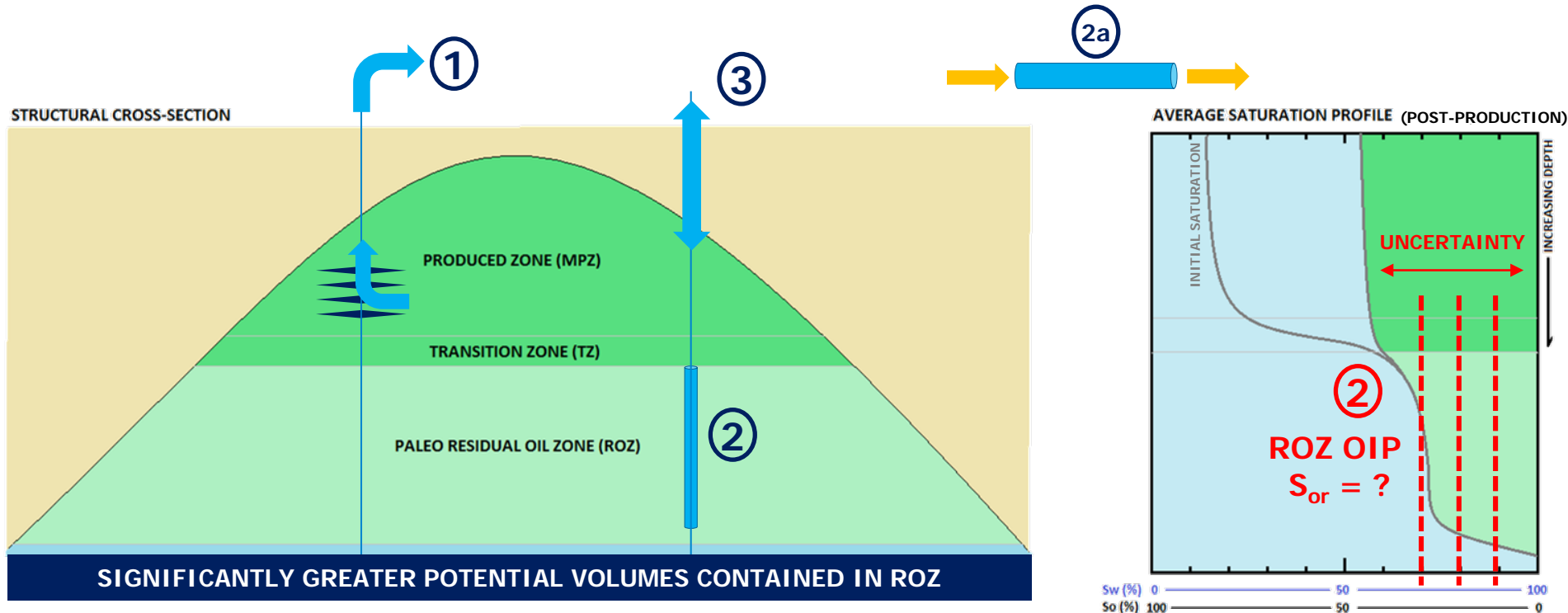
## ENGAGEMENT

- + Operators, service providers and consultants engaged for input to appraisal activities, pilot scoping, concept select/design & reserves justification
- + Maintaining dialogue with peers for feedback on technical deliverables and appraisal well objectives



# Subsurface overview – key uncertainties

US informed subsurface (uncertainty) workflow and appraisal plan



**SIGNIFICANTLY GREATER POTENTIAL VOLUMES CONTAINED IN ROZ**

1. **Fluid sampling & Analysis** Main Pay Zone (MPZ) – Existing well, assess miscibility of CO<sub>2</sub> and oil, (i.e. determine whether CO<sub>2</sub> flooding is technically feasible)
2. **Drill & core appraisal well(s)** in Residual Oil Zone (ROZ) – Assess residual saturations ( $S_{or}$ ) and define oil volume in place (i.e. establish the size of the prize)
  - 2a. **Core Flooding** – Assess fraction of recoverable oil and CO<sub>2</sub> utilisation efficiency (i.e. define recoverable volumes)
3. **Single Well Injection Tests (SWIT)** – Assess in situ application of miscibility and demonstrate mobility of previously immobile oil (i.e. confirm miscibility & recovery at reservoir conditions)

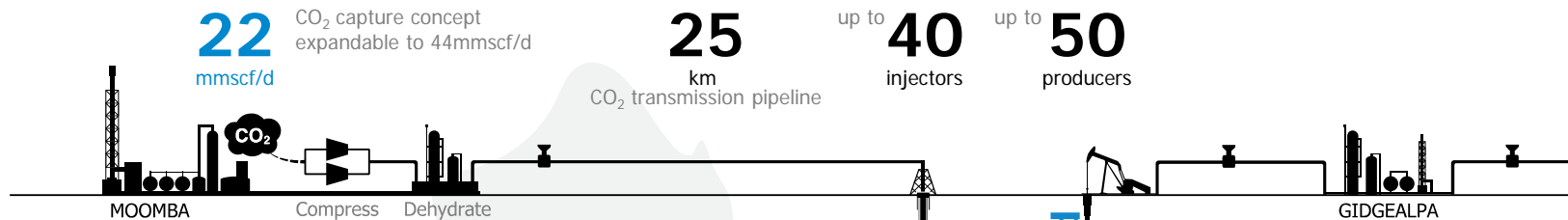
MAY 2018

1H 2019

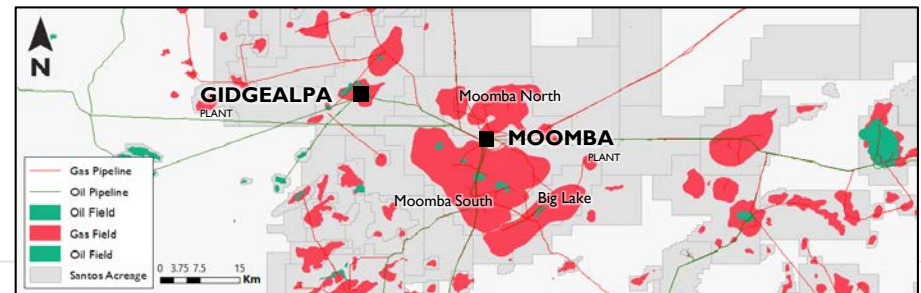
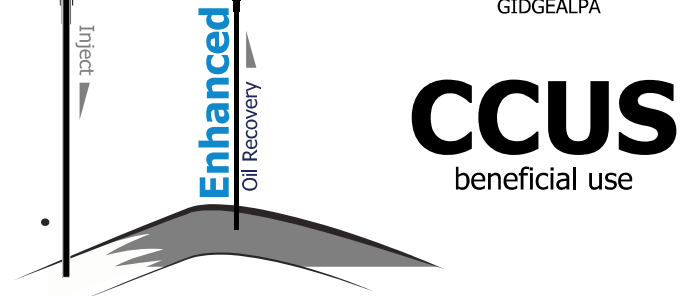
Q4 2019



# Cooper Carbon Capture Utilisation Storage Project



- 1 2018 Concept defined - appraisal sanctioned
- 2 2019 1H Appraisal drilling - facilities FEED entry
- 3 2019 2H Single well injection test
- 4 2020 Feasibility assessment and FID
- 5 2022 Target CO<sub>2</sub> injection
- 6 2023 Target incremental CO<sub>2</sub> EOR production
- 7 FUTURE Permanent CO<sub>2</sub> storage



\* Timeline shown is indicative and subject to achievement of milestones and Santos and joint venture approvals.

# Cooper Basin CCUS Opportunity Summary

Carbon capture, utilisation & storage (CCUS) can convert an emissions liability into a revenue stream



Leverage mature asset base in the Cooper Basin to grow production & reserves

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Draw on experience & success in the US

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CO<sub>2</sub> available from Moomba Gas Plant at globally competitive cost

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Opportunity for substantial long-term infrastructure investment

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Successful implementation could lead to transport and utilisation of 3<sup>rd</sup> Party CO<sub>2</sub>