South Australian petroleum prospectivity summary

NAPE 2021

South Australian Petroleum Review (May-2021)

INTRODUCTION
The Energy Resources Division in the South Australian Department for Energy and Mining is the lead agency for petroleum, geothermal and carbon capture and storage activities in the state. It has responsibility for the generation of royalty income, economic development, wealth and jobs, public safety and the minimisation of impacts on the environment through efficient management of the state’s petroleum and geothermal rights on behalf of the people of South Australia.

PETROLEUM EXPLORATION & PRODUCTION ACTIVITY

Onshore Petroleum Licensing

Petroleum Exploration Licences: Forty-two petroleum exploration licences (PELs) are current over the State’s onshore petroleum prospective areas. Nearly all of the petroleum prospective regions of the State are now under licence or application with the total area of granted PELs covering 190,856 km² and a further 434,175 km² of the State under application (Figure 1).

Overlapping applications can be made over current PEL Applications (PELAS) at any time but the first PELA has priority for determination followed by successive applications.

Information about how to apply, the licence register and maps showing current licences and applications can be accessed here: https://www.petroleum.sa.gov.au/licensing-and-land-access/onshore-licensing

Acresage Releases: Competitive acreage releases have been used successfully by the Department to manage highly prospective Cooper Basin acreage since 1998. The expiry of long term exploration licenses (PELs 5 and 6) enabled the most significant structured release of onshore Australian acreage in the industry’s history, and has generated (in today’s terms):
- 44 PELs and 5 PELAs and resultant PPLs and PRLs from 89,100 km² of acreage;
- $834 million in guaranteed work;
- 298 conventional exploration wells – 40% of which achieved commercial success;
- 142 new field discoveries;
- royalties of $567.1 million from sales of $8.7 billion to 30 June 2020; and
- increased gas supply-side competition.


Most Cooper Basin applicants (blocks C02019-A to E) will have to conclude native title land access agreements ahead of licence grant – either via the ILUA process or the right to negotiate process (Figure 2). PEL 680 has been granted to Beach Energy and Cooper Energy in the Otway Basin (formerly OT2019-8 block).

Petroleum Retention Licences: An initiative in 2013 to increase the extent of retention and production licences has been very successful resulting in a massive increase from 7,645 km² in 2013, up to the current 171,107 km² in April 2021. There are currently 210 petroleum retention licences, with almost all of these located over proven productive oil and gas play trends in the Cooper/Eromanga Basins (Figure 2). Petroleum retention licence agreements for proven oil and gas play trends in the Cooper/Eromanga Basins have to date been concluded with Senex Energy, Beach Energy, Drillsearch Energy (now a Beach Energy subsidiary), Santos Limited and Armour Energy (and joint venture partners with those companies).

Since the first of the PRL initiative licences were granted in May 2014 to end April 2021, 45 exploration wells have been drilled resulting in 19 new field discoveries. A further 33 appraisal wells have been drilled (19 successful) and 9 development wells (8 successful).

Hydrogen: on 11 February 2021 the Petroleum and Geothermal Energy Regulations 2013 were amended to declare hydrogen, hydrogen compounds and by-products from hydrogen production regulated substances under the Petroleum and Geothermal Energy Act 2000. Companies are now able to apply to explore for hydrogen via a PEL and the transmission of hydrogen or compounds of hydrogen are now permissible under the transmission pipeline licencing provisions of the PGE Act.

Potential exists for native hydrogen plays in South Australia – possible source rocks occur in iron-rich cratons (hydrogen generated by oxidation of Fe(II) by water) and uranium-rich basement (hydrogen generated via radiolysis of water), both of which occur on the Gawler Craton.

In September 2019, South Australia’s Hydrogen Action Plan was launched with an initial focus on ‘green’ hydrogen from renewable energy sources. Santos are progressing clean hydrogen and by 2030 aim to use Carbon Capture and Storage (CCS) technology to improve the economic feasibility of clean hydrogen while reducing Cooper Basin emissions.

SA offers a Free Hydrogen Export Prospectus and Online Modelling Tool

Figure 1: South Australian Petroleum Tenements

Figure 2: Petroleum exploration licences

Native Title/Land Access

Right to Negotiate: To date, the relevant registered native title claimants/holders, petroleum explorers and the State Government have concluded 55 land access agreements in relation to a total of 51 licence areas:

- 7 in the Arckaringa Basin;
- 37 in the Cooper Basin;
- 4 in the Eromanga Basin;
- 1 in the Officer Basin; and
- 2 in the Arrowie Basin.

All of these South Australian agreements cover the full cycle of petroleum activities including exploration, development and production. An additional twelve PEL applications are currently progressing through the Right to Negotiate process, pursuant to the Native Title Act 1993 or will alternatively enter into an existing Indigenous Land Use Agreement.

Conjunctive Indigenous Land Use Agreements (ILUAs)

The following conjunctive ILUAs are in place over much of the Cooper Basin:

- In February 2007, the Yandruwandha/Yawarrawarrika people entered into the first petroleum ILUA in the South Australian Cooper Basin over approximately 40,000 km². This agreement also represented the first conjunctive petroleum ILUA with the Wangkangurru/Yarluyandi people and was registered with the National Native Title Tribunal.

A meeting was held with representatives of the Dieri native title holders in February 2020 to initiate discussion on the development of a similar conjunctive ILUA.

To date, industry has signed on to at least nineteen ILUAs with the Yandruwandha/Yawarrawarrika and Wangkangurru/Yarluyandi people, of which 12 related to the granting of PELs in the Cooper/Eromanga Basins.

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- On 2 February 2012, a second conjunctive petroleum ILUA with the Wangkangurru/Yarluyandi people was registered with the National Native Title Tribunal.

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To date, industry has signed on to at least nineteen ILUAs with the Yandruwandha/Yawarrawarrika and Wangkangurru/Yarluyandi people, of which 12 related to the granting of PELs in the Cooper/Eromanga Basins.

Cooper/Eromanga Basins Aboriginal Conference: The Cooper Eromanga Basins Aboriginal Conference (CEBAC), supported by the South Australian government, was most recently held in October 2019 and continues to bring together representatives from the Dieri, Yandruwandha/Yawarrawarrika and Wangkangurru/Yarluyandi people together with executives of oil & gas industry participants within the basins, as well as government officials in order to foster ongoing relationship building and increased Aboriginal participation in the oil and gas sector workforce.

Over the 2018-19 period, key focus areas of the program have included developing strategies to encourage Aboriginal people to undertake pre-employment training, as well as the success in assisting to secure ten employment placements for Aboriginal people in the oil and gas industry. Participating employers include Santos Limited, Compass Group (who provide camp and facilities services in Moomba), OZ Minerals, Schlumberger and Global Engineering. The CEBAC program has been largely dormant during the COVID pandemic, however a return to normal activity is expected later in 2021.

GISERA

To foster a constructive dialogue in the State’s South East, in 2017 the South Australian Government partnered with CSIRO’s Gas Industry Social and Environmental Research Alliance (GISERA) for a three-year in-depth study. GISERA have engage local stakeholders as well as industry and regulators to research social and environmental issues related to natural gas operations. The initial tranche of six projects have been completed and four research projects are ongoing and will conclude in 2021-22 (https://gisera.csiro.au/states/sa/).

Drilling & Seismic Surveys

Cooper Basin: In 2020, a total of 128 wells were drilled including side tracks, 95 (6 exploration, 25 appraisal, 64 development) have been cased for production (Figures 2, 3 and 4).

Santos drilled 65 of the SA Cooper Basin wells, Beach Energy drilled 43. Success rates are shown in Figure 3 and Table 1.

As at 30 April 2021, 5 appraisal and 12 development wells have been drilled in the Cooper-Eromanga basins.

Otway Basin: One petroleum development well was drilled in the SA Otway Basin in 2020 (Haselgrove 4 side track).

Vintage Energy (JV partner of Otway Energy in PEL 153) reported strong CO2 flow rates during production testing of

Table 1. Cooper and Eromanga basins conventional oil & gas success rates, January 2002 to 23 April 2020

<table>
<thead>
<tr>
<th>New Entrants</th>
<th>Santos Joint Venture</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration wells drilled</td>
<td>300</td>
<td>55</td>
</tr>
<tr>
<td>Commercial success rate (%)</td>
<td>40</td>
<td>52.7</td>
</tr>
<tr>
<td>Technical success rate (%)</td>
<td>44</td>
<td>54.5</td>
</tr>
<tr>
<td>Appraisal &amp; development wells drilled</td>
<td>302</td>
<td>722</td>
</tr>
<tr>
<td>Commercial success rate in appraisal &amp; development wells (%)</td>
<td>88</td>
<td>95</td>
</tr>
</tbody>
</table>

Table 3. Cooper and Eromanga basins oil & gas success rates, January 2002 to 23 April 2020

<table>
<thead>
<tr>
<th>Exploration wells drilled</th>
<th>Santos Joint Venture</th>
<th>All</th>
</tr>
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<tbody>
<tr>
<td>Commercial success rate (%)</td>
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<td>95</td>
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Figure 2: Map showing Cooper Basin tenements, drilling and seismic acquisition in 2019-20.

Figure 3: Oil exploration success rates for the SA Cooper region, 1982 to 2020.
Cumulative petroleum production is shown in Table 2 and Figures 5–9 show sales and production trends. Detailed production data (to well and individual pool level) can be accessed via the PEPS South Australia online database: https://peps.sa.gov.au/home

Petroleum royalty payments to the State for the 2019/20 financial year were $120.3m, with estimated total production sales of $1.53b. This brings the cumulative royalty paid since 1970 to $3.37b (2019/20 dollars) and cumulative sales to an estimated $54.98b (2019/20 dollars). Since 1991 the average royalty paid equals a globally competitive 6.79% of the sales value.

Table 2: South Australian Cooper Basin production statistics

<table>
<thead>
<tr>
<th></th>
<th>2019/20</th>
<th>2018/19</th>
<th>2017/18</th>
<th>2016/17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude oil sales</td>
<td>427.6m</td>
<td>390.5m</td>
<td>386.8m</td>
<td>383.2m</td>
</tr>
<tr>
<td>Royalties (201 – $m)</td>
<td>9.2m</td>
<td>9.2m</td>
<td>9.2m</td>
<td>9.2m</td>
</tr>
<tr>
<td>Condensate sales (t)</td>
<td>1.05m</td>
<td>0.74m</td>
<td>0.7m</td>
<td>0.6m</td>
</tr>
<tr>
<td>Royalties (201 – $m)</td>
<td>0.9m</td>
<td>0.9m</td>
<td>0.9m</td>
<td>0.9m</td>
</tr>
<tr>
<td>LPG sales (10³kL)</td>
<td>20.0m</td>
<td>13.0m</td>
<td>12.9m</td>
<td>12.8m</td>
</tr>
<tr>
<td>Royalties (201 – $m)</td>
<td>0.9m</td>
<td>0.9m</td>
<td>0.9m</td>
<td>0.9m</td>
</tr>
</tbody>
</table>

The Joint Venture are aiming to produce food grade CO2 which is used for refrigeration/dry ice (vaccine storage), carbonation of soft drinks and beer, firefighting equipment, medical devices and winemaking. CO2 was previously sourced from the Caroline 1 well operated by Air Liquide in the SA Otway Basin, which was on production between 1969 and 2017.

Leigh Creek Energy’s Underground Coal Gasification Project: In 2018, the South Australian Government approved Leigh Creek Energy to construct and operate a small scale, pre-commercial demonstration plant to test the commercial feasibility of underground coal gasification at Leigh Creek. Leigh Creek Energy commissioned the demonstration plant in October 2018, and decommissioned the plant in April 2019. LCK have indicated that they intend to continue exploration activities to identify and delineate potential structures, the depth of the coal seams, formation permeability and stress orientations.

Tri-star ENERGY’s Arckaringa basin exploration: Tri-Star Energy’s Statement of Environmental Objectives (SEO) for fracture stimulation in their Arckaringa Basin PEL 122 and 123 licences was approved and gazetted on 4 April 2019 following a public consultation process. Tri-Star are currently in the process of reviewing the SEO for drilling in the Arckaringa Basin, and will not commence operations until it receives the final stage of government approvals.

Seismic acquisition: no seismic was acquired in South Australia during 2020. Up to three 3D seismic surveys are expected to be acquired during 2021.

<table>
<thead>
<tr>
<th>Wells</th>
<th>Cooper Basin</th>
<th>Otway Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum exploration and appraisal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petroleum development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource gas pay</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 4: Exploration, development and appraisal drilling metrics, 2012 to 2020.

Figure 5: Petroleum sales and royalty payments, 2010-11 to 2019-20.

Figure 6: Gas sales, 2010-11 to 2019-20.

Figure 7: Crude oil sales, 2010-11 to 2019-20.

Figure 8: Condensate sales, 2010-11 to 2019-20.

Figure 9: LPG sales, 2010-11 to 2019-20.

Nangwurry 1 production test courtesy of Vintage Energy.
PACE Gas grants are supporting a strong and diverse portfolio of projects in the Cooper and Otway basins (Figure 10) that are expected to result in more than $223 million of industry co-investment. The nine grants approved under the $223 million of industry co-investment. That is expected to result in more than 5,000 tera-joules (TJ) of natural gas produced for South Australian customers from February 2018 to December 2020. Production from PACE Gas supported projects include more than 5,000 tera-joules (TJ) of natural gas produced for South Australian customers from February 2018 to December 2020.

From PACE Gas supported projects include more than 5,000 tera-joules (TJ) of natural gas produced for South Australian customers from February 2018 to December 2020. Production from PACE Gas has averaged 10 TJ/day from the Cooper Basin and 10 TJ/day from the Otway Basin. Highlights include:

- Beach Energy’s Haselgrove 3 and Dombey 1 Otway Basin gas discoveries. Successful follow-up drilling at Haselgrove 4 and funding from the Commonwealth’s Gas Acceleration Program (GAP) enabled Beach to construct a new gas plant at Katnook and this is now supplying gas to local markets in the South-East.
- Senex Energy-operated Vanessa East Under-balanced drilling projects, are both supplying gas to the Pelican Point Power Station.
- Santos-operated Cooper Basin re-fracture stimulation and underbalanced drilling projects, are both supplying gas.
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For more information go to: https://www.petroleum.sa.gov.au/industry-activity/pace-gas-grants

**Gas Incentivisation**

**PACE Gas projects**

- Round 1
  - 1 - Senex Energy Ltd
  - 2 - Santos Ltd
  - 3 - Santos Ltd
  - 4 - Strike Energy Ltd
  - 5 - Beach Energy Ltd
- Round 2
  - 6 - Santos Ltd
  - 7 - Senex Energy Ltd
  - 8 - Beach Energy Ltd
  - 9 - Vintage Energy Pty Ltd

**Commonwealth GAP Grant**

Beach Energy Ltd

**Figure 10:** Location of PACE Gas grant projects.

**Gas Incentivisation**

**PACE Gas grants**

PACE Gas grants are supporting a strong and diverse portfolio of projects in the Cooper and Otway basins (Figure 10) that are expected to result in more than $223 million of industry co-investment. The nine grants approved under the program target upside potential to unlock more than 1,950 petajoules (PJ) of gas and all but two projects (pending results of flow testing) have now delivered gas to SA markets.

Round one aimed to deliver additional gas to markets from the end of 2019, and round two by the end 2020. PACE Gas is aimed to bring forward industry investment that would increase the supply of locally produced and competitively priced gas to South Australian markets. PACE Gas funded discoveries and additional production will generate royalties and deliver gas from fields located nearer to markets than from interstate.

The Department for Energy and Mining continues to monitor progress and success of the existing nine PACE-funded projects. Production results from PACE Gas supported projects include more than 5,000 tera-joules (TJ) of natural gas produced for South Australian customers from February 2018 to December 2020.

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**Roundtable for Oil & Gas Projects**

The Roundtable for Oil & Gas Projects in South Australia was formed in 2010 and its members come from industry, governments, peak representative organisations for industry, environment and round two by the end 2020.

The Roundtable for Oil & Gas Projects in South Australia was formed in 2010, and its members come from industry, governments, peak representative organisations for industry, environment protection organisations, aboriginal people, research institutions and individuals. The aim of the Roundtable is to provide a forum for members to help inform the South Australian Government on the key priorities that will underpin the Roadmap of Onshore and Offshore Oil & Gas Projects.

The last meeting was held on 11 November 2019 but the 2020 meeting proposes that the title of the PGE Act be changed to the Energy Resources Act.

Other key improvements include:

- Enhancing stakeholder consultation requirements for statement of environmental objectives;
- Enhancing the rehabilitation and decommissioning security provisions of the Act;
- Introducing Ministerial determinations, to provide more explicit guidance and tailored legislative requirements outside the regulations;
- Adding greater flexibility over licences such as the size of the licence area and strata titling; and
- Aligning the penalties under the PGE Act with comparative regulations within the state and other jurisdictions.

These proposed amendments will maintain the PGE Act as a modern, efficient an effective regulatory framework for the upstream energy industry delivering outcomes that meet both community and investor expectations.

An Issues Paper is publicly available. A presentation on the Issues Paper is also available.

It is suggested that the Issues Paper be read in conjunction with the current Petroleum and Geothermal Energy Act 2000 and Petroleum and Geothermal Energy Regulations 2013. Public submissions on the Issues Paper are now closed.

**Regulatory Compliance**

The Petroleum and Geothermal Energy Act is designed as an effective, efficient
and flexible regulatory system for all exploration and production activities for petroleum, gas storage and geothermal resources onshore in South Australia, as well as the construction, operation and technical regulation of high-pressure transmission pipelines.

Key objects of the Act include:

- protecting the public and the environment from risks inherent in activities regulated under the Act;
- establishing appropriate consultative processes, both with people directly affected by activities regulated under the Act, and the general public; and
- ensuring appropriate levels of security of natural gas supply.


NEW WEBSITE

DEM-ERD launched a new website in December 2020, readers are asked to update their web favourites with the new address: https://www.petroleum.sa.gov.au/

NEW VIRTUAL SA CORE LIBRARY

In April 2021, DEM-ERD launched a new module of the PEPS South Australia online database detailing 2,400 cored intervals from petroleum and geothermal drillholes and containing 13,000 core photographs (~32 GB in total).

Users are able to preview, interact with and download individual core photos.

In addition, as well as individual photo downloads, users can download all core photos for the selected well in a zip file.

The online database can be found here https://peps.sa.gov.au/home

Figure 11: Screen capture of the new PEPS Core Photo database
State of Play in SA

Department for Energy and Mining
South Australia

Elinor Alexander
Director Geoscience and Exploration Branch
Energy Resources Division

July 2021
SA’s diverse rock record

Australian Shield (Archaean-Mesoproterozoic)

Tasman Fold Belt (late Neoproterozoic-Mesozoic)

Southern Margin

Prospective basins

OZ SEEBASE® Image (Geognostics, 2021)

Pliocene-Quat
Olig-Mioc
Coniacian-Eocene
Aptian-Turonian
Neocomian
L Jurassic
L Permian-M Jurassic
L Carb- E. Permian
Carboniferous
L Dev- E Carb
E-M Devonian
Silurian
Cambro-Ord
Neproterozoic
Mesoproterozoic
Palaeoproterozoic
Archaean

Modified from Sorkhabi, R. (2009). Earth, 54(12)
SA offers:

- Acreage positions up to 10,000 km².
- Easy access to well and seismic data.
- Blue sky opportunities in frontier basins with *bona fide* oil and gas shows (red and green on map).
- Neoproterozoic-Cretaceous plays.
- Gas storage and CCS licensing regime in place.
- Hydrogen exploration & pipeline transmission now under the *PAGE Act 2000* and *Regulations*.
Licences

PEL applications:
• Fee $4,755.
• 5 year work program.
• Evidence of technical & financial capacity.

Competitive tender regions:
• Cooper & Otway basins.
• Vacant acreage only available via releases.
• Work program bidding.
• No acreage releases planned this year.

Over-the-counter applications:
• Everywhere else.
• Applications can be lodged at any time.
• ‘Top filing’ option exists over PELAs (pink areas).
Gas storage and CCS Licences

• Leading practice regulation in place for CCS and gas storage.

• SA offers:
  o Gas Storage Exploration licences (up to 2,500km²),
  o Gas Storage Retention Licenses (up to 1,000km²),
  o Gas Storage Licences (up to 1,000km²).

• An operator can fulfil their Gas Storage work program by activity in their overlying PEL, PRL or PPL (if GS licence is not stand alone).

• Depleted oil and gas fields in the Cooper and Otway basins have potential as storage reservoirs suitable for CCS.

• The proposed Santos Ltd JV CCS project at Moomba, SA Cooper Basin aims to store 1.7 million tonnes/y of CO₂ in depleted gas fields.
Cooper Basin

- CO2019 blocks all under application.
- Farm-in opportunities.
- No acreage releases planned in 2021.
- Cumulative production: 5.6 TCF sales gas since 1970 and 225 mmbbl oil since 1983 (plus LPG and condensate).

The SA Cooper Basin offers:
- stacked high quality reservoirs,
- high flow rates of sweet light oil, condensate & gas,
- variety of established oil and gas plays & new play concepts.

PACE Gas drilling – SA Govt funded up to $6m, contributed to 3 discoveries:

- Beach/Cooper Haselgrove 3 and Dombey 1 gas.
- Vintage/Otway Nangwarry 1 CO₂ – high flow rates during recent production testing.
- Otway Basin acreage release OT2019-B granted as PELA 680 in February.
- Otway Hydrocarbon Generation Model delivery by end 2021.

Hydrogen exploration in SA

- Exploration for natural hydrogen can now occur via a PEL in SA.
- Natural hydrogen may be generated in iron-rich cratons and uranium-rich basement – e.g. Gawler Craton, Curnamona and Musgrave provinces.
- 50-80% hydrogen measured in 1931 by DME (photo) in gas samples from wells on Kangaroo Island (fractured Kanmantoo Gp metamorphics) and Yorke Peninsula (Early Cambrian limestone).
- Two PELAs lodged by Gold Hydrogen.
SA Department for Energy and Mining

For more information:

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Elinor.alexander@sa.gov.au