



Unconventional Hydrocarbons

A New Regime for Papua New Guinea

July 2016

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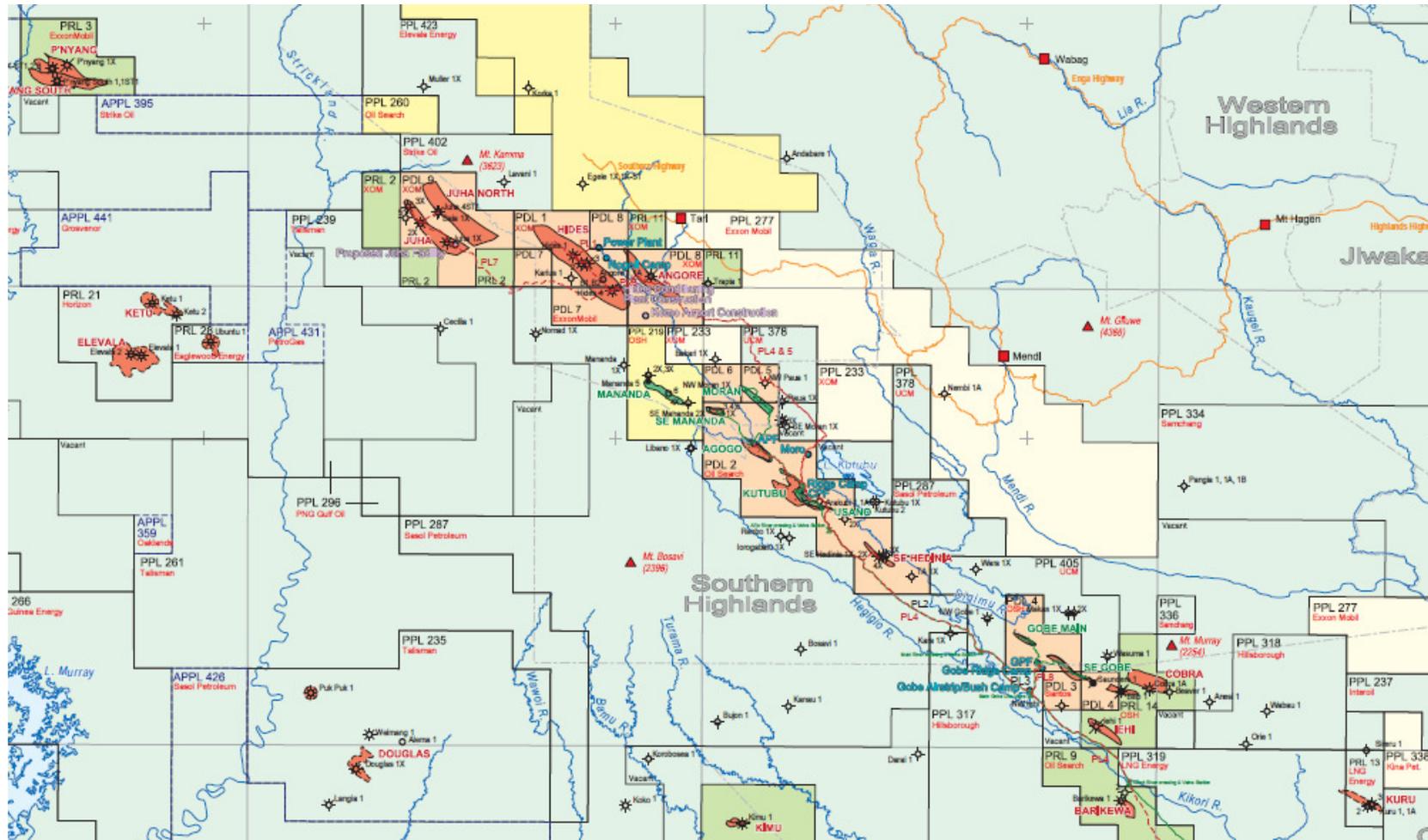
The enticement of shale gas

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- ❑ As conventional oil and gas reserves are diminishing, worldwide, attention is being paid to exploring for unconventional oil and gas resources – principally shale gas and coal seam gas, which are seen as the resource of the future.
- ❑ Shale basins cover very large areas and contain enormous amounts of hydrocarbons.
- ❑ Some 50% of all USA oil and gas production now comes from domestic shale, meaning that the USA is now energy self-sufficient for the first time. It is one of the key reasons for the current world oil and gas glut, and why oil prices have fallen significantly in recent years.
- ❑ It was considered important to investigate whether PNG might have this same potential opportunity

Current PNG landscape – small conventional fields

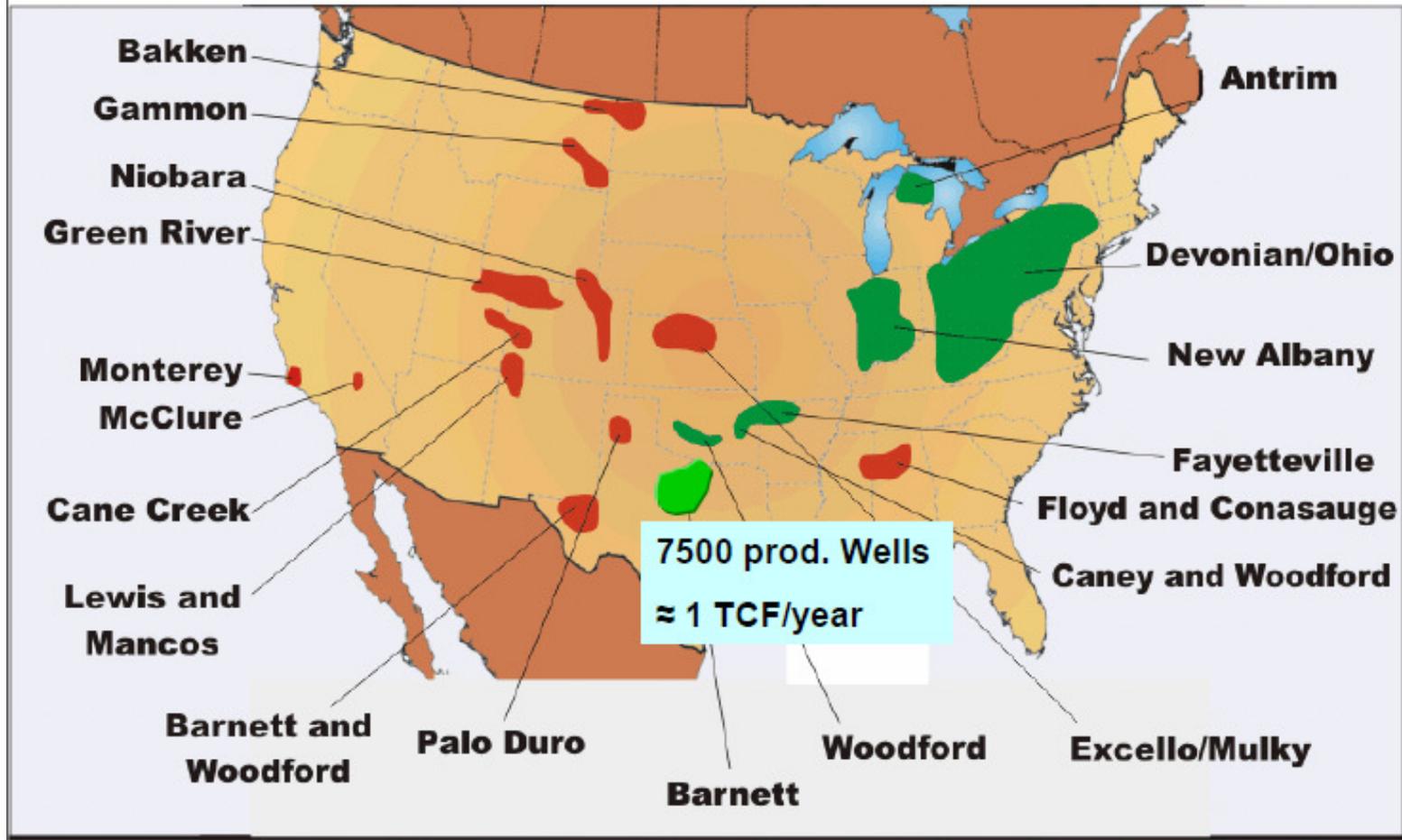
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Current USA landscape – large shale basins

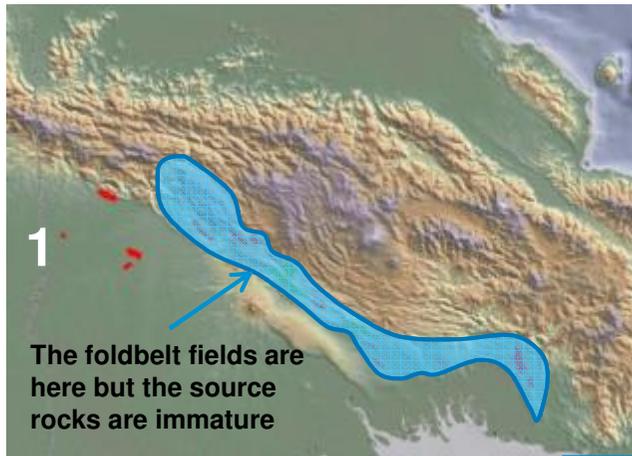
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Gas Shale Basins of the United States

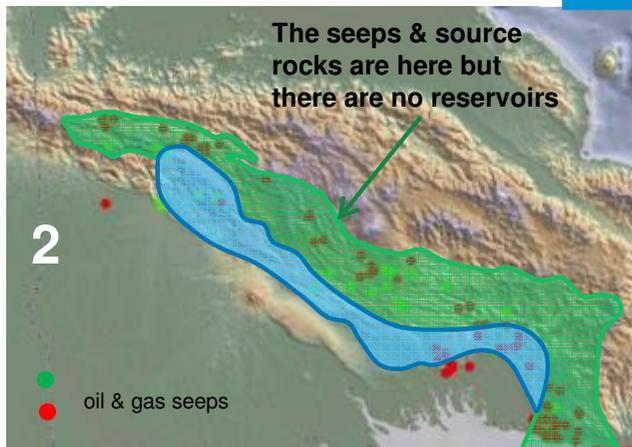


An idea...

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1 + 2 =



- Informal meeting March 2011 concluded that **Source rocks in PNG had never been properly identified**
- “What about **shale gas** in PNG?” but
- Shale gas exploration was not allowed in PNG:
 - “**petroleum**” excludes coal, shale or any substance extracted from coal, shale or other rock (*Oil & Gas Act 1998*)
 - “**minerals**” means all valuable non-living substances excluding petroleum obtained or obtainable from land (*Mining Act 1992*).
- Minister confirmed that shale gas had never been considered a priority in PNG
- **22nd April 2011** CSP delivered its Shale Gas Proposal to former Minister Duma

Background - 2011

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- Former Minister Duma approved the study and made various undertakings if the study was encouraging, including:
 - ▣ **legislative change**; and
 - ▣ **commitments in respect of issuing shale gas licences to CSP**

MINISTER FOR PETROLEUM AND ENERGY

03 May 2011

Indo Pacific Energy Pty Ltd/Coral Sea Petroleum Limited
Level 5
56 Pitt Street
Sydney
NSW, 2000

Dear Mr. Haiveta,

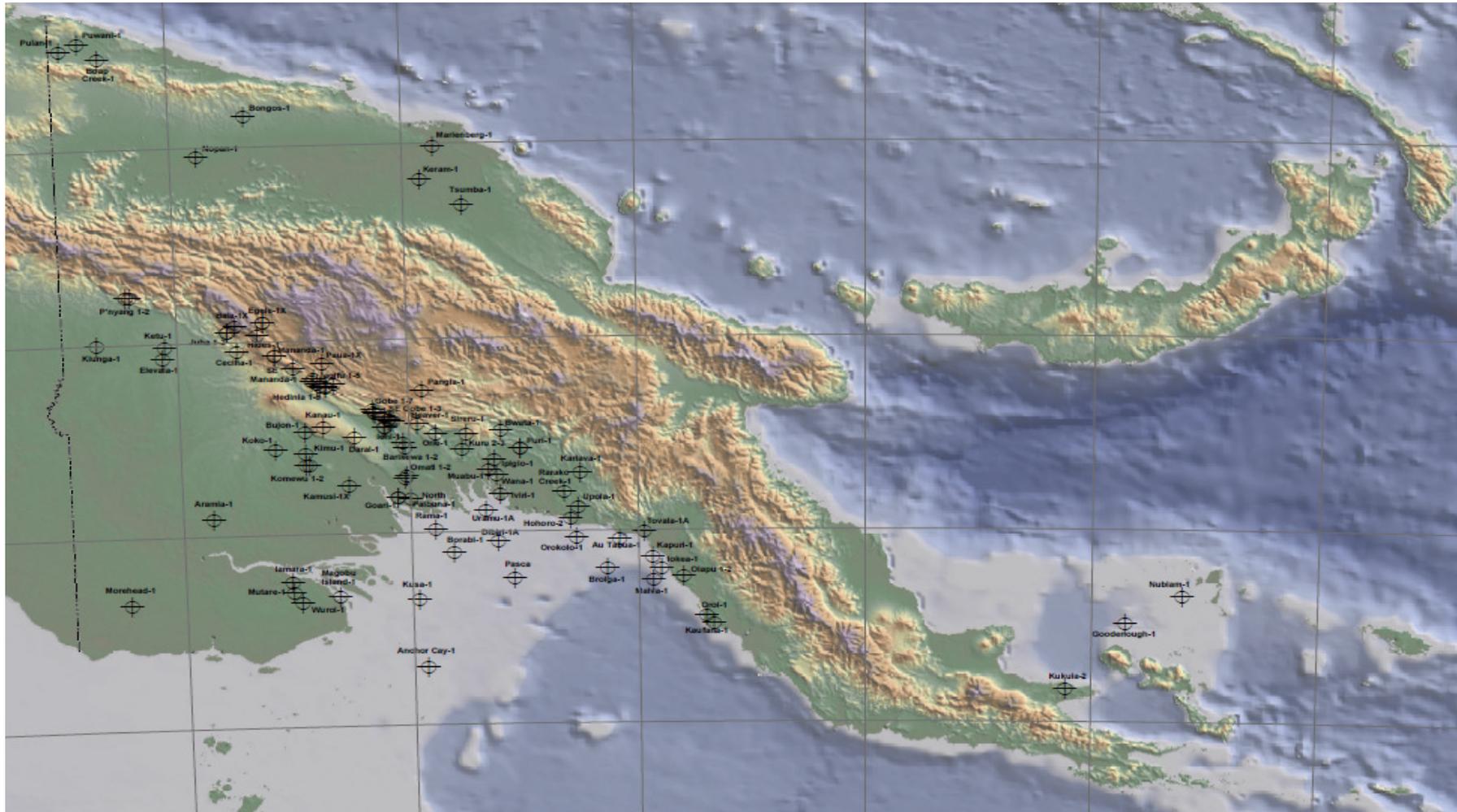
RE: APPROVAL OF PROPOSAL FOR SHALE GAS STUDY IN PNG

Thank you for the Indo Pacific Energy Pty Ltd/Coral Sea Petroleum ('IPE/CSP') proposal dated 22 April 2011 (attached) offering to undertake an Investigation of Shale Gas Potential of Papua New Guinea.

(c) On conclusion of the investigation, provided the results are positive, IPE/CSP will earn the exclusive right to apply for the areas of their choice in which to undertake the first dedicated shale gas exploration activities in PNG.

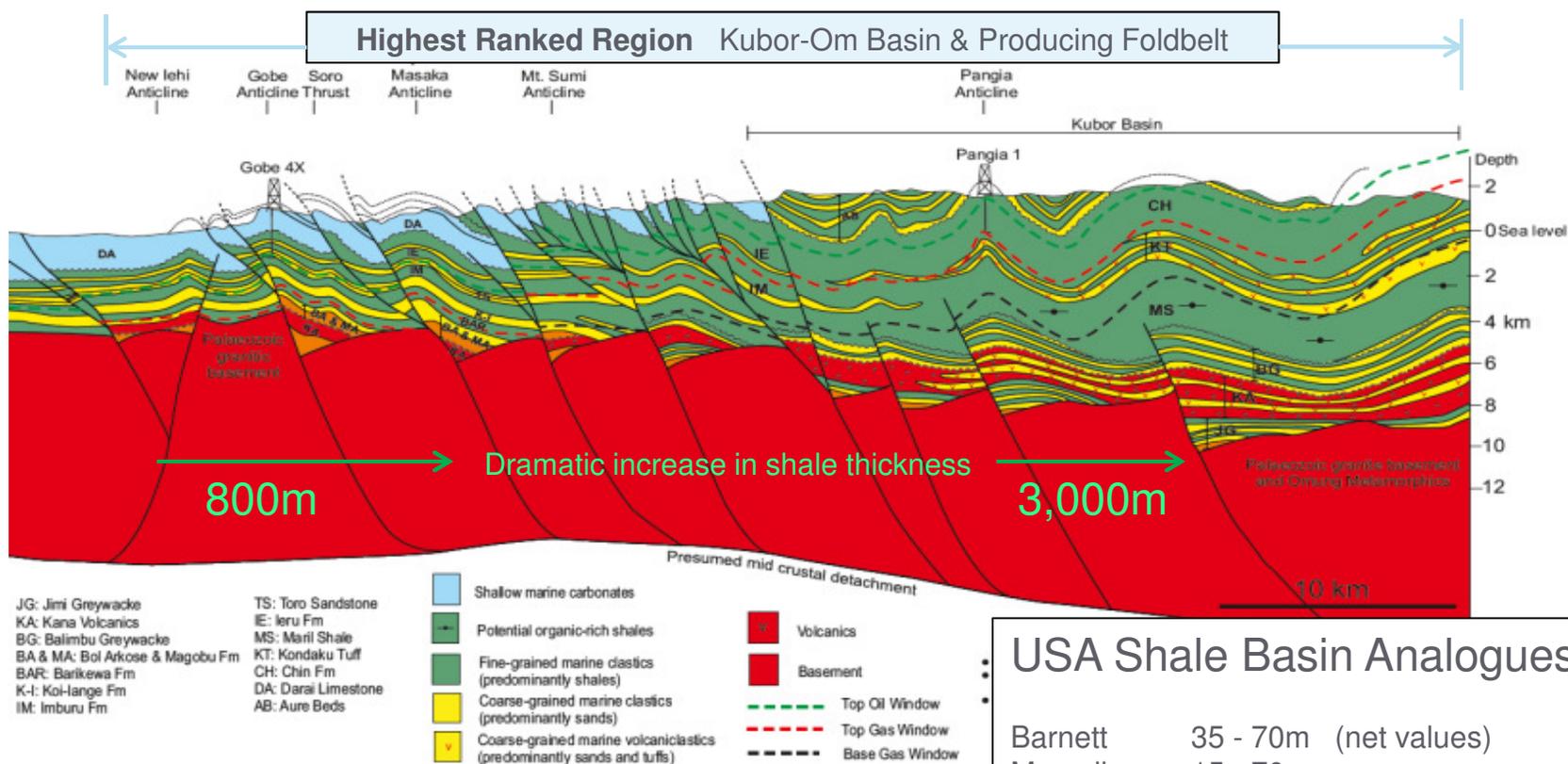
Well data used in the study

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Review results: Significant thickness of shale plays in PNG

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USA Shale Basin Analogues

Barnett	35 - 70m	(net values)
Marcellus	15 - 70m	
Woodford	40 - 75m	
Fayetteville	7 - 70m	
Haynesville	70 - 100m	

In the USA **30m** is commonly used to define the minimum thickness required for exploiting a shale-gas play (Arthur et al., 2008)

Shale depths and qualities were determined by reviewing data available from all exploration wells drilled, plus PNG seismic and outcrop data

Review Results: Shale Area Resource Summary

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Global analogue benchmark for Tcf Technically Recoverable Shale Resources

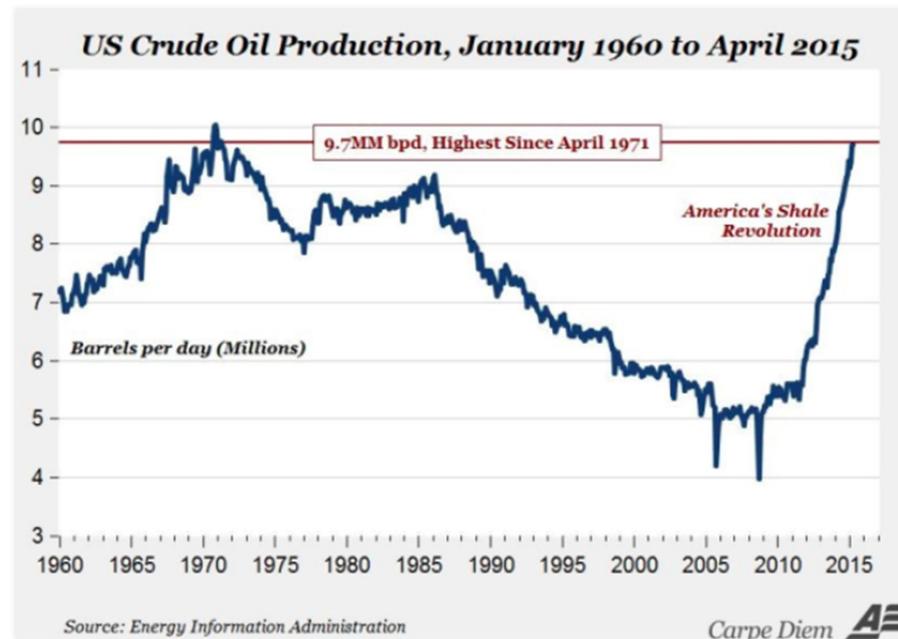
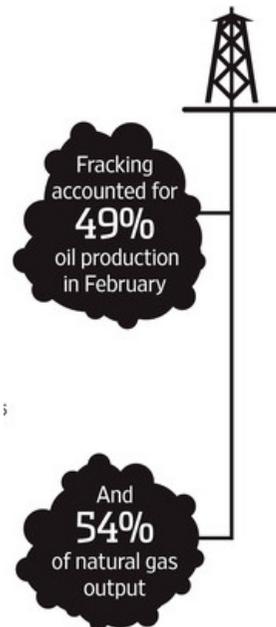
China	1,275
USA	862
Argentina	774
Mexico	681
S. Africa	485
Australia	396
Canada	388
Libya	290
PNG	282
Algeria	231
Brazil	226
Poland	187
France	180

- ❑ PNG Resource estimates from Neftex Geological Consultants, Apr 2012
- ❑ The study concludes that for every 1 TCF of conventional gas, some 3 TCF of unconventional gas is within its proximity

Overall results of the study...

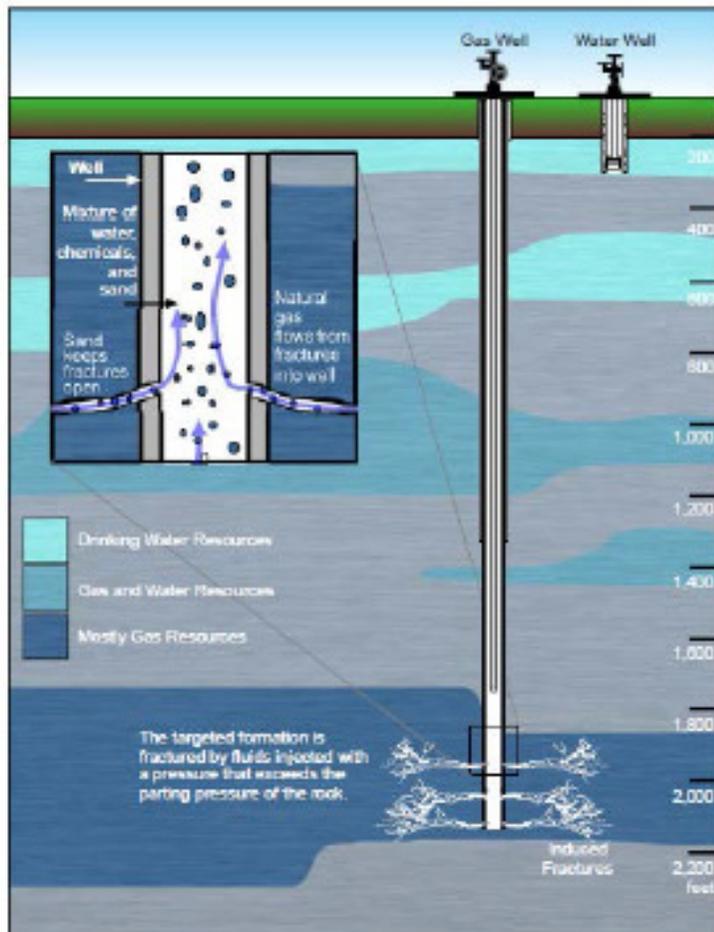
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- ❑ The review of the shale gas potential of PNG found that:
 - ❑ PNG has the potential for huge quantities of shale gas; and
 - ❑ There exists significant quantities of coal with the potential for coal seam gas exploration.



Overall results of the study...

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Typical groundwater depth compared to shale gas well depth

- As the results of the study were encouraging:
 - Legislative change was required to allow for shale gas exploration and development.
 - **New, stand-alone legislation was enacted in early 2016 - *The Unconventional Hydrocarbons Act*.**
 - Licenses were to be applied for and issued in order for SPR to undertake the work necessary to determine if shale gas is commercial in PNG.
 - **In July 2016 five license areas of choice were Reserved for SPR by Minister Micah, with licenses presently being processed.**

Unconventional Hydrocarbons

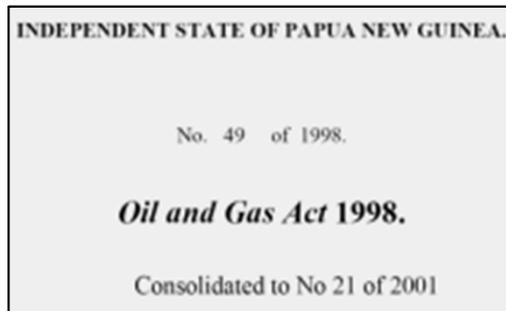
- The legal framework

Background: The existing legislative framework

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- PNG resource operations are governed by either the Oil and Gas Act 1998 or the Mining Act 1992, **but**
 - Exploration and development of coal seam gas and shale gas is specifically **excluded** under the Oil and Gas Act;
 - The definition of “minerals” in the *Mining Act 1992* includes all valuable non-living substances excluding petroleum obtained or obtainable from land.

The PNG Oil & Gas Act 1998 definition of **petroleum**:



“petroleum” means—

- (a) any naturally occurring hydrocarbons, whether in a gaseous, liquid, or solid state; or
- (b) any naturally occurring mixture of hydrocarbons, whether in a gaseous, liquid, or solid state; or
- (c) any naturally occurring mixture of one or more hydrocarbons, (whether in a gaseous, liquid, or solid state) and any other substance,

and includes any processed petroleum, and any petroleum as defined by Paragraph (a), (b) or (c) that has been returned to a natural reservoir, but **does not include coal, shale, or any substance that may be extracted from coal, shale, or other rock;**



OIL SEARCH LIMITED

(Incorporated in Papua New Guinea)
ARBN – 055 079 868

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OIL SEARCH AWARDED MINERAL EXPLORATION LICENCES IN PNG 25 August 2009

Oil Search Limited is pleased to announce that it has been awarded seven mineral exploration licences, covering approximately 17,500 square kilometres in the Strickland Basin, PNG Foreland, by the PNG Government.

The purpose of these licences is to investigate the potential for Coal Seam Gas (CSG) production from coaliferous lithologies present within the Pliocene/Pleistocene Era Formation.

Exploration and production of CSG in Papua New Guinea is governed by the PNG Mining Act hence the licences are administered by the Mineral Resources Authority.

Oil Search's Managing Director, Peter Botten, commented:

"CSG exploration and production has increased markedly in recent years in countries such as Australia, USA and Indonesia and CSG technology is developing rapidly. While substantial coal seams have been penetrated by previous petroleum wells in the Foreland area of PNG and estimated net coal thickness compares favourably to existing CSG projects globally, the potential for CSG in PNG has yet to be fully investigated. Based on our extensive in-country operational experience, augmented by specialist CSG expertise, Oil Search is in an excellent position to undertake this work. While at a very early grass-roots stage, we believe there is good potential for the presence of CSG in PNG which, over time, could represent another significant source of gas. Any successful discovery of CSG resources in PNG could be integrated with supply from nearby conventional gas fields, thereby reducing the risks for any development.

AUSTRALIAN REGISTERED OFFICE

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Telephone: (61) 2 8207 8400 Facsimile: (61) 2 8207 8500

The result - PNG Unconventional Hydrocarbons Act

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INDEPENDENT STATE OF PAPUA NEW GUINEA.

No. 41 of 2015

AN ACT

entitled

Unconventional Hydrocarbons Act 2015

Being an Act to enact comprehensive legislation governing the exploration for and production of unconventional hydrocarbons in Papua New Guinea, including the offshore area, and the grant to traditional landowners and Provincial Governments and Local-level Governments of benefits arising from projects for the production of unconventional hydrocarbons, and to repeal various Acts, and for related purposes,

MADE by the National Parliament to come into operation in accordance with a notice in the National Gazette by the Head of State, acting with, and in accordance with, the advice of the Minister.

PART I.—PRELIMINARY.

1. Compliance with Constitutional requirements, etc.

(1) This Act, to the extent that it regulates or restricts a right or freedom of the citizen under Subdivision III.3.C (*qualified rights*) of the *Constitution*, namely—

- (a) Section 44 (*the freedom from arbitrary search and seizure*);
- (b) Section 48 (*the right to freedom of employment*); and
- (c) Section 49 (*the right to privacy*); and
- (d) Section 51 (*the right to freedom of information*),

is a law made for that purpose, taking into account the National Goals and and the Basic Social Obligations, in particular the National Goals and Directions, and is entitled—



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PORT MORESBY, FRIDAY, 26th FEBRUARY

[2016

Unconventional Hydrocarbons Act 2015

NOTICE OF COMMENCEMENT

PNG Unconventional Hydrocarbons Act – Key features

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Under the Oil and Gas Act

“petroleum ” continues to mean—

any naturally occurring hydrocarbons, whether in a gaseous, liquid, or solid state... **but does not include coal, shale, or any substance that may be extracted from coal, shale, or other rock**

Under the Mining Act

“minerals” continues to mean—

all valuable non-living substances **excluding petroleum** obtained or obtainable from land;

Under the Unconventional Hydrocarbons Act

“unconventional hydrocarbons” means—

any naturally occurring hydrocarbons, whether in a gaseous, liquid, or solid state... and any other substance, which is or are or may be extracted from coal, shale, or other rock, and includes processed unconventional hydrocarbons, **but does not include any hydrocarbons which is or are or may be extracted from a conventional petroleum pool**

The definition is based on the source of the hydrocarbon, which can never be compromised

PNG Unconventional Hydrocarbons Act – Key features

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Under the new Act a:

- Petroleum Prospecting License;
- Unconventional Hydrocarbon Prospecting License; and
- Mining Exploration License...

Can all co-exist over the same area of land.

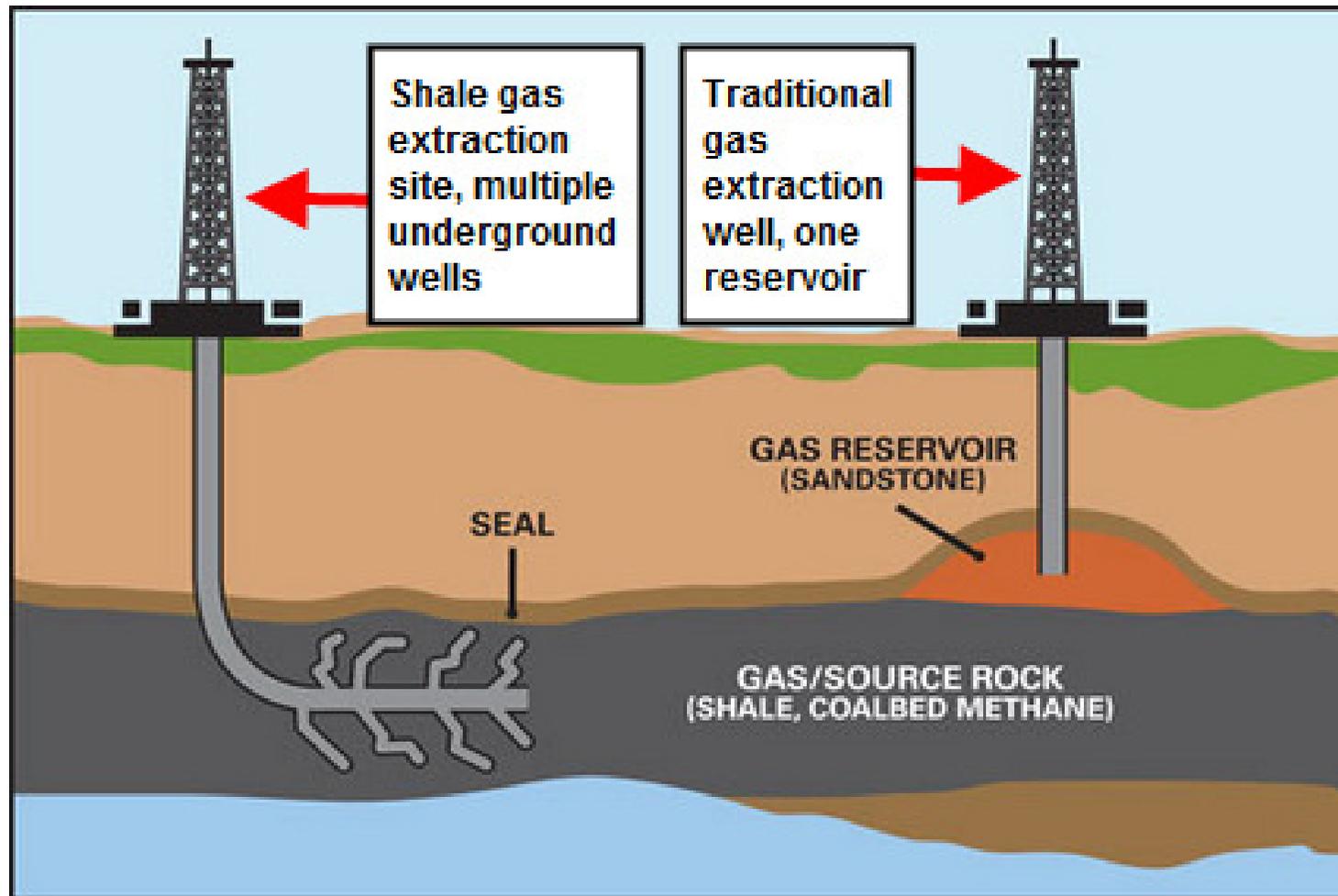
Potential conflicts can certainly exist but are resolved (Sec 63-65):

- Where unconventional hydrocarbons are discovered in a PPL, ownership reverts to the UHPL holder
- Where conventional hydrocarbons are discovered in a UHPL, ownership reverts to the PPL holder

- No rights of existing PPL/PDL/PRL holders are impacted**

The interaction of existing and new licenses - conventional and unconventional oil and gas production

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PNG Unconventional Hydrocarbons Act – Key features

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Terms consistent with Oil & Gas Act 1998:

- ❑ The “Normal” maximum license area = 60 graticular blocks
- ❑ The “Maximum” license area = 200 graticular blocks upon special application to the Minister
 - ❑ Note: Shale operations require a much larger footprint to be economic due to the limited reach, and limited life, of each well. Many more wells must be drilled than in conventional operations.
- ❑ Unconventional Prospecting License: 6 years + 5 year extension;
- ❑ Unconventional Retention License: 5 years + 5 year extension;
- ❑ Unconventional Development License: 25 years + 25 year extension;
- ❑ Fees, royalties and development levies, State participation, rights of landowners, Development Forums, surrender of licenses are all consistent with the Oil & Gas Act 1998

PNG Unconventional Hydrocarbons Act – Key features

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Relationship with the Oil & Gas Act – Administration

- ❑ It is very important for the avoidance or resolution of conflicts between the traditional petroleum regime and the unconventional hydrocarbons regime that each regime be **administered by the same bodies**. For this reason all relevant officers and administrative organs were cross-referred to their equivalent under the Oil and Gas Act, including the Minister.
- ❑ **The Board is created under the Oil and Gas Act, the Director, Inspector, Warden, etc., are all appointed under the Oil and Gas Act**, so those provisions were not repeated in the new legislation.

PNG Unconventional Hydrocarbons Act – Key features

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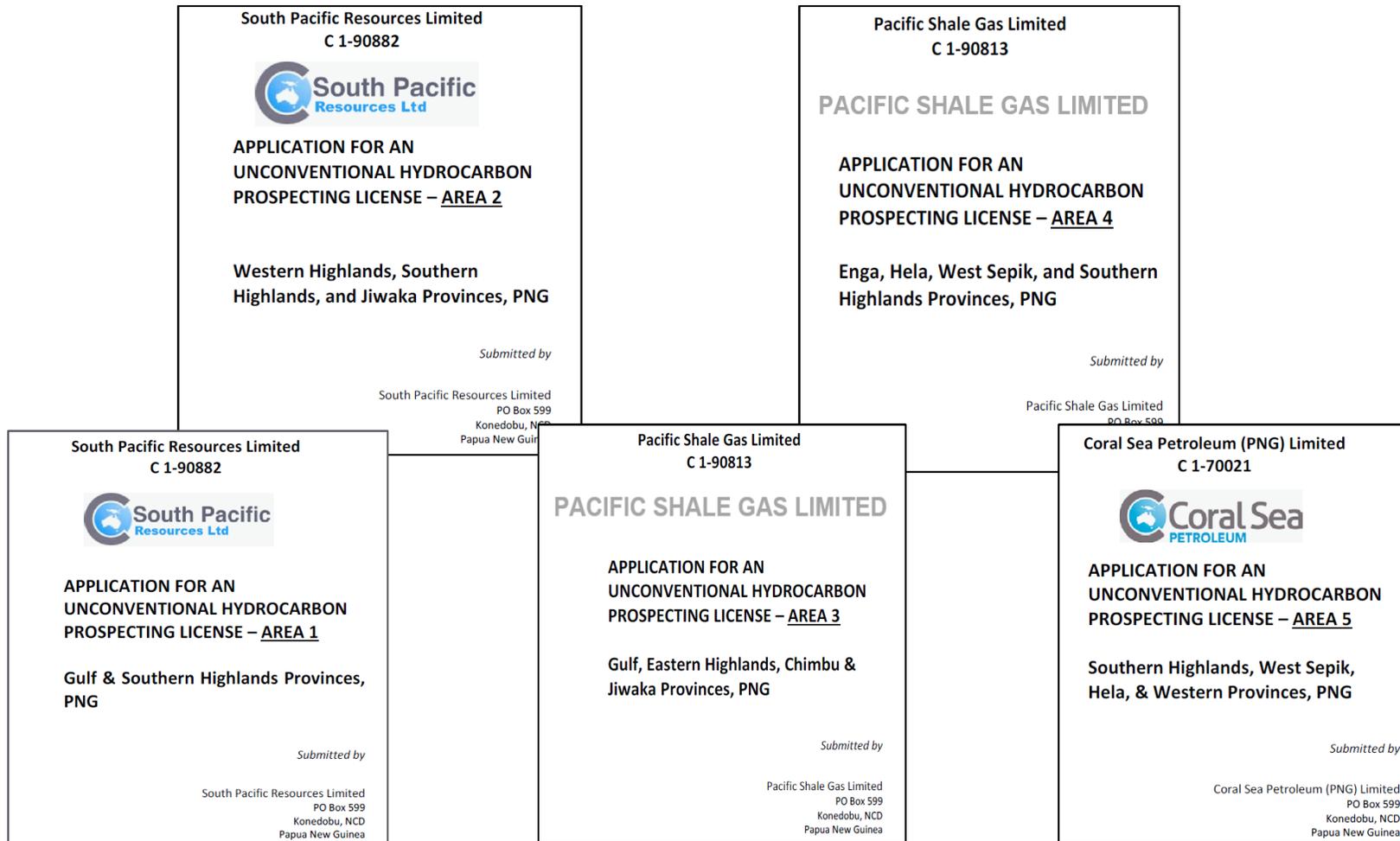
Relationship with the Oil & Gas Act – Pipelines and Processing Facilities

- ❑ Unconventional petroleum, once it has been produced, is exactly the same substance as petroleum produced from conventional petroleum operations. **A processing facility and a pipeline for unconventional hydrocarbons are exactly the same** things as that for conventional petroleum. In fact any pipeline can be used for either unconventional hydrocarbons or their normal petroleum equivalent, and once there are both conventional and unconventional projects in existence it is highly likely that unconventional and conventional hydrocarbons will be commingled, processed, and transported in the same infrastructure at the same time.
- ❑ To avoid regulatory uncertainty it is important that there is only **one source of licensing for pipelines and for processing facilities**, regardless of what is processed and transported. The new Act therefore **leaves pipeline and processing facility licensing to the OGA**, although modifications to the OGA are required so that the pipeline licensing and processing provisions cover processing and transportation of unconventional hydrocarbons as well as conventional petroleum.

Unconventional Hydrocarbons

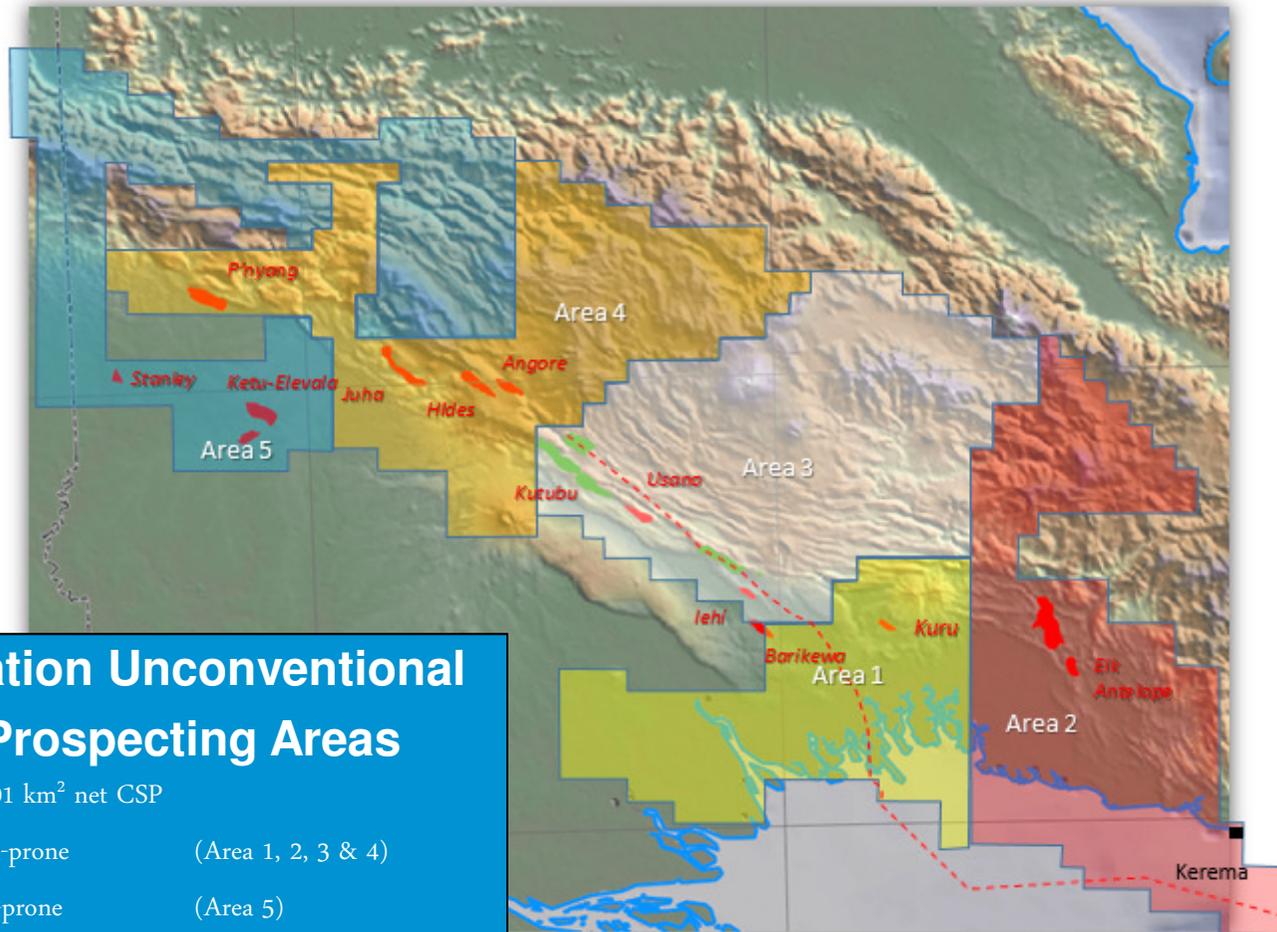
- 5 x License applications lodged
- Areas Reserved by Minister exclusively for SPR for 5 years

5 shale gas applications lodged



License application areas

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Application Unconventional HC Prospecting Areas

75,701 km² net CSP

4 gas-prone (Area 1, 2, 3 & 4)

1 oil-prone (Area 5)

Unconventional Hydrocarbons

- The opportunity to fast-track projects in PNG

Commercialising stranded fields & extending Gobe / SE Gobe

- Application Area 1

Oil Search' stranded fields

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CURRENT STATUS

Oil Search's suite of stranded fields presently have no way to be commercialised without infrastructure

- ❑ Multiple dysfunctional JVs
- ❑ Standalone developments have -ve NPV
- ❑ Individual reserves are small (total ~1.2 Tcf UR IRR)
- ❑ No certain access to PNG LNG infrastructure as LNG infrastructure is not a "Strategic Asset"

Opportunity presented

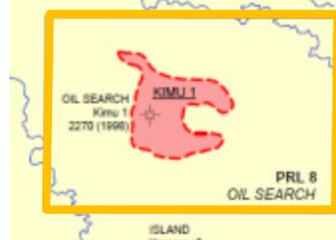
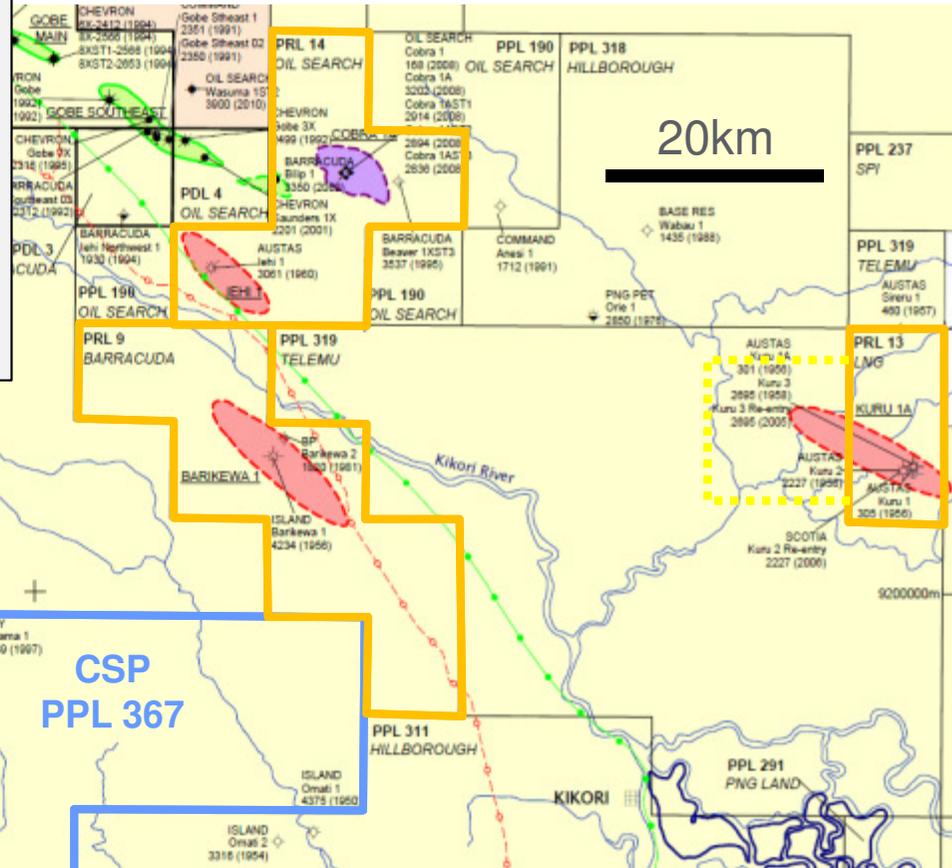
- ❑ Cluster development may improve chance of 'success'
- ❑ Incremental shale reserves may deliver commerciality
- ❑ Low operating costs are essential for shale

Commercialising Stranded Fields

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PRL 8	Kimu	500 Bcf IRR
PRL 9	Barikewa	500 Bcf IRR
PRL 13	Kuru	50 Bcf IRR
PRL 14	Iehi, Cobra, Bilip	100 Bcf IRR
PPL 319	Kuru extension	50 Bcf IRR
Total		1.2 Tcf IRR

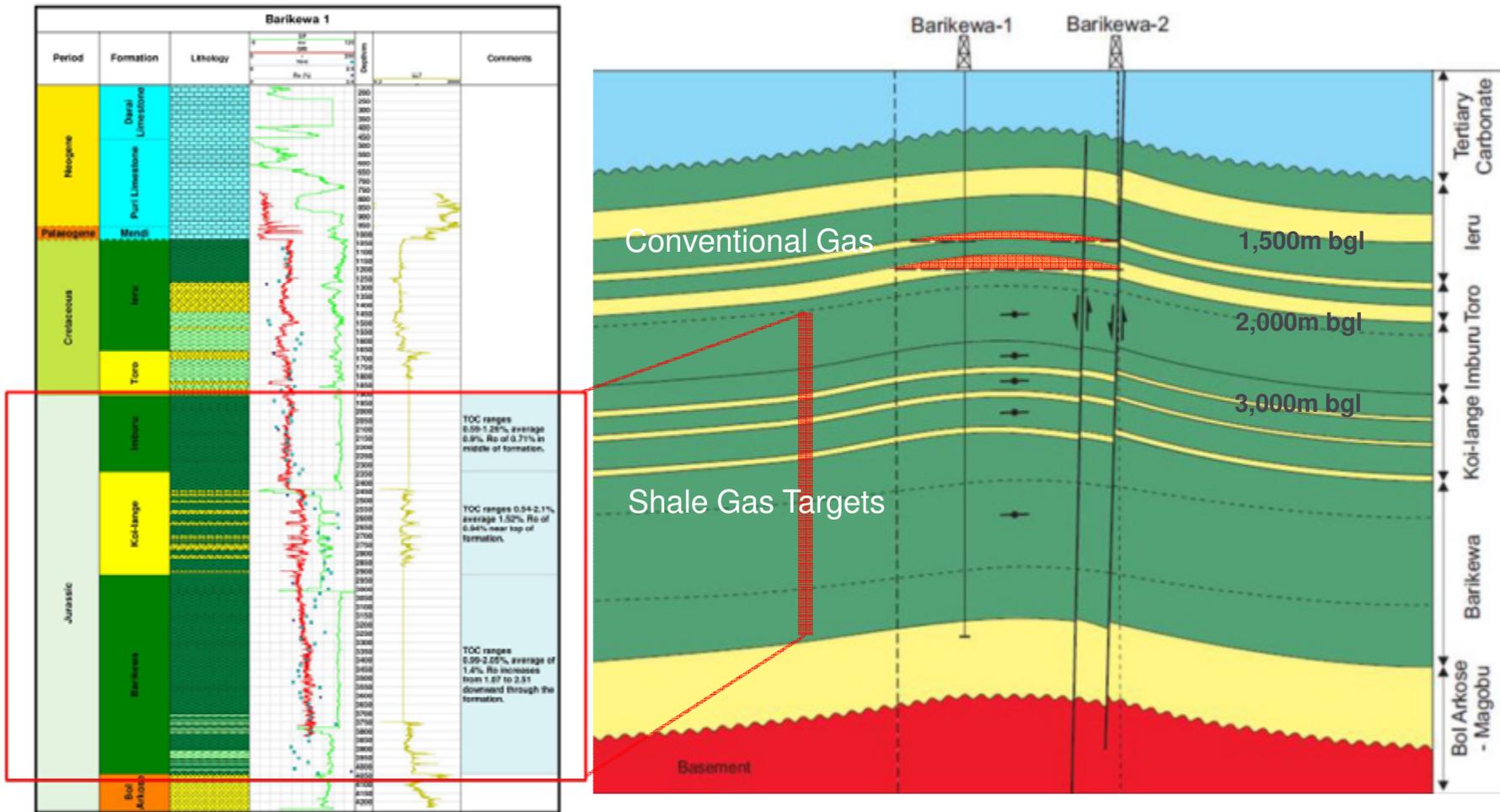
Gas volumes are estimates only from public information



Concept is to commercialise stranded conventional fields as part of an integrated shale development

Interaction between existing fields and source rocks

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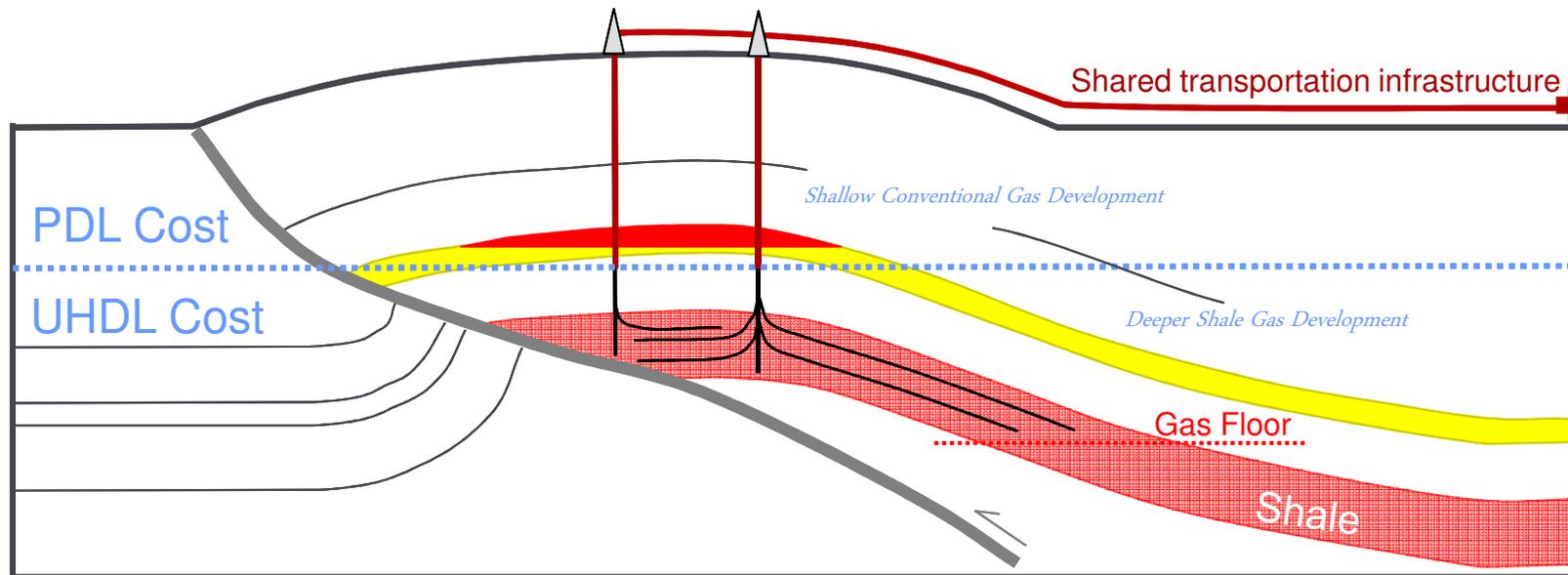


Solution – Combined Development provides Economic Synergy

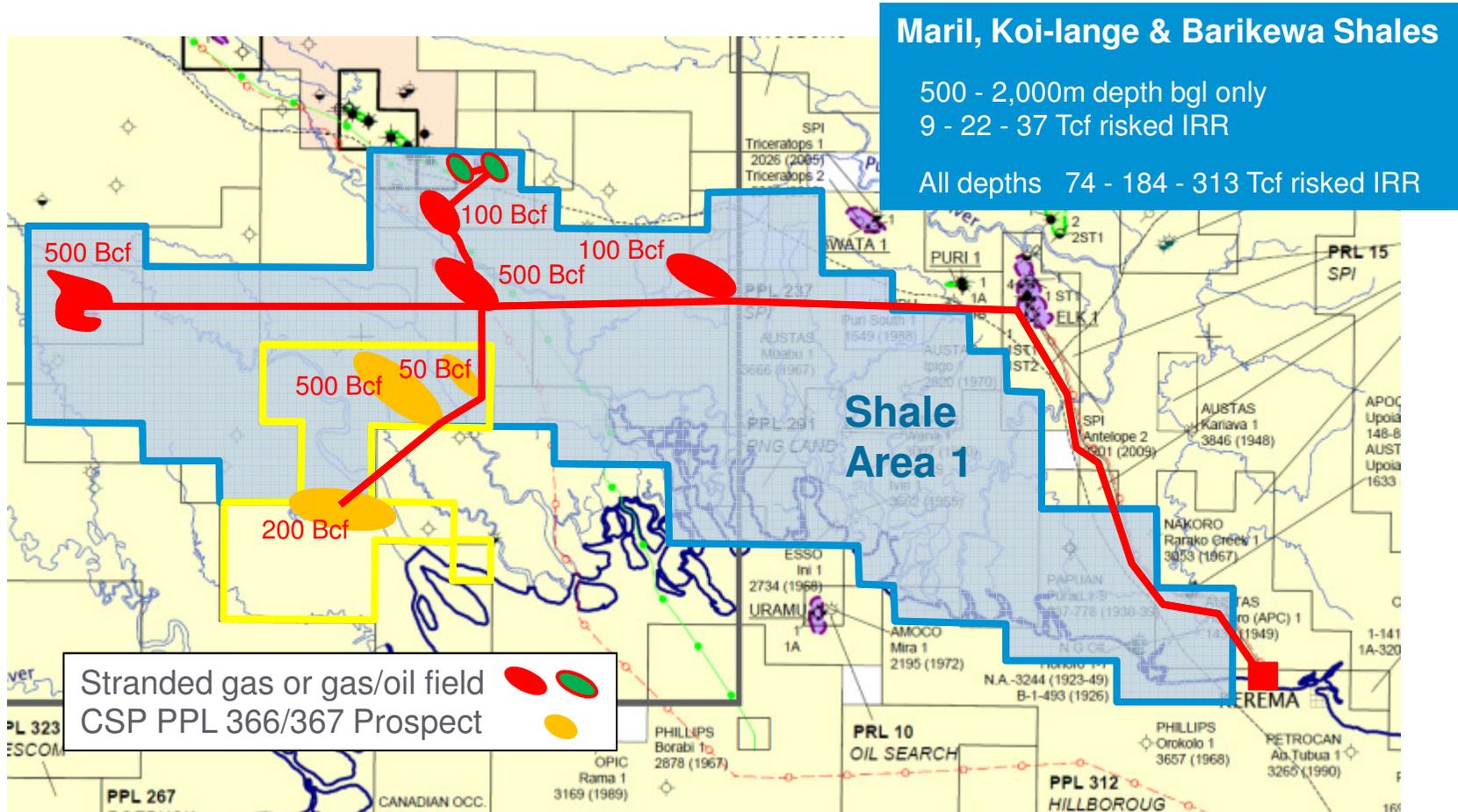
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Shale Development

- As shale sits below conventional fields, shale gas developments allow the **cost of infrastructure & wells to be shared between the shale development and stranded fields**
- Operating costs for **both shale and stranded fields** are minimized as costs are shared
- Allows for development of otherwise uneconomic stranded fields, as **shale and conventional fields are developed together**



Integrated development concept for Area 1



Shale gas volumes from Neflex 2012 (Coral Sea Petroleum proprietary report)

Area 1 – stranded fields draft development plan

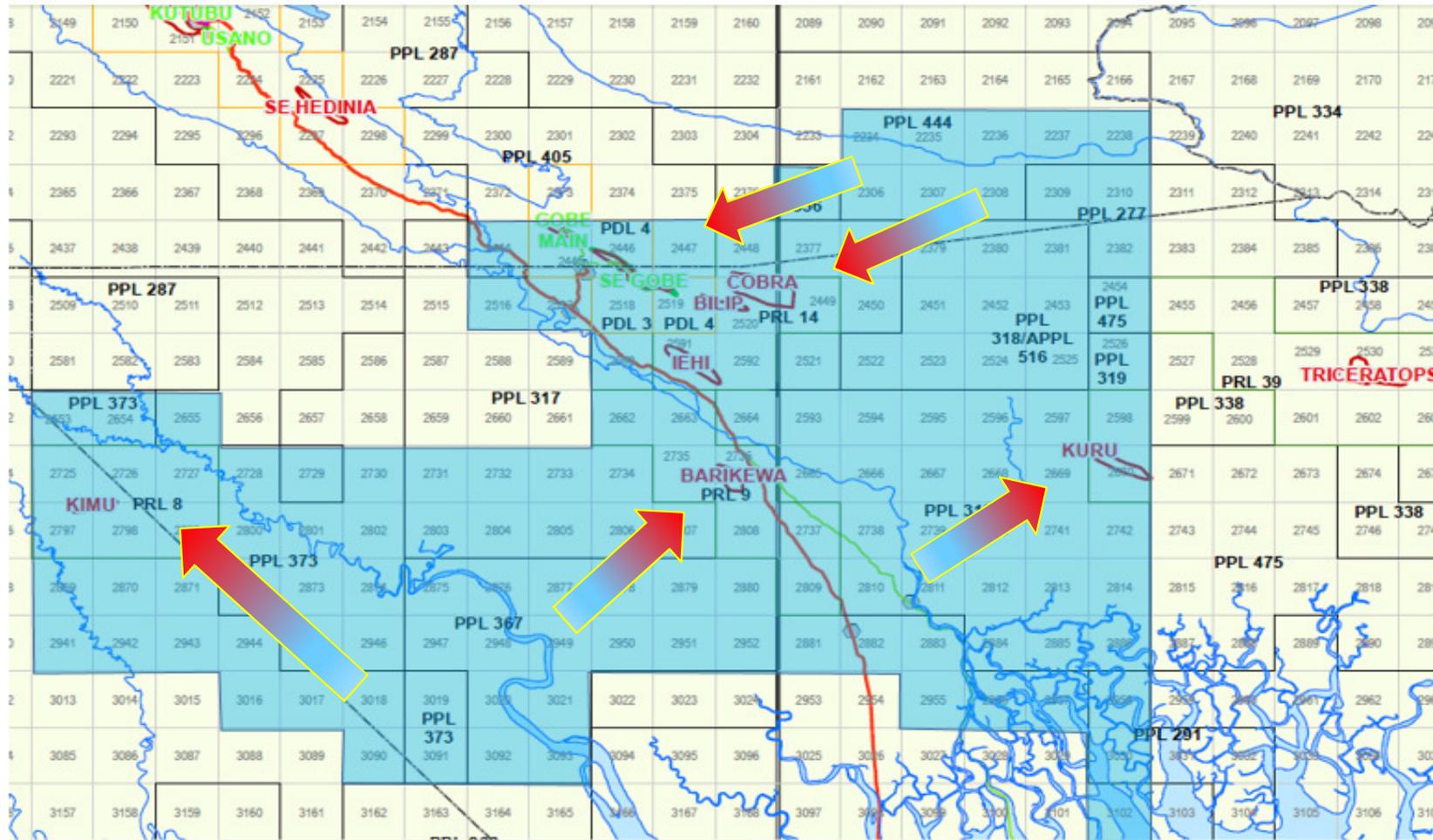
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Application Area 1 may supplement existing stranded oil and gas fields

- The stranded fields, within Area 1 of the study, were assessed as having significant potential unconventional gas resources that could potentially be applied to commercialise the existing stranded fields.
- Re-enter existing abandoned (stranded field) wells with the view to deepening as required to the target shales, and fracking to ascertain production capabilities of the shales in order to build up an overall picture of how the integrated development may evolve.
- Possible early FEED activities for stand-alone LNG project

Area 1 license area

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Gobe / SE Gobe

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CURRENT STATUS

Oil production from Gobe / SE Gobe fields is no longer economic

- ❑ Economic oil reserves have essentially been depleted
- ❑ Gas from Gobe has now commenced providing feedstock for PNG LNG
- ❑ Oil and gas infrastructure remains in place
- ❑ Good road access via the Kutubu and Samberigi Roads

Area 1 Gobe possible development plan

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Application Area 1 may extend the life of the Gobe / SE Gobe oilfields

- ❑ Production at Gobe / SE Gobe has the potential to be fast-tracked by re-entering and fracking existing suspended or abandoned Gobe wells. Subject to suitable commercial arrangements any liquids could be immediately transported via existing infrastructure.
- ❑ Road access around Gobe / SE Gobe is good, which allows for early shale gas operations within the immediate vicinity of facilities. Drilling along the existing road network is also a possibility.
- ❑ Possible joint arrangement with existing operators.
- ❑ Gobe / SE Gobe reservoirs could be well suited as the site of the proposed National Gas Reserve, and so produced shale gas could either be reinjected and stored in the Gobe reservoirs, or used to underpin a third train for the PNG LNG Project.
- ❑ Pre UHDL production could commence immediately under S20(1)(d) of the Act.

The potential to provide sufficient reserves to underpin the Papua LNG Project

- Application Area 2

Total's Papua LNG project – Elk / Antelope

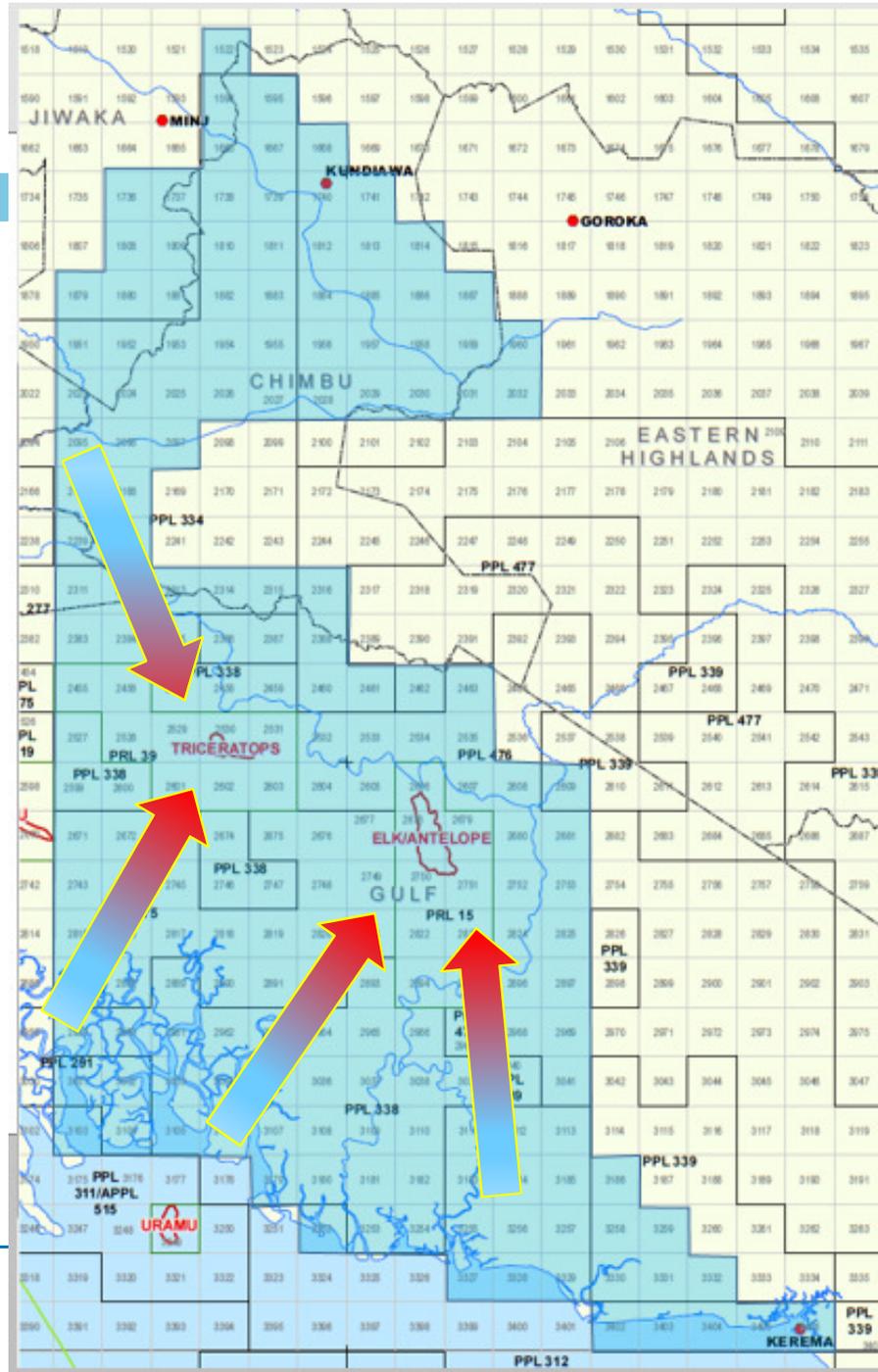
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CURRENT STATUS

Total-operated Elk/Antelope (Papua LNG Project) is presently awaiting confirmation of sufficient reserves before proceeding to FID

- ❑ Application Area 2 may provide sufficient reserves to enable the project to quickly move to FID
- ❑ Present reserves are between 5 – 9 TCF. FID for the Papua LNG Project is dependent on proving sufficient gas reserves.
- ❑ Further drilling is required to establish sufficient reserves.
- ❑ Antelope 6, completed in April 2016, was Plugged and Abandoned. It's objective was to “provide structural control and reservoir definition on the eastern flank of the field” *Source, Oil Search Drilling Report, 5th February 2016.*
- ❑ *Antelope 7 scheduled to be drilled 2H 2016*
- ❑ While Area 2 results were drawn from sparse data, the data that was present indicated the presence of good quality shales. It provided the largest shallow resource volumes of the entire PNG study.

Area 2 license area



Oil Search's declining oil and gas fields
(Kutubu, Moran, Agogo, Hedinia...)

- Application Area 3

Oil Search' declining fields

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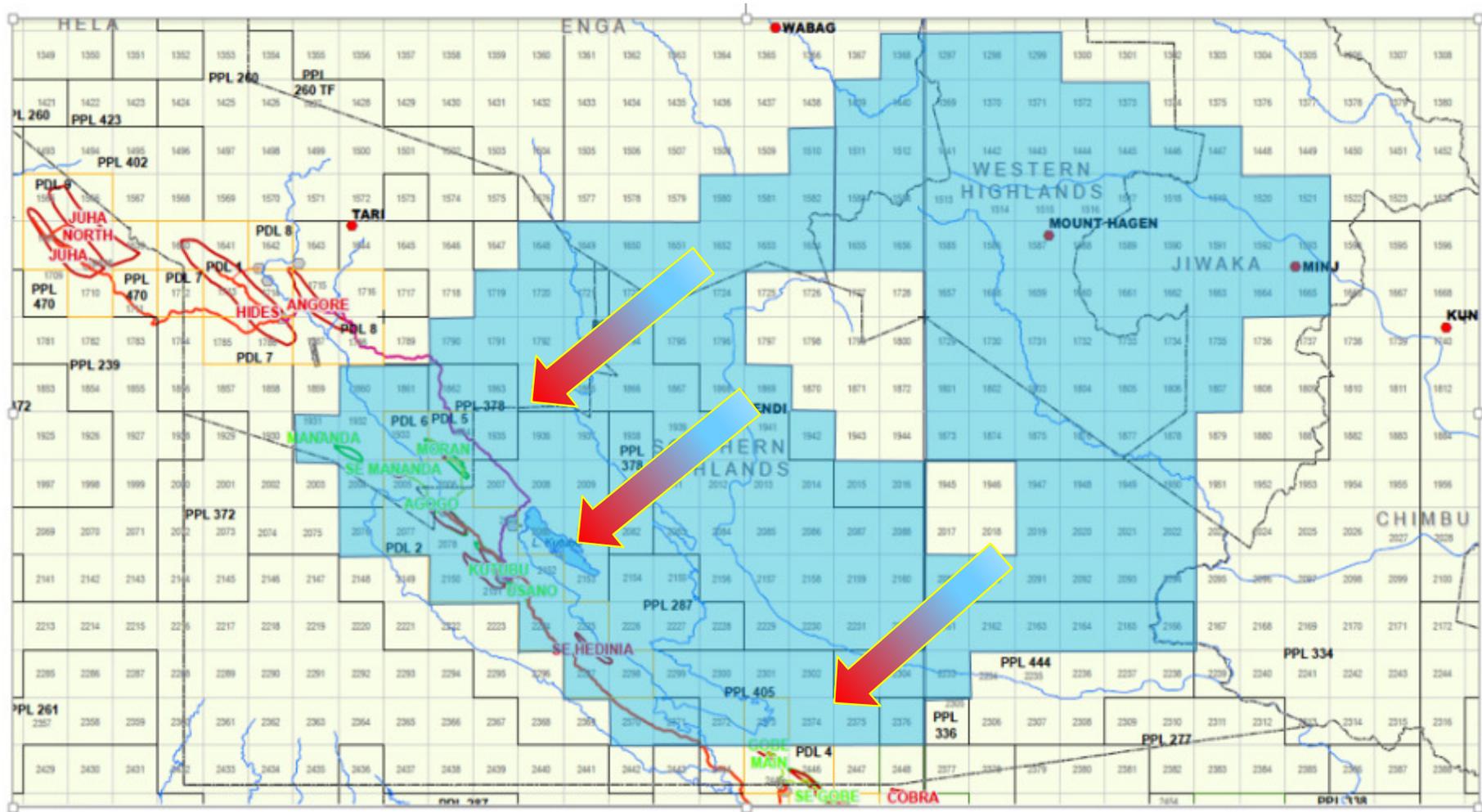
CURRENT STATUS

Oil Search-operated Kutubu, Moran, Agogo, Mananda suite of oil fields have been in decline for many years

- ❑ Oil Search's oil production has been in continuous decline for many years now.
- ❑ Gas production from the Oil Search operated fields is earmarked for the PNG LNG Project

Area 3 license area

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Area 3 possible development plan

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Application Area 3 may supplement existing producing oil and gas fields

- ❑ The oil producing trend was within the Area 3 of the study. Area 3 shales are deep and considered to be likely both oil and gas prone.
- ❑ The oil and gas producing Foldbelt comprises multiple producing, suspended or abandoned wells, with road access and extensive facilities, all of which have spare processing and transportation capacity.
- ❑ Re-entering and fracking existing shut-in wells could happen at reduced drilling costs especially where road access is available. Joint arrangements with existing operators are important.
- ❑ In the event that shale oil was located and able to be produced effectively, oil and gas production could commence pre UHDL under S20(1)(d) of the Act, which operates similar to an extended well test under the Oil and Gas Act.
- ❑ Shale gas could be produced and reinjected into existing conventional reservoirs either to establish a National Gas Reserve for future needs, or it could be used to supply a third train for the PNG LNG Project.

The potential to provide additional reserves for the PNG LNG Project's third train

- Application Area 4

Exxon's PNG LNG project's third train

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CURRENT STATUS

The Exxon-operated PNG LNG Project is presently considering adding a third train, utilising P'Nyang gas from PRL 3

- ❑ Construction of a third train is being considered, subject to resource confirmation.
- ❑ FID estimated end 2017 **subject to resource confirmation.**
- ❑ Current PNG LNG production rates are some 10% above Nameplate Given the higher depletion rate than was anticipated at the design stage of the project, the possibility of construction of a third train would appear unlikely.

Area 4 possible development plan

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Application Area 4 may provide additional reserves, sufficient to justify a third train for the PNG LNG project

- ❑ The PNG LNG project area was included within the original Area 4 of the study. The shales are deep and considered to be likely both oil and gas prone.
- ❑ Area 4 includes multiple wells in close proximity to the PNG LNG Project that can be easily re-entered and deepened, at a fraction of the normal drilling cost. Once drilled, the wells can then be fracked to determine likely reserves and the suitability of the shales for gas production.
- ❑ Joint arrangements with existing operators are important.
- ❑ With positive results, early production can commence pre UHDL under S20(1)(d) of the Act, which operates similar to an extended well test under the Oil and Gas Act.

Potential to provide sufficient reserves
for the Stanley LNG Project

- Application Area 5

Horizon's Stanley LNG project

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CURRENT STATUS

Horizon-operated Stanley LNG Project requires sufficient reserves to proceed to FID

- “The combined contingent gas resources of around 1.4 TCF in PDL 10 (formerly PRL 4) and PRL 21 **approach the scale required for a mid-scale LNG project** and Horizon Oil is advancing its pre-development studies of this opportunity.”
Source, Horizon web site, PRL 21 project description
- FID is therefore dependent on proving sufficient gas reserves. Present reserves are around 1 TCF

Area 5 possible development plan

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Application Area 5 may provide sufficient reserves to enable the project to proceed

- ❑ Stanley / Ketu / Elevela / Ubuntu within the original Area 5 of the study. The shales are deep, and considered to be likely both oil and gas prone.
- ❑ The area around Stanley, Ketu, Elevela is remote, with minimal existing facilities. Horizon has stated that 1.5 TCF would be sufficient to underpin a small scale LNG project, of which around 1 TCF is already identified.
- ❑ Existing (suspended or abandoned) wells could be re-entered to fast-track reserve delineation and also to reduce drilling costs, although drilling costs will always be high due to the remote location.
- ❑ Multiple drill rigs are presently stacked at various locations in PNG, so drilling can happen quickly.

Unconventional Hydrocarbons

- Benefits to PNG

Unconventional hydrocarbons – Benefits to PNG

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- ❑ Unique opportunity to develop the shale gas industry in PNG
- ❑ Potentially enormous **scale** of unconventional hydrocarbons at < 2,000m below ground level. The thickness of shale is significantly larger than producing commercial USA shale basins
- ❑ Perfect opportunity for PNG to build a **National Gas Reserve** by reinjecting produced shale gas into existing conventional reservoirs for future strategic use
- ❑ Proximity to SE Asia markets, with the potential to build new LNG plants on the north coast of PNG given the size of the resource, will result in **PNG potentially becoming an energy supply hub for SE Asia**
- ❑ Enables the potential to **commercialize** otherwise proven reserves in **stranded, uneconomic, conventional oil and gas fields** as part of a combined development (Barikewa, Kimu, Kuru, Iehi, Cobra, Bilip, that may otherwise never be developed)

Unconventional hydrocarbons – Benefits to PNG

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- Potential to immediately provide **significant benefits to the people of PNG**, via employment opportunities and taxation revenue throughout both the construction and production phases of a project

- **PNG benefits**, with undertakings to:
 - Set aside **15% of shale gas production for domestic gas requirements**,
 - Ensure minimum of **10% of local content during construction phase**
 - **Both commitments are reflected in the Government Policy Paper and will be given effect by Regulation**

- Providing sufficient, widespread, gas supply certainty to **enable conversion of PNG oil-fired power stations to gas-fired**

- Shale gas **does not have the environmental concerns** associated with coal seam gas exploration and development

Unconventional hydrocarbons – Benefits to PNG

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- The new legislation:
 - **Immediately doubles the acreage of hydrocarbon resources** in PNG
 - Will enable **at least 13 shale-bearing provinces to benefit from shale gas development** (*Gulf, Morobe, Eastern Highlands, Simbu, Madang, Jiwake, Western Highlands, Southern Highlands, Hela, Western, Enga, East Sepik, West Sepik*)
 - Will enable coal seam and all other unconventional hydrocarbons in PNG to be explored for and developed
 - Government fully supportive of shale gas initiative and the required legislation has been drafted, which has **no adverse impact on existing license holders**. The legislation addresses issues of coexistence of unconventional licenses with existing petroleum licenses