Government of Western Australia
Department of Mines and Petroleum

Unconventional Gas Resources in Onshore Western Australia
Australia-India Energy and Minerals Forum

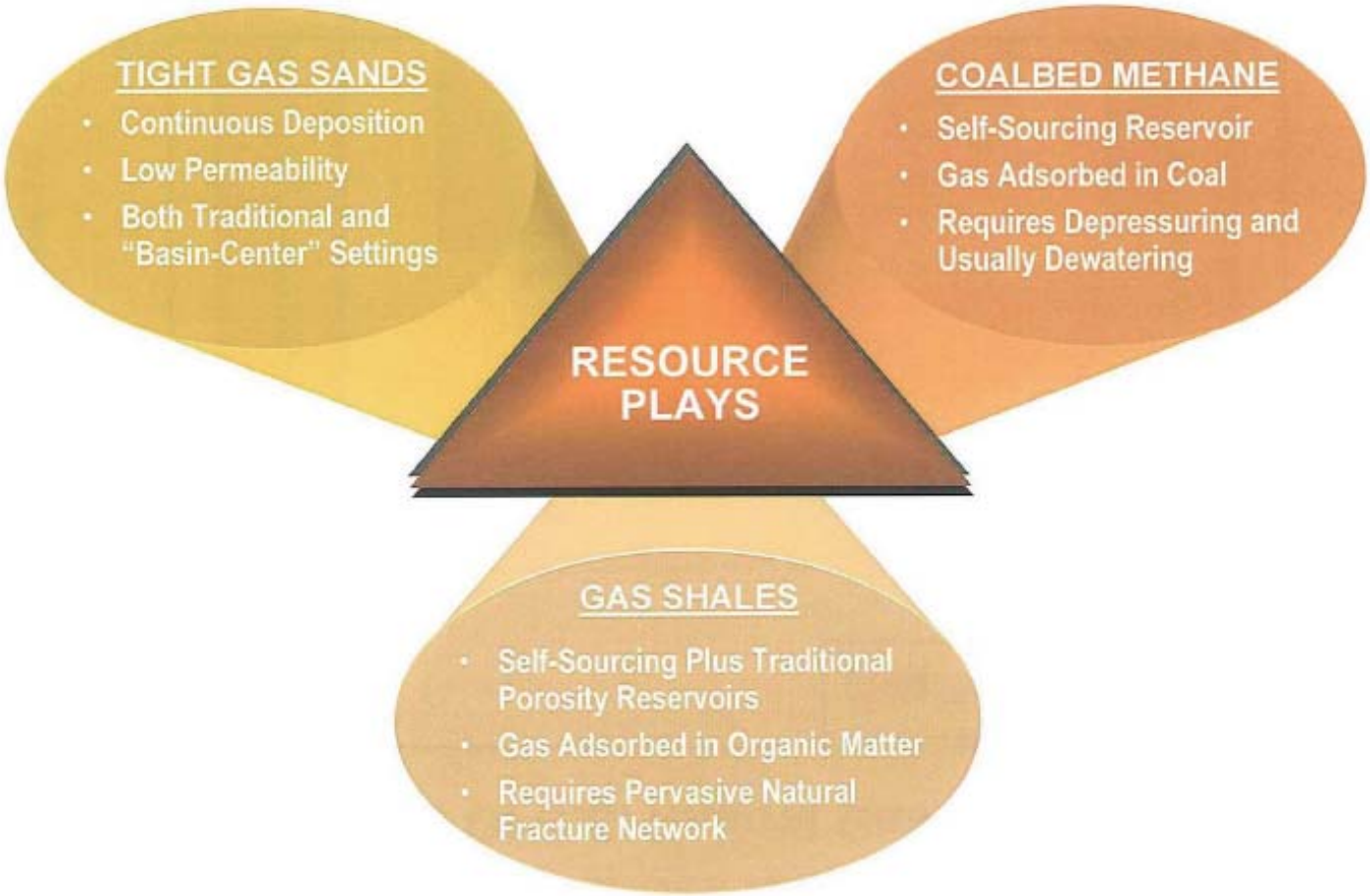
Ali Sharifzadeh
Senior Petroleum Engineer

June 8 2010

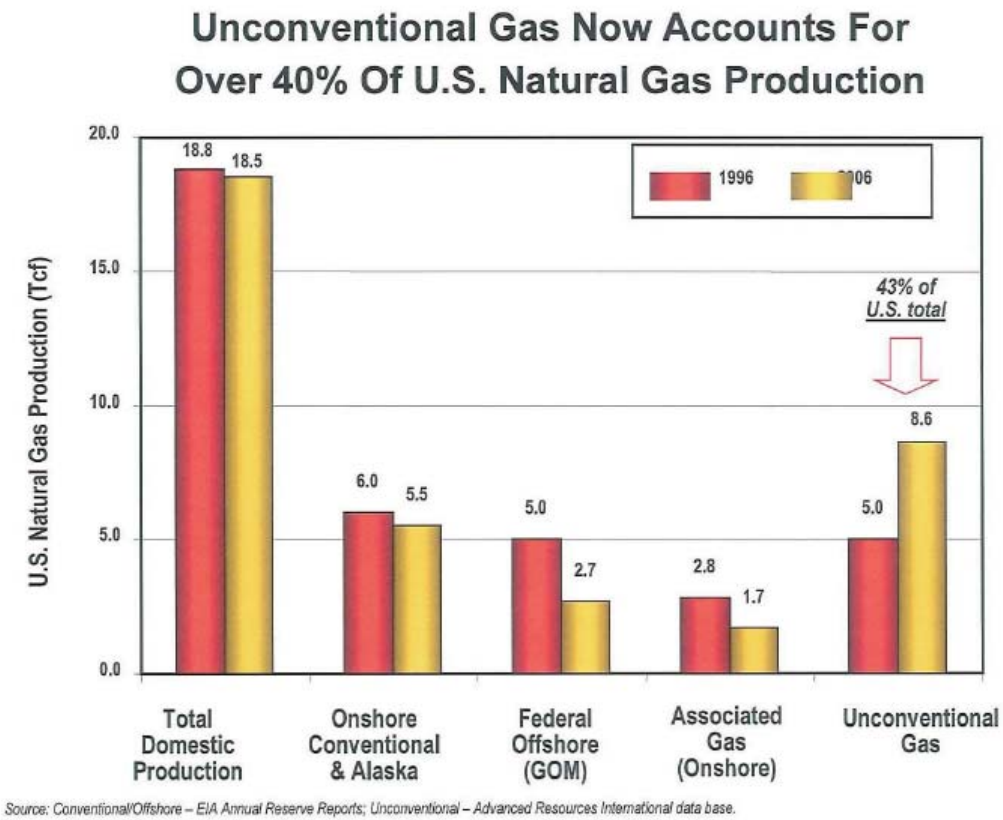
INTRODUCTION

- Unconventional resources are ones that do not produce economic volumes of oil and gas without assistance from massive stimulation treatments or special recovery processes
  - Highly Technical
  - More costly

Unconventional Gas and Resource Plays

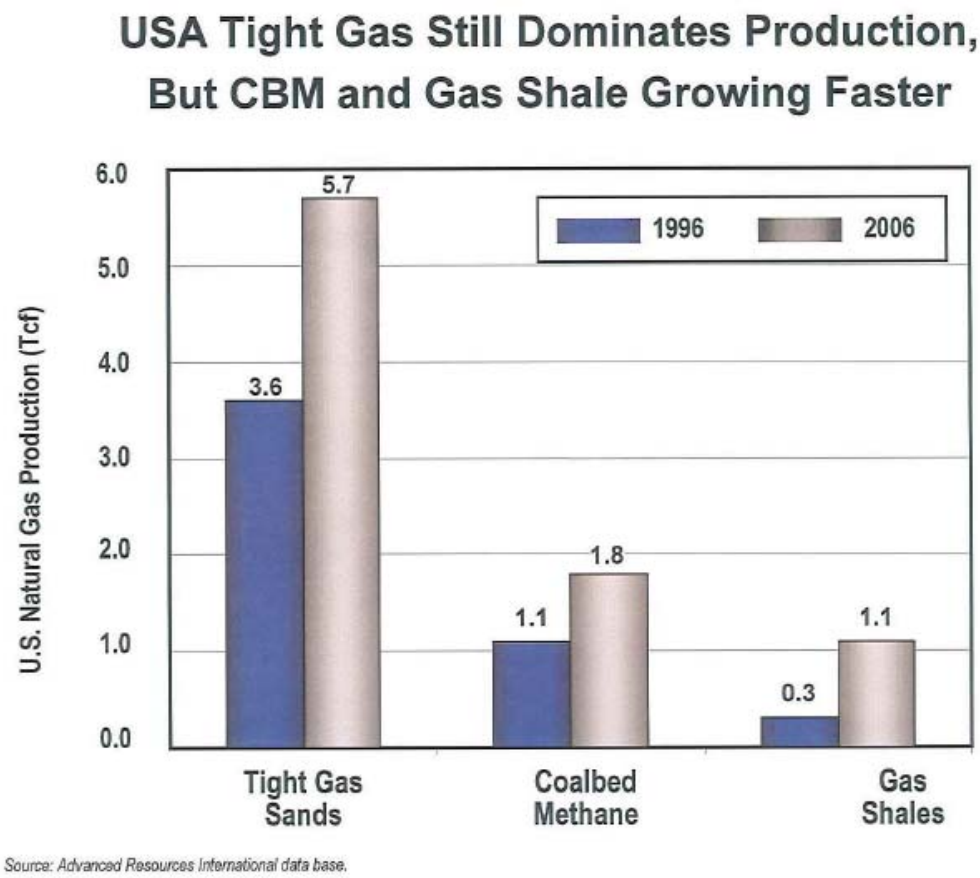


Unconventional Gas Production in the U.S.



Source: Conventional/Offshore – EIA Annual Reserve Reports; Unconventional – Advanced Resources International data base.

Unconventional Gas Production in the U.S. (contd.)



TIGHT GAS SANDS

- Natural gas from tight sands is conventional natural gas extracted from unconventional reservoirs.
- Important characteristics of such reservoirs are **porosity** – the volume of the pore spaces, and **permeability** - how connected the pore spaces are.
- Porosity is what stores the natural gas and permeability is what allows the natural gas to move.

Tight Gas Resources

•There are many significant tight sand structures onshore and offshore Western Australia.

•The key to producing this vast resource is locating areas and drilling wells where natural fractures abound. If natural fractures are scarce, hydraulic fracturing is used to give the gas an easier pathway to the well.

•Proper applications of existing and new technologies in tight-gas wells can increase the amount of gas produced significantly.

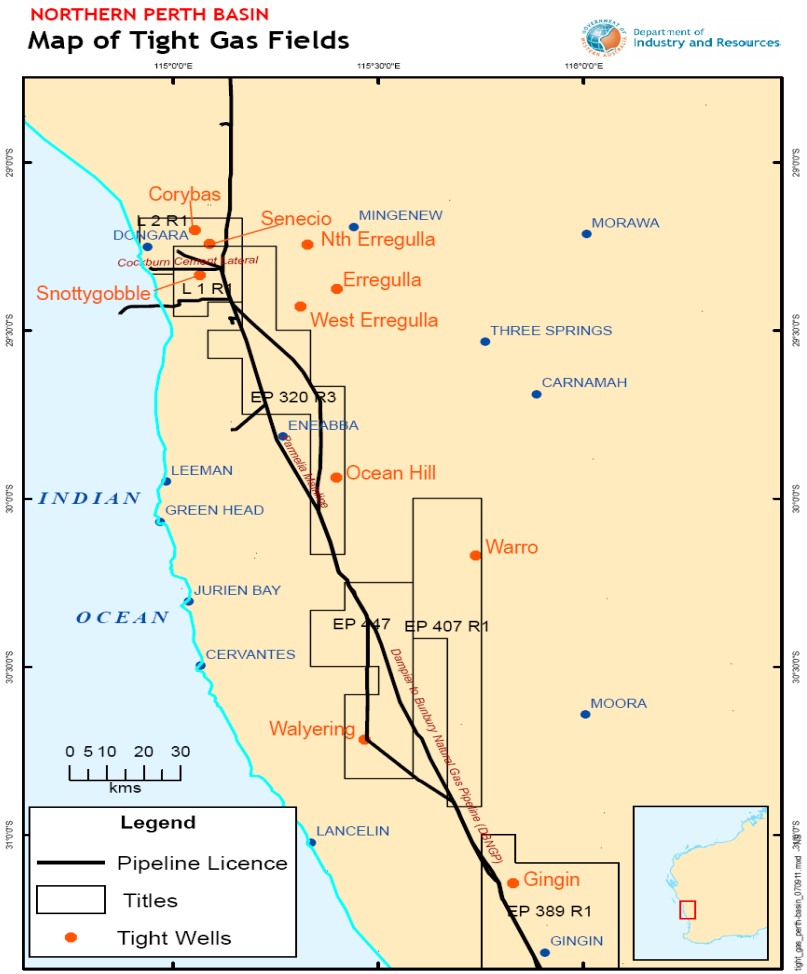
Tight Gas Wells - Northern Perth Basin

North Perth Onshore Tight Gas Fields

Onshore Tight Gas	Operator	Permit	Discovery Date	Expiry Date	Gas Resources	Comments
GinGin	Empire Oil	EP 389 (R1)	1965	24/09/2009	1 TCF	4 wells Drilled All might not be tight gas
Whicher Range	Whicher Range Energy	EP 408/381 408 (R1)	1968	28/07/2008	Multi TCF in Place	5 Wells Drilled
Warro	Latent Petroleum	EP407 EP321 407 (R1)	Feb-1977	13/04/2009	5 TCF	3 Wells Drilled
West Erregula	Warrego Energy	Vacant Acreage	23/07/1990	N/A	1 TCF	Tight Gas
Ocean Hill	ARC Energy	EP 320 (R3)	April 1991	23/07/2008	*See Note 1	Very Tight Gas
Corybas	ARC Energy	L2 (R1)	Jan 05	17/05/2014	*See Note 2	Tight Gas Producing
Senecio	ARC Energy	L2 (R1)	Sep -05	17/05/2014	*See Note 3	2 Wells Drilled
Snotty Gobble	ARC Energy	L1 (R1)	Feb -06	17/05/2014	26.12 (BSCF)	

* Note 1: No quantifiable production of hydrocarbon occurred
* Note 2: Three unsuccessful DST test
* Note 3: Awaiting Well Final Report

Tight Gas Wells - Northern Perth Basin (continued)



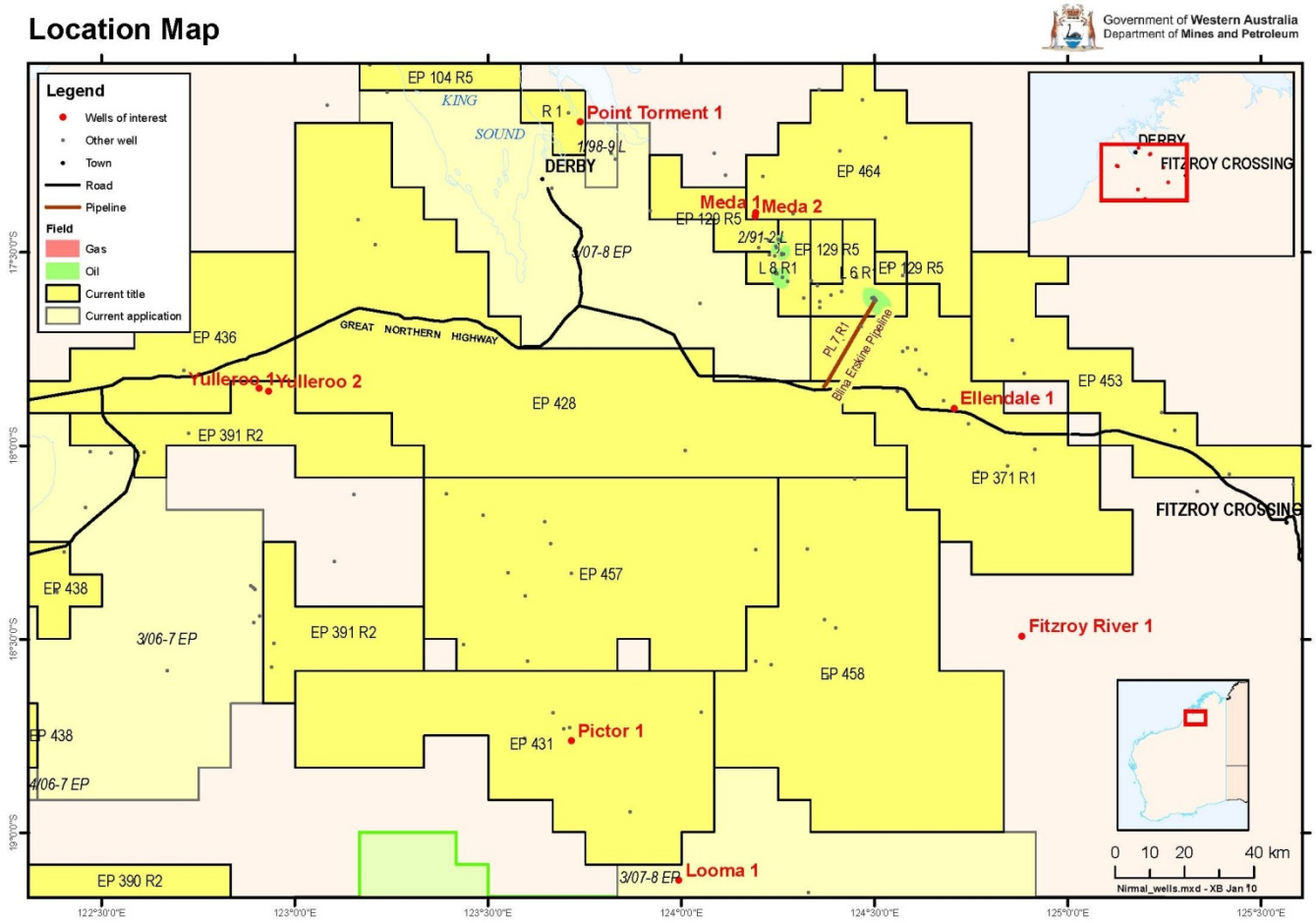
Tight Gas – Onshore Canning Basin

- Total of 279 wells drilled in the Canning Basin since early 1920's
- 265 wells were drilled onshore and 14 wells were drilled offshore
- Hydrocarbon shows (specifically the gas show) of the various onshore wells were studied
- Number of wells was narrowed down to a total of 43 onshore gas wells
- A total of 7 tight gas occurrences were identified (as shown in the Table)

Tight Gas Wells – Onshore Canning Basin

Wells	Year	Operator	T.D. (m)	HC shows
Ellendale 1	1979	Amax Petroleum Pty Ltd.	3190.5	Oil and gas
Fitzroy River 1	1980	Amax Petroleum Pty Ltd.	3134.0	Minor gas kicks
Looma 1	1996	Shell Development Australia	2535.0	Oil and gas
Meda 1	1958	WAPET	2684.98	Oil and gas
Meda 2	1959	WAPET	2325.01	Oil and gas
Pictor 1	1980	BHP Petroleum Pty Ltd.	2146.0	Oil and gas
Point Torment 1 Deepening	1980	Stirling Resources N.L.	2603.6	Gas
Yulleroo 1	1967	Gewerkschaft Elwerath Inc.	4572.3	Gas
Yulleroo 2	2008	Arc Energy	3730.0	Gas

Tight Gas Wells – Onshore Canning Basin (continued)



SHALE GAS

- Shale gas is natural gas within fine grained, organic rich rocks of regional extent.
- Shale acts as both source and reservoir for gas
- Gas stored intersitially within pore spaces and or fractures and absorbed onto the organic components within the shale
- Although laterally pervasive the “shales” are highly variable in terms of reservoir properties and production capabilities
- At present, shale gas produces approximately 10% (2.0 TCF/year) of the daily consumption in the USA and is predicted to rise dramatically in the short term

Primary characteristics

- Regional extent
- Lack of obvious top seal and trap
- Absence of a well defined gas water contact
- Natural fracturing
- Ultimate recoveries generally lower than conventional accumulations
- Very low matrix permeability
- Heavily dependent on special drilling and completion technologies.

Common Properties of Shale Gas

- Large gas in place resources (10 to 200 BCF / over large areas)
- Low recovery efficiency (8 to 12%)
- High initial gas flow rates with steep decline to a long well life
- Large developments
- Need fracture stimulations
- The optimum depth appears to be between 1,500 and 2,500m due to reservoir pressures and gas absorption and drilling / completion costs
- Optimum thickness, for both gas in place and operational constraints, appears to be in excess of 100m

Critical Parameters for developing Unconventional Gas

Infrastructure

- Access Roads
- Available Land
- Pipelines
- Water Supply
- Technical / Logistics Capability

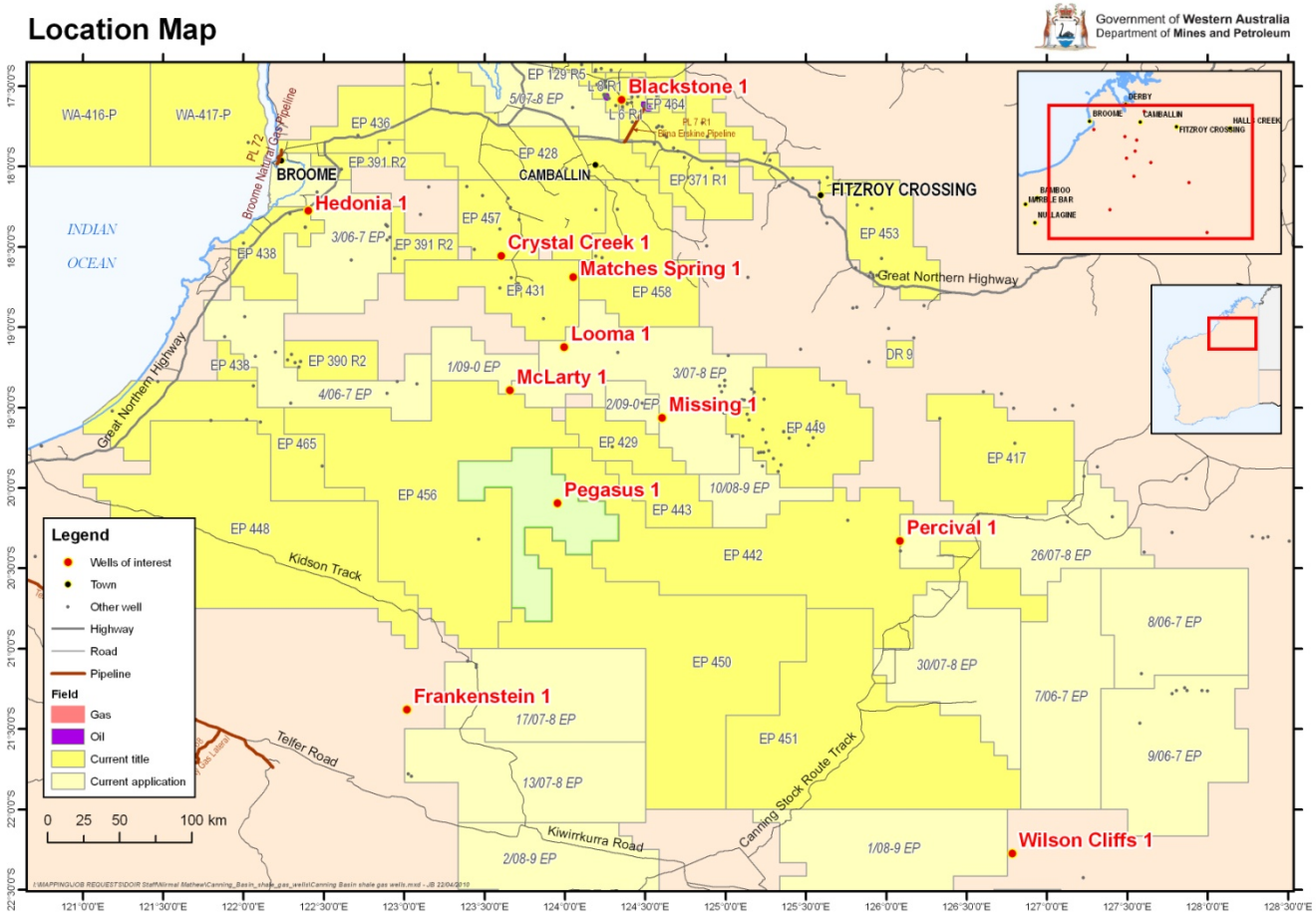
Technology

- Access to drilling and completion technologies developed for unconventional resources development

Shale Gas Wells – Onshore Canning Basin

Wells	Year	Operator	HC shows	Current Permit Status
Blackstone 1	1967	WAPET	Gas	LP-124-H
Crystal Creek 1	1988	Kufpec Australia Pty Ltd	Gas	EP 103 R2
Frankenstein 1	1988	Command Petroleum Holdings NL	-	EP 232 R1
Hedonia 1	1984	Gulf (Aust) Resources NL	Oil	EP 114
Looma 1	1996	Shell Development (Aust) Pty Ltd	Oil and Gas	EP 353
Matches Spring 1	1969	Total Exploration Australia Pty Ltd	Oil	EP 37
McLarty 1	1968	Total Exploration Australia Pty Ltd	-	LP-200-H
Missing 1	2001	Hughes & Hughes Australia Pty Ltd	-	EP 353 R1
Pegasus 1	1988	Amoco Australia Petroleum Company	-	EP 316
Percival 1	1985	Western Mining Corporation Ltd	Oil	EP 225
Wilson Cliffs 1	1968	Australian Aquitaine Petroleum Pty Ltd	Oil	LP-199-H

Shale Gas Wells – Onshore Canning Basin



WAY FORWARD

- WA has huge potential for Unconventional Resources
- It is not unreasonable that unconventional gas resources could match or exceed WA offshore conventional gas reserves
- Some estimates of Queensland Coal Seam Gas puts the resources at 270 TCF (twice the current WA conventional gas resources)

Market Drivers

- Increasing Demand
- Decreasing Supply
- Increasing Price
- Short term markets to supply local resource projects and infrastructure developments
- Large local companies are seeking alternative sources of gas supply
- Medium term contribution to the domestic gas supply network through pipeline extensions
- Longer term aim to add to potential gas reserves for LNG hub currently proposed for development by Woodside at James Price Point to help meet any shortfall for LNG trains that are being proposed

WAY FORWARD

Issues and Challenges

- High Recovery Cost
- Price Volatility
- Land Access
- Shale gas production at economic rates depends primarily on the volume of gas in place, matrix permeability and completion quality.
- Gas in place is often the critical factor for evaluating economics, taking precedence over matrix permeability and completion quality.
- Reservoir / Fluid Compatibility (Drilling and Frac Fluid)

THANK YOU