



Hot Rock Limited

A Review of Current Geothermal Development Activities in the Otway Sedimentary Basin, Victoria, Australia

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SMU Conference, Dallas

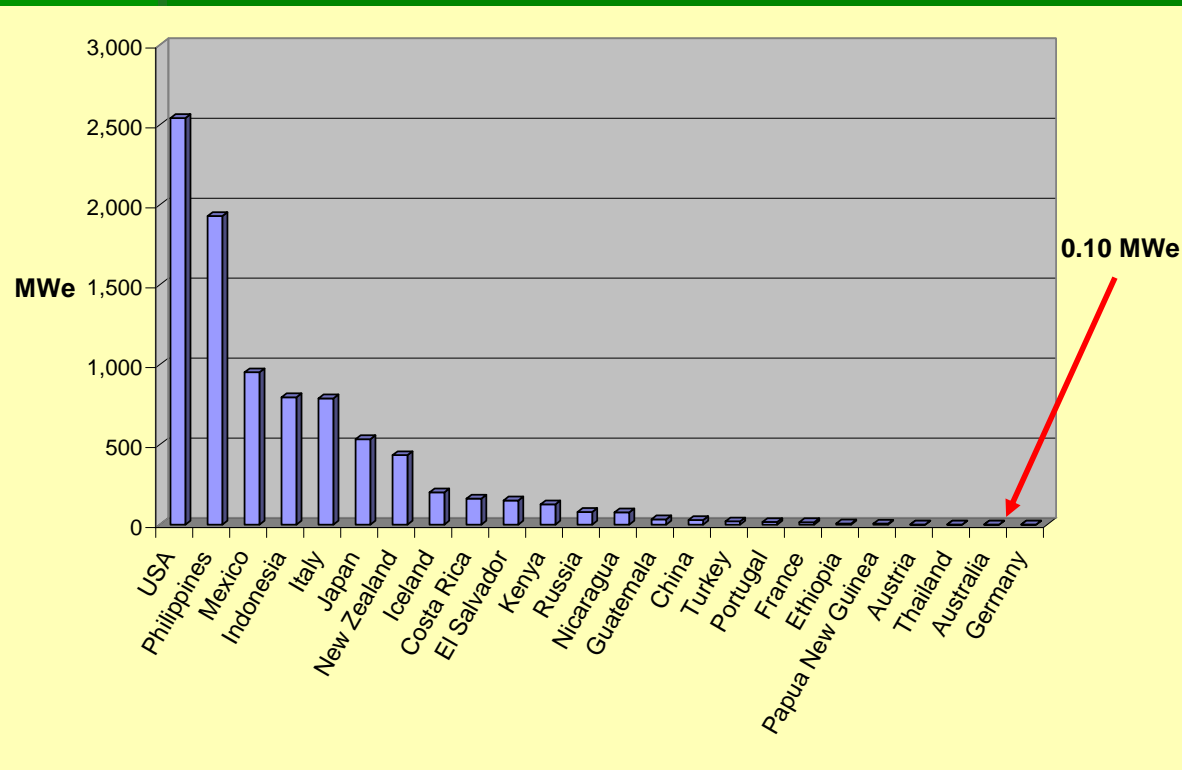
17-18 June, 2008

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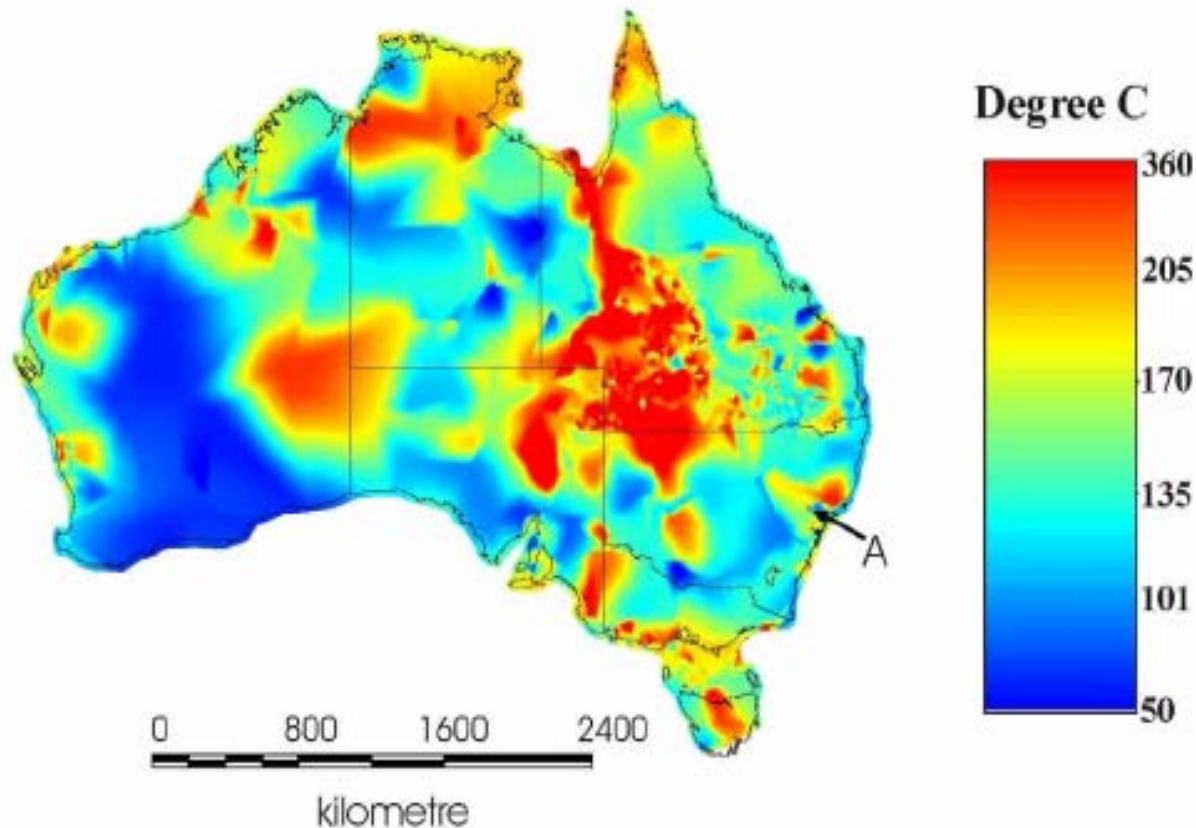
Australia's current geothermal generation capacity



Birdsville, 80 kWe net ,ORC power plant

Australia's future geothermal generation capacity?

- **Potentially HUGE**



Strong drivers for geothermal development in Australia

- **Vast sources of deep heat**
 - In granites
 - In wet and dry sedimentary rocks above the granites
- **Pioneering “EGS” work by Geodynamics**
 - Cooper Basin
 - the ‘right’ tectonic environment
- **Recent strong Government support for renewables**
 - Reduction of large carbon footprint
 - Wind
 - Geothermal
 - Solar
 - Geosequestration
 - Incoming Labour Government
 - Back on track with Kyoto Protocol
 - Providing grants
 - Regulatory supports and incentives
 - Absence of royalties in Victoria, MRET, REC’s,

Rapidly growing private sector involvement in geothermal

Geothermal Stocks	ASX	Price	Shares (m)	Options (m)	Mkt Cap (\$m)	Area	Model
Geodynamics	GDY	\$1.55	211.6	4.0	334	SA/NSW	HDR
Eden Energy	EDE	\$0.34	166.8	86.5	86	Focus on hydrogen	HDR
Petratherm	PTR	\$0.85	57.9	13.1	60	SA/Spain	HDR/HWR
Geothermal Resources	GHT	\$0.66	33.0	1.8	23	SA	HDR
Torrens Energy	TEY	\$0.40	50.1	28.2	31	SA	HDR
Green Rock Energy	GRK	\$0.10	159.7	2.2	16	SA/Hungary	HDR
Panax Geothermal	PAX	\$0.17	110.0	17.0	22	SA/India/Kyrgyzstan	HWR
KUTh Energy	KEN	\$0.21	53.7	0.3	11	Tasmania	HDR
Greenearth Energy	GER	\$0.11	66.7	61.4	14	Victoria	HWR
Hot Rock	HRL	\$0.13	61.2	6.0	9	Victoria	HWR

as at 18 June 2008

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Note:

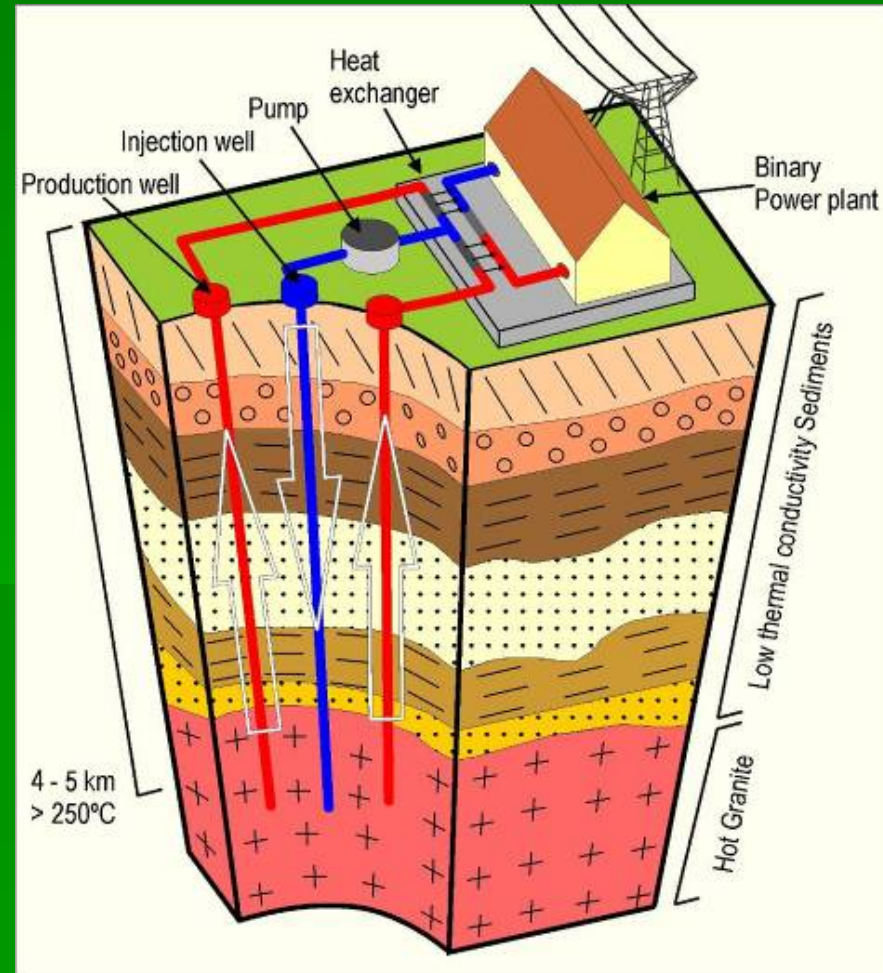
HDR Hot dry rock model - granite 4-5km depth

HWR Hot wet rock model - sedimentary aquifers: 3-4km depth



Types of Australian Geothermal Resources

- High temperature granites $>200^{\circ}\text{C}$
 - Naturally impermeable / require fracturing
 - “HDR” / “HFR” / “EGS”
- Moderate temperature sedimentary, $100\text{--}200^{\circ}\text{C}$
 - Naturally permeable
 - “HWR”, “SG”
 - Naturally impermeable
 - thermal insulators above granites
 - “HEWI” (Petratherm)
 - “EGS”



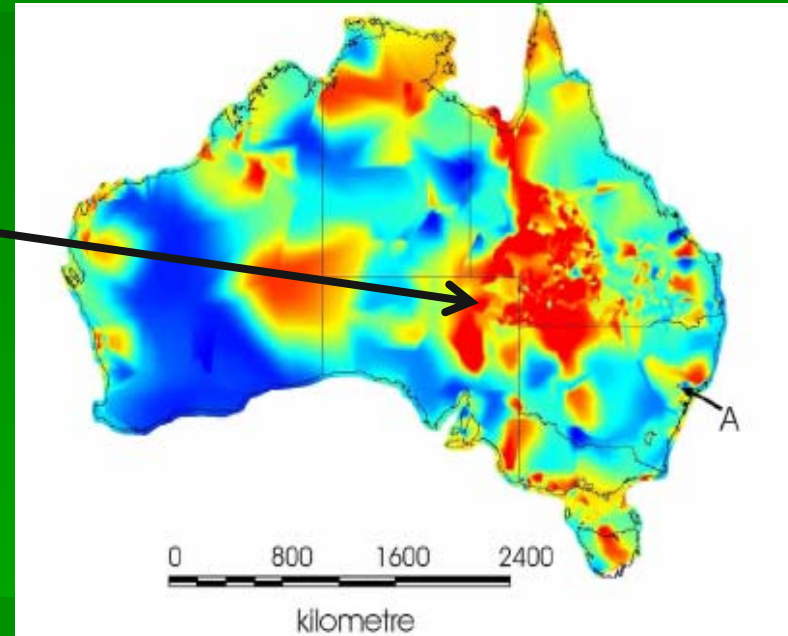
Location of “HDR” / “HFR”/ “EGS”

- HDR resources widespread
- Current interest largely focussed in SA /QLD border area

- particularly in the Cooper Basin in SA
- identified by O&G industry through extensive drilling in Cooper Basin over the past 30 years

- HDR has been main focus in the establishment of the geothermal industry in Australia

but generally projects have been at a considerable distance to major power markets



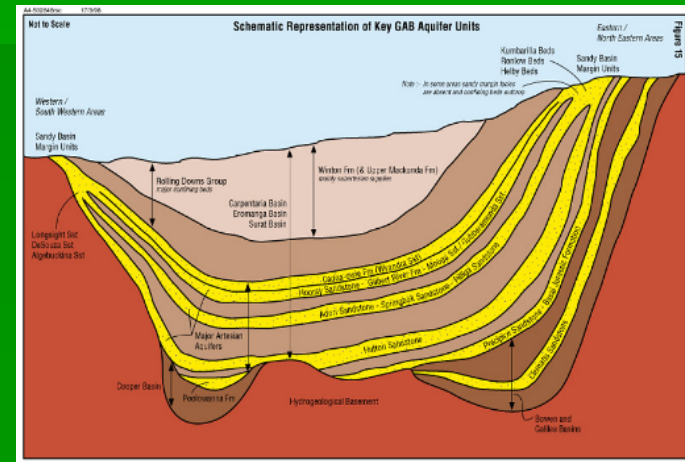
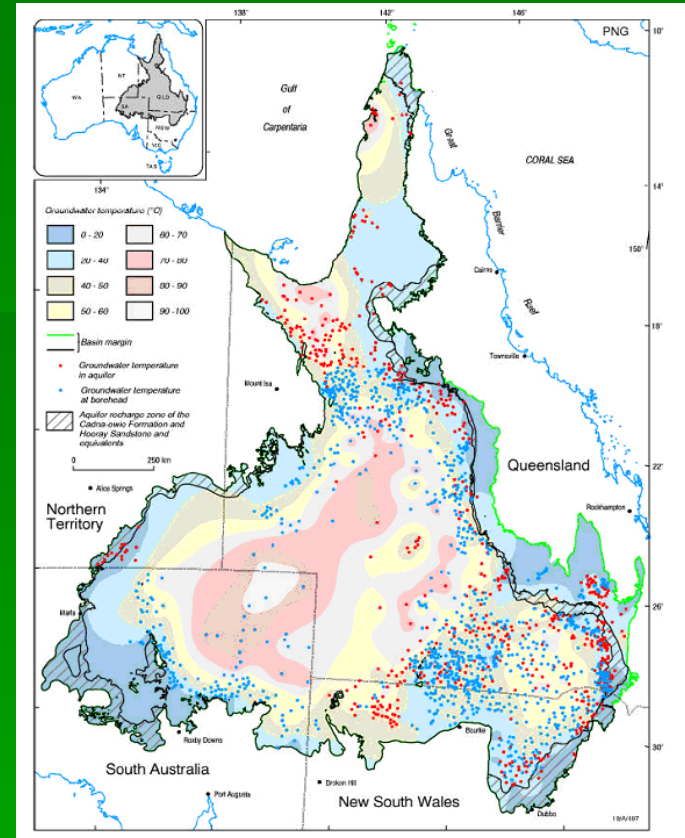
HRL focus is on “Sedimentary Geothermal”

- **Naturally permeable systems**
 - Don't require hydro fracturing
- **Naturally wet**
 - Don't require injection of water / circulation loop
- **Lower development costs due to**
 - Shallower production drilling targets
 - Higher well flow rates
- **Lower operating costs**
 - Reduced parasitic pump costs
- **Lower Risk**
 - Proven production and power plant technology
 - 100 year history of geothermal electricity generation
 - commercial geothermal power projects in 24 countries
 - 9,000 MWe installed

Sedimentary Geothermal:

1. Great Artesian Basin

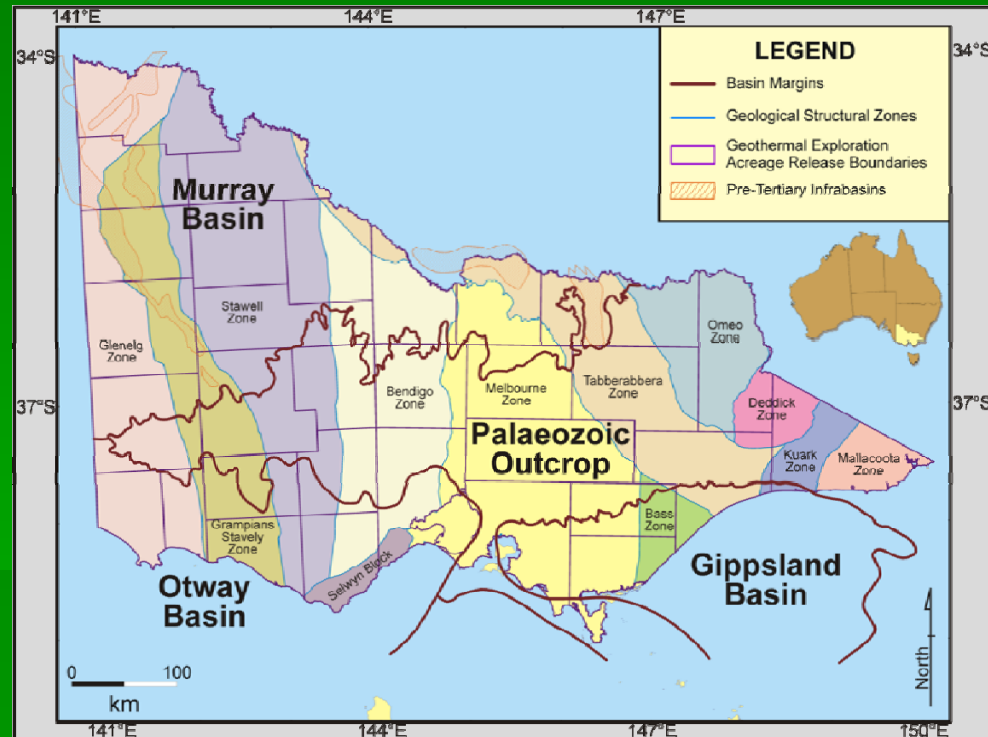
- Very large basin of artesian water
- Heated in parts as fluid flows over deep granite “hot spots”
- Water temperatures typically around 100°C
 - e.g. Birdsville 100kWe plant



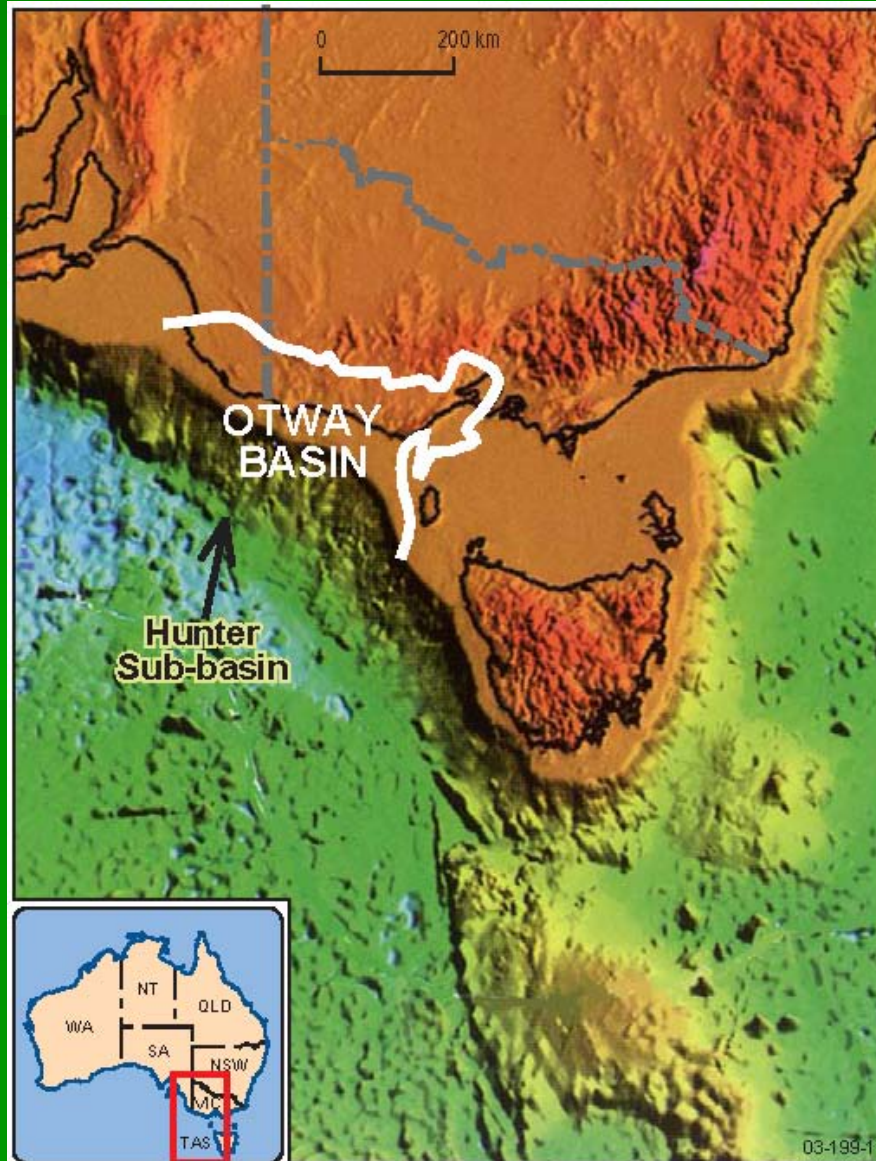
Sedimentary Geothermal:

2. Basins in Victoria and SA

- 3 Major Sedimentary Basins
 - Otway Basin
 - Gippsland Basin
 - Murray Basin
- Of considerable current exploration and development interest
 - for renewable electricity developments close to urban and industrial markets



Onshore extent of Otway Basin



Onshore outcrops of Otway Basin sedimentary rocks



Otway Basin - Stratigraphy

- Thick sequences of:
 - Low permeability msts and zsts (thermal insulation)
 - high porosity / permeability clean ssts
- Crustal thinning as a result of rifting
 - Elevated heat flow
 - Voluminous recent basaltic volcanism

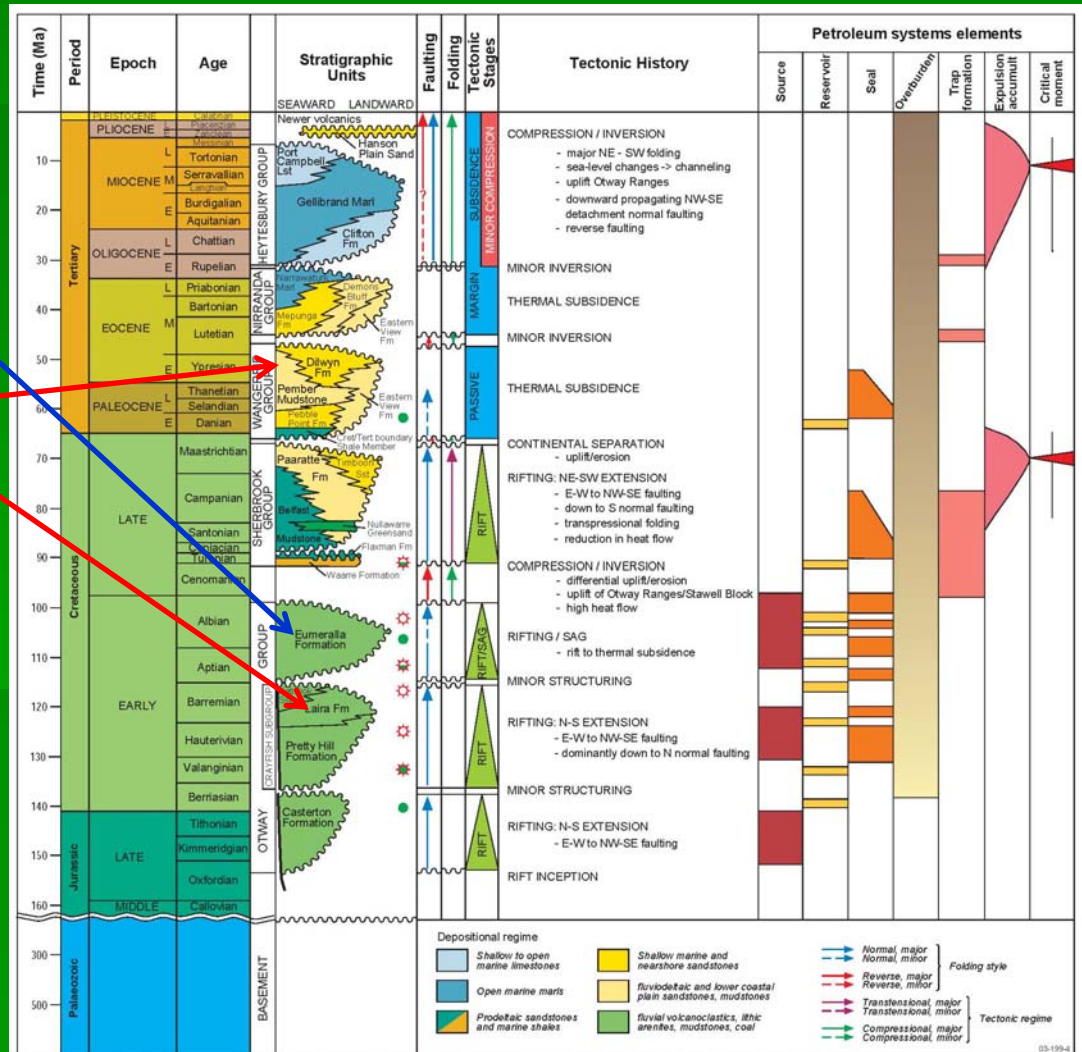


Figure 4. Stratigraphic chart, showing tectonic history and petroleum systems elements.



Otway Basin – recent volcanism



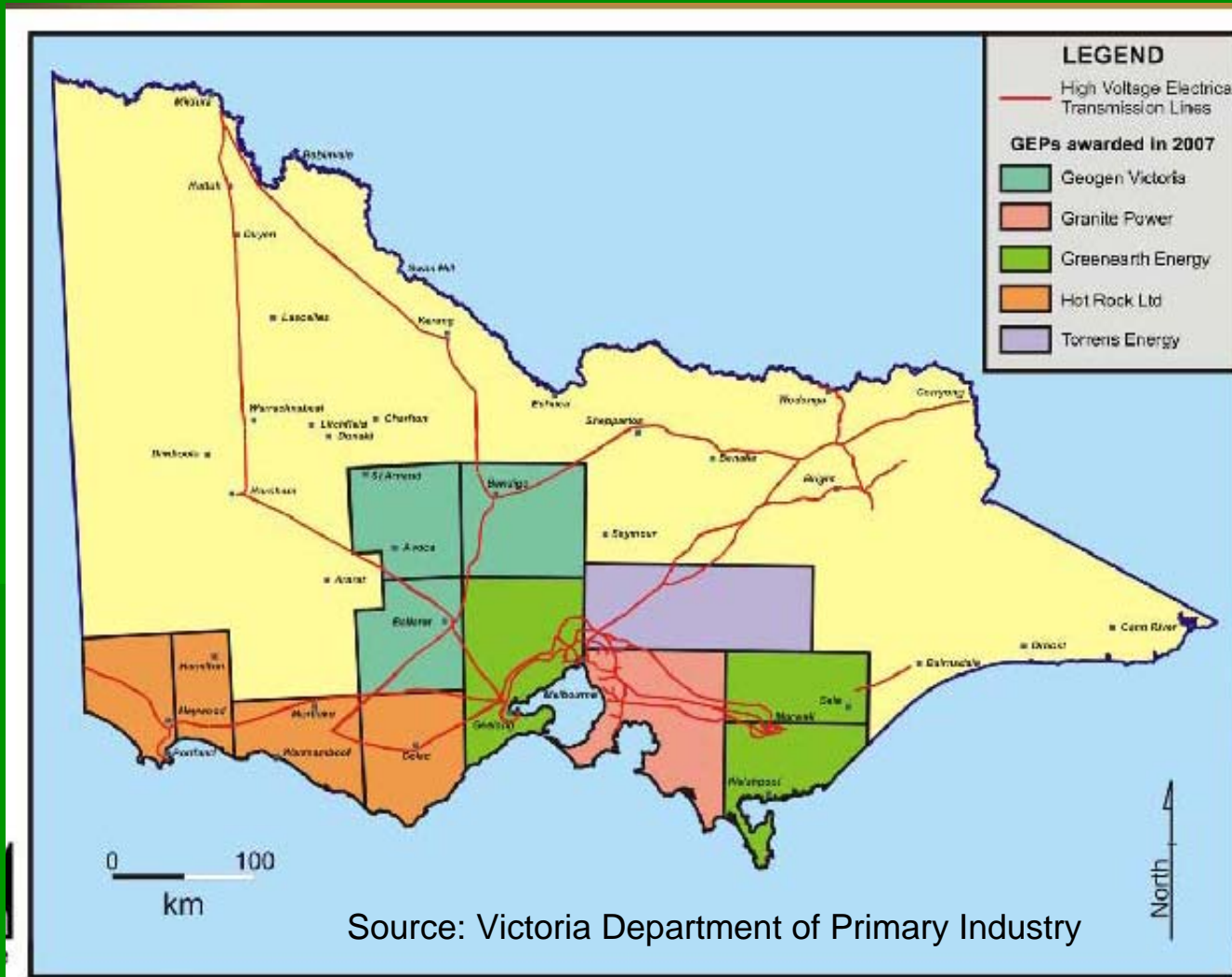
Otway Basin – recent volcanism



HRL focus is on Victoria

- HRL was formed in 2006 to specifically target sedimentary geothermal developments in Victoria
 - existence of extensive Oil & Gas well database
 - attractive “SG” / “HWR” targets
 - favourable regulatory environment:
 - no State Government royalties
 - full support from State Premiere and Minister
 - surrounded by large power market and infrastructure

Victoria State – tenements awarded in 2007



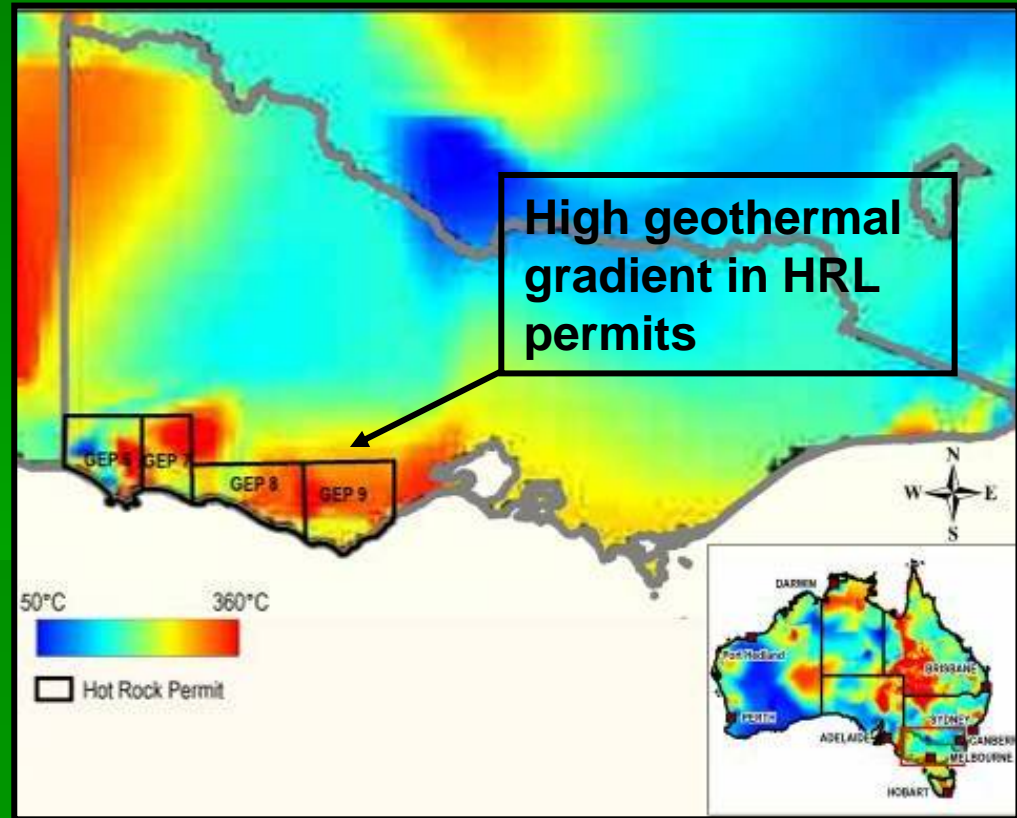
Close proximity to markets & transmission lines

- **High capacity transmission lines**
 - Connected to capital cities
- **Existing infrastructure**
 - cities, roads etc
- **Large nearby customer base**
 - Regional & city population +5m
 - Industrial areas at Portland, Hamilton, Ballarat, Geelong, Melbourne & Adelaide



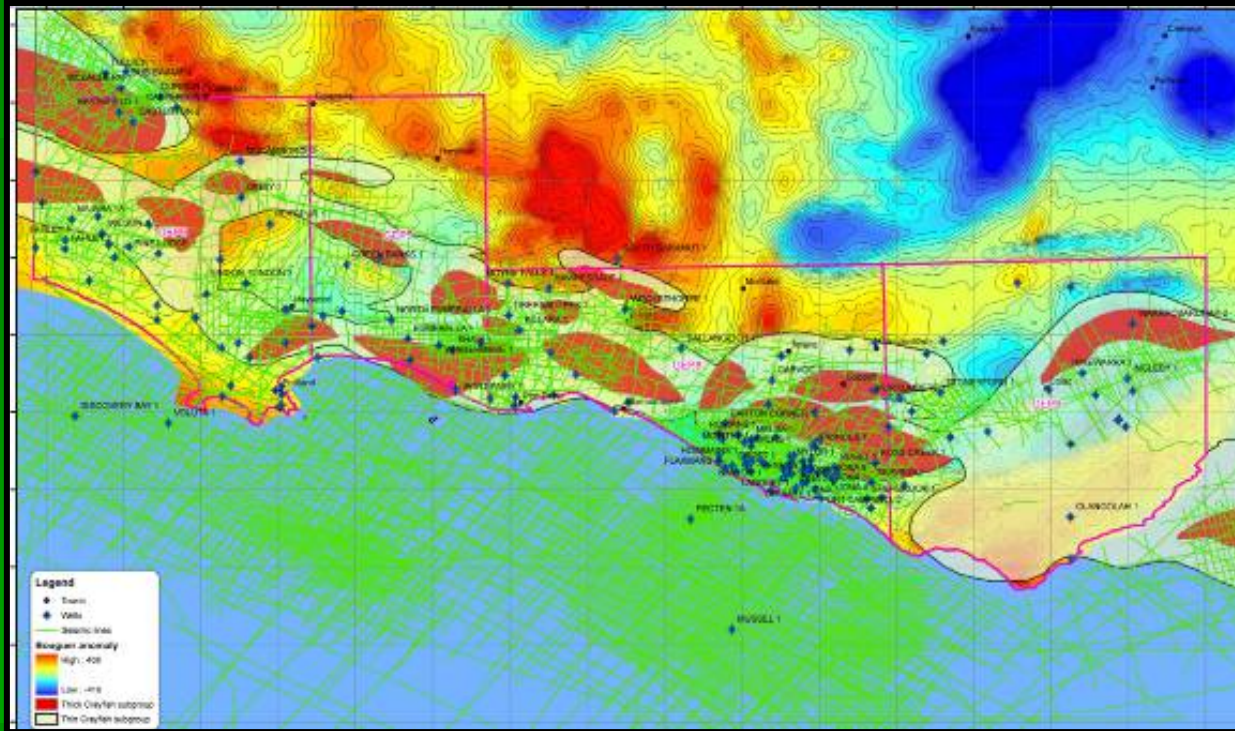
HRL Otway Basin Geothermal Permits

- 4 permits cover large area of prospective Otway Basin (+18,000sqkm)
- Anomalous geothermal gradients
 - Elevated heat flow up through basement
 - Structurally controlled upflows of hot fluids from depth to shallow levels
 - Some association possible with young volcanic



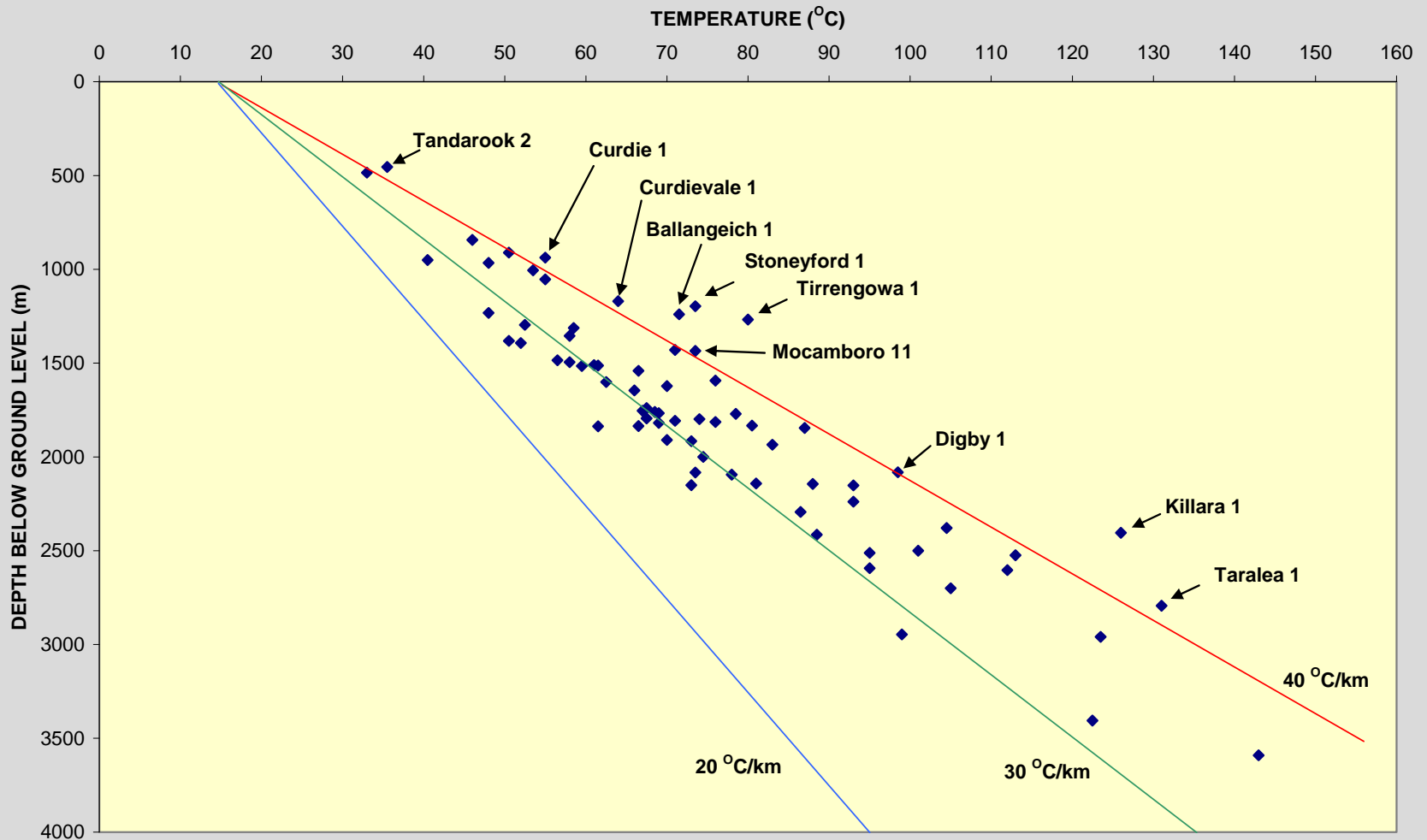
Very large amount of surface & sub-surface data exists and is readily accessible

Invaluable existing exploration and well data

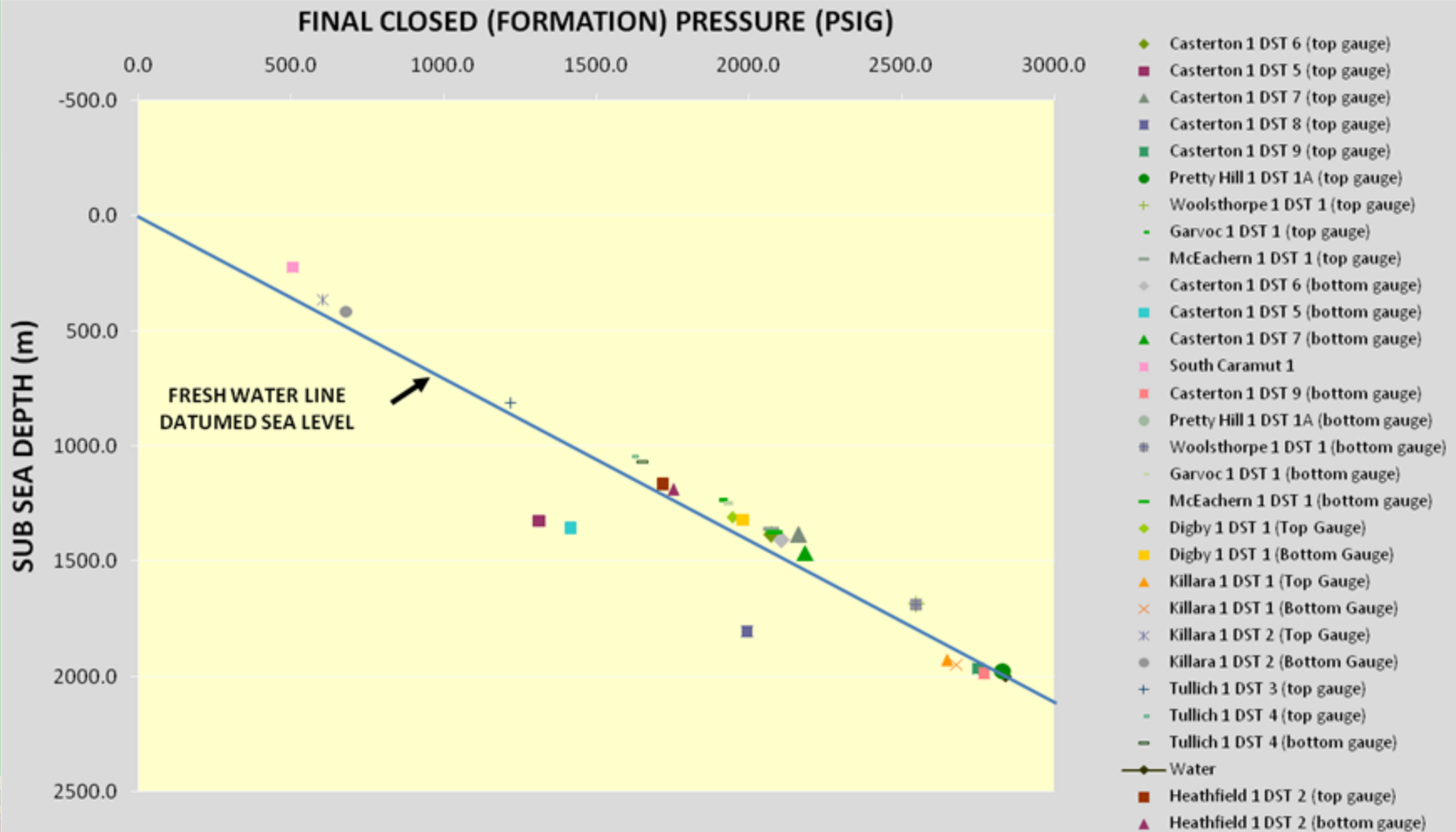


- **Decades of active oil and gas exploration**
 - **Aeromagnetics**
 - intrusives & volcanics
 - **Gravity**
 - basin troughs
 - **Extensive seismic**
 - > 14,000 line-km
- **>180 wells drilled within HRL permits**
 - **In situ geothermal data from existing O&G wells**
 - basin fluids at +140°C
 - suitable for generating electricity

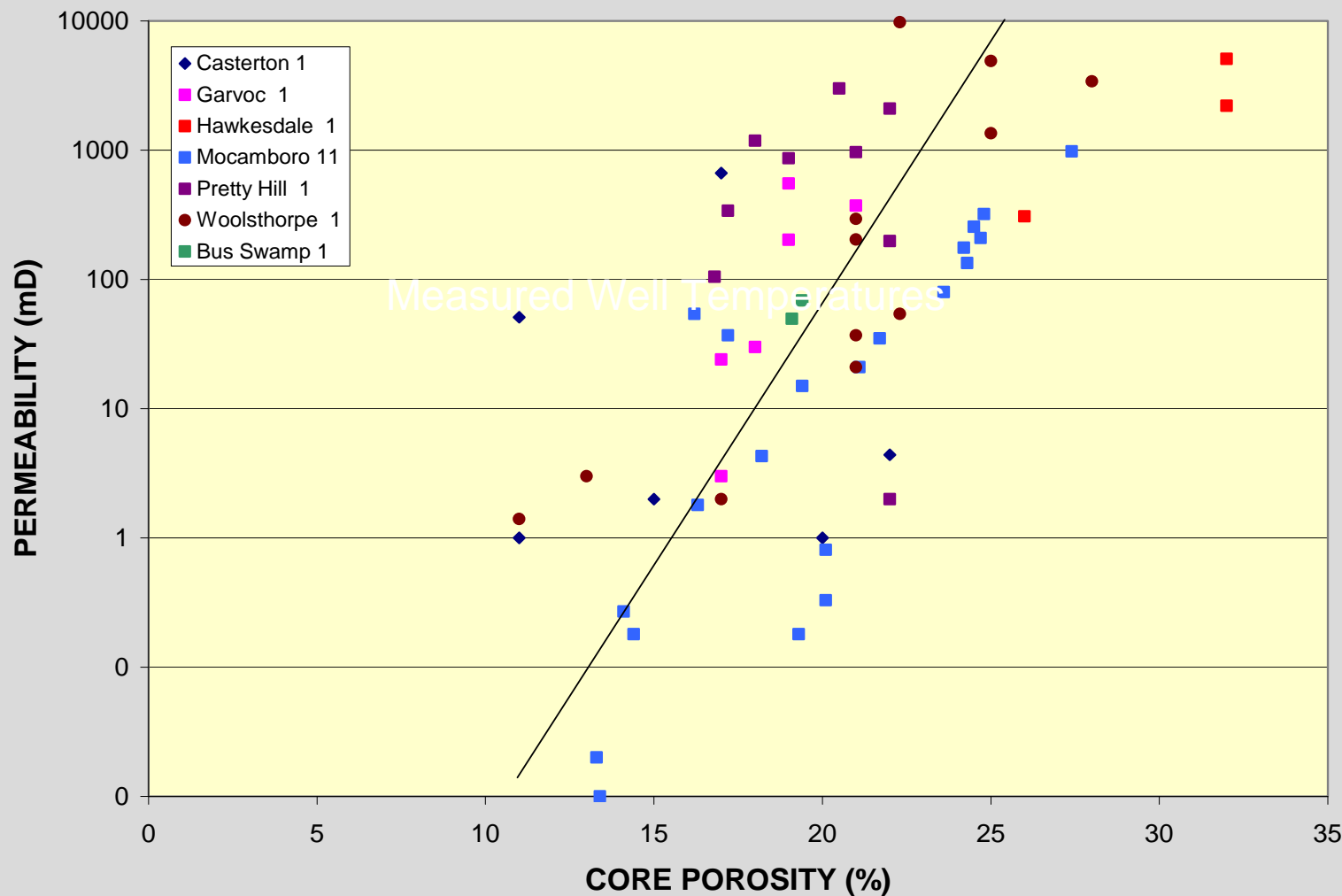
Otway Basin wells - measured temperatures



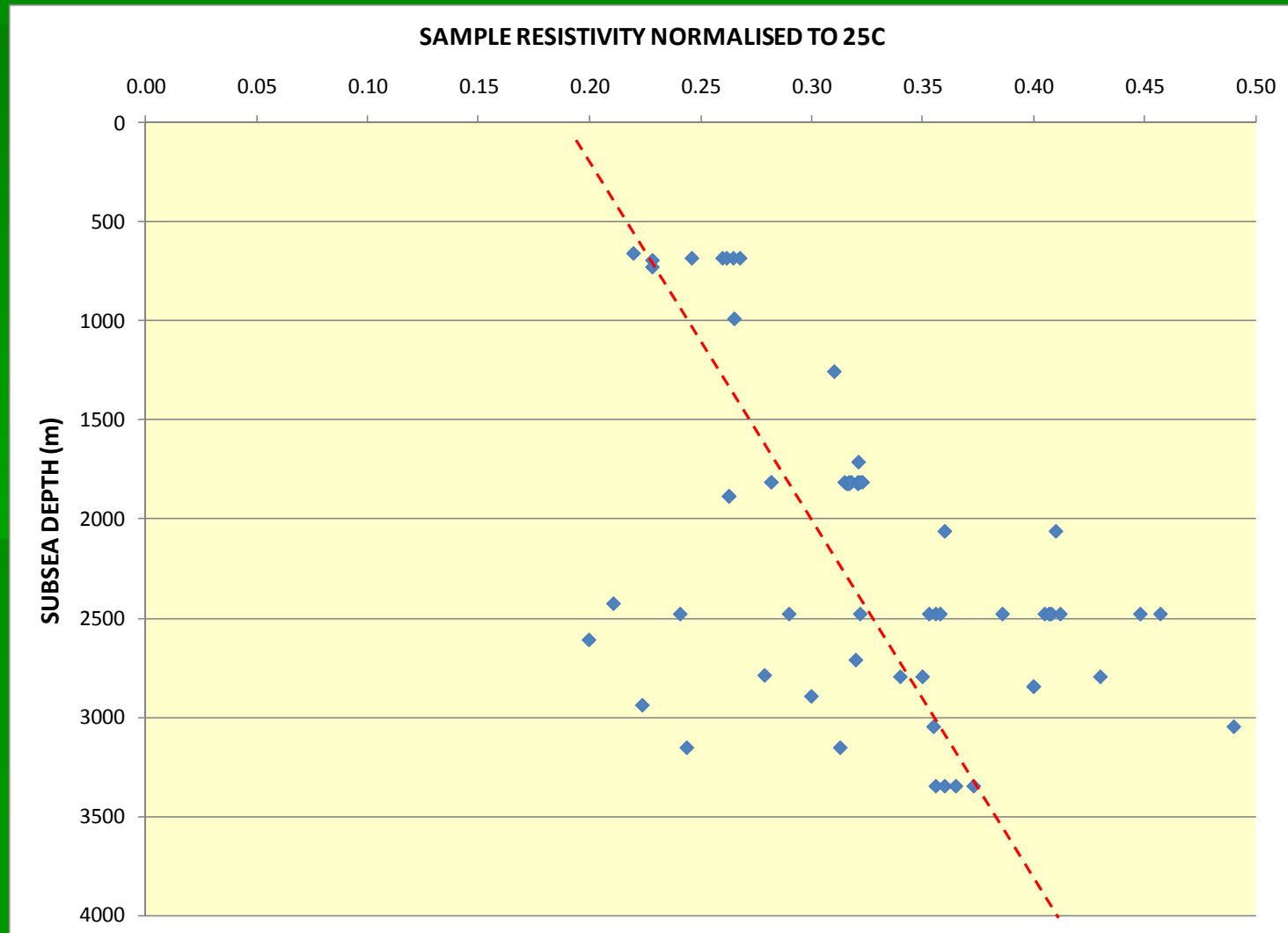
Otway Basin wells - measured pressures for depth



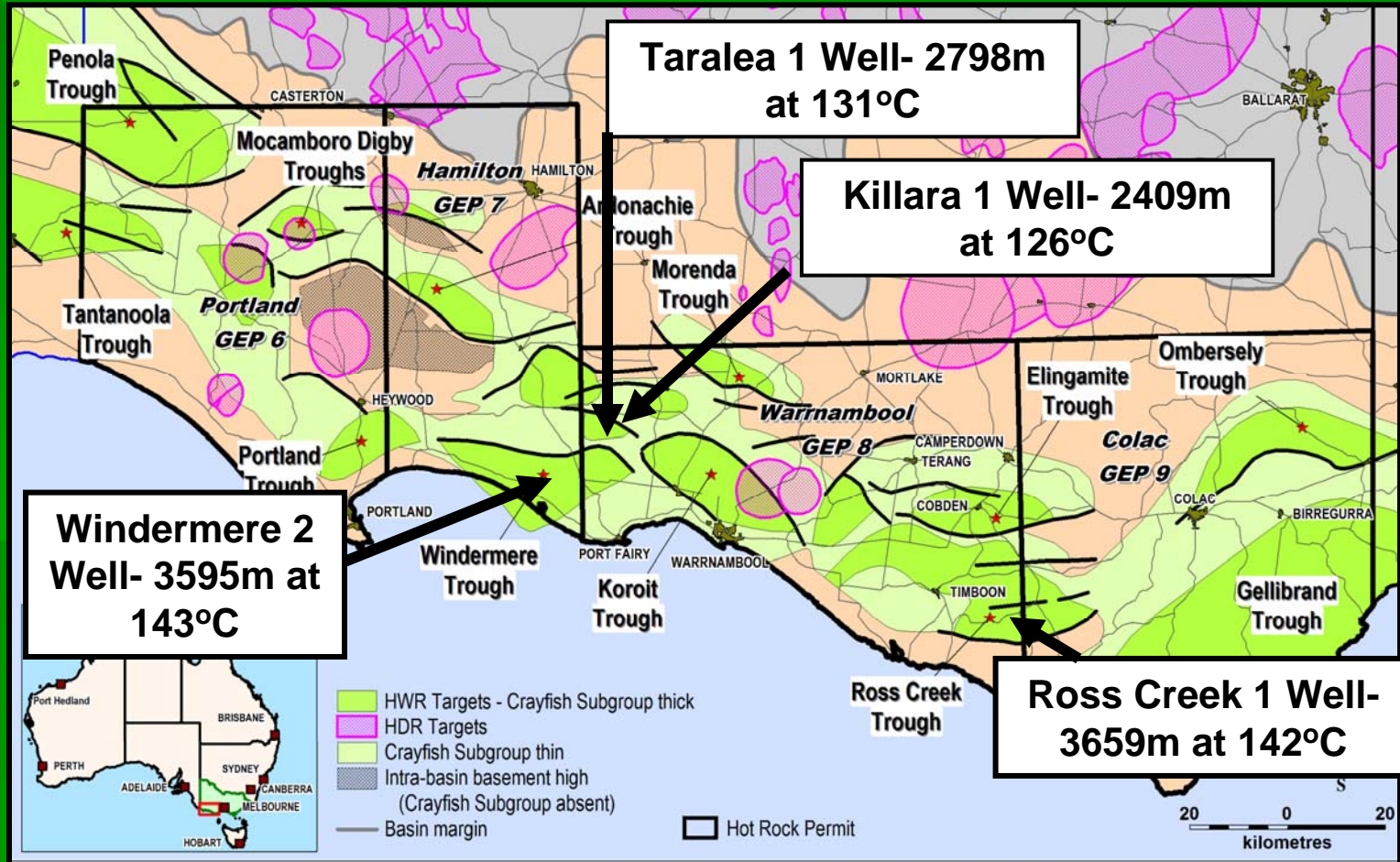
Otway Basin wells - measured core permeabilities & porosities



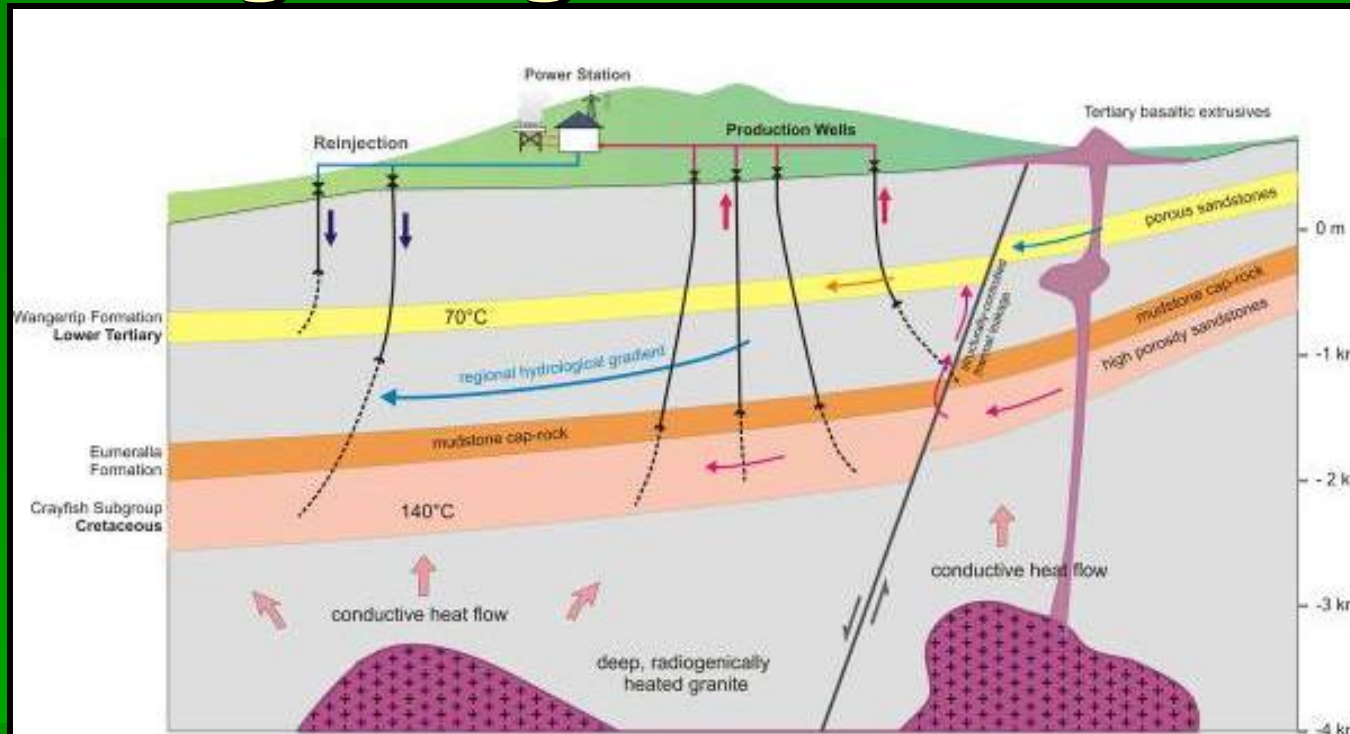
Otway Basin wells - measured formation water salinities



Hot Sedimentary Rock Discoveries in Crayfish Subgroup



Otway sedimentary basin hydro-geological model



- Large sedimentary basin with several hot aquifers
- Geothermal reservoir contained in Early Cretaceous Crayfish Group
 - Up to 800m thick aquifer / High porosity 20% / High perm (1000 mD)
 - Temperatures of at least 142°C + at 2,700m to 3,500m depth
- Developable with low risk, proven HWR technology²⁷

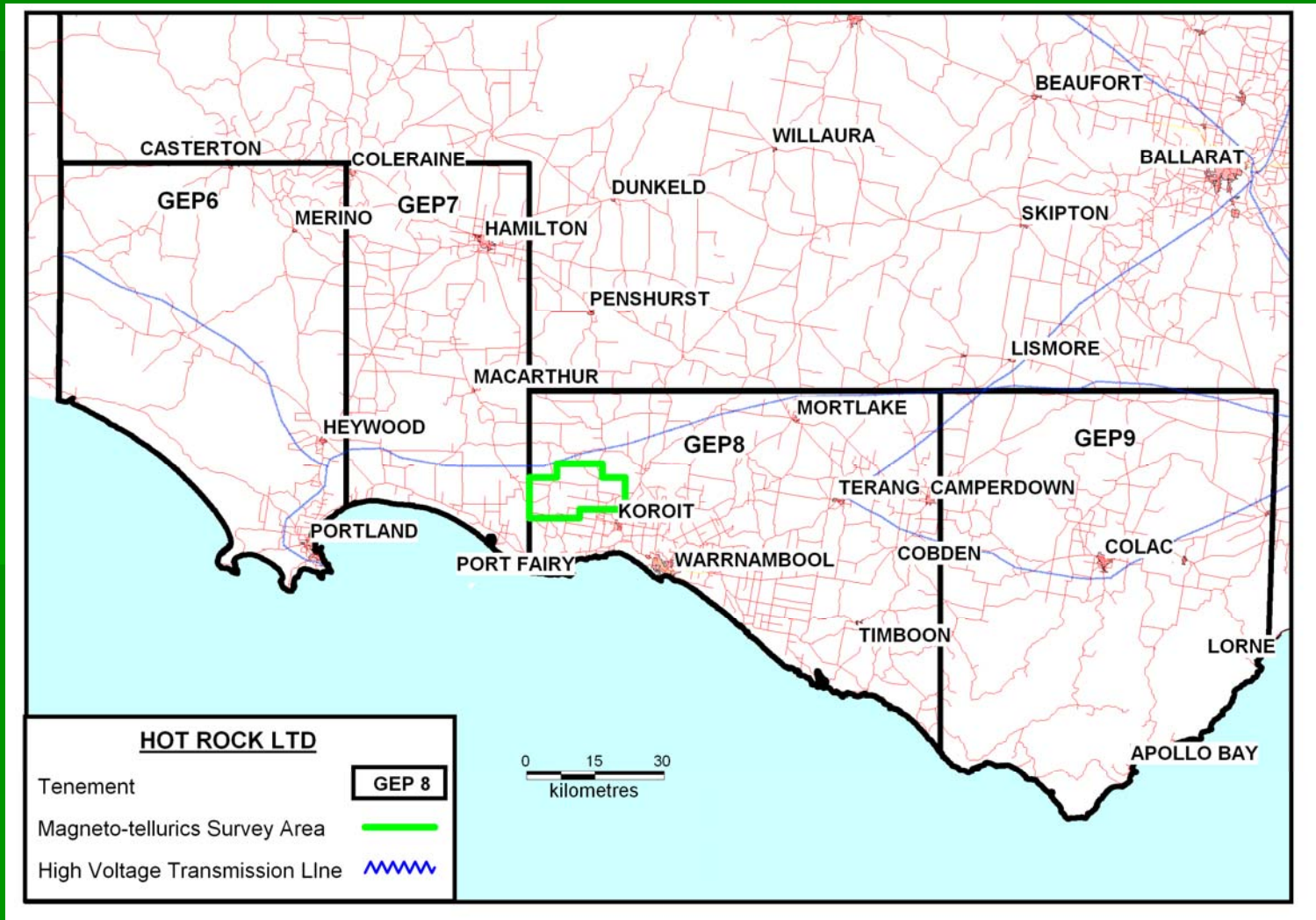
Initial assessment of geothermal resource capacity

- **Volumetric stored heat calculations for 17 geothermal “depo – centres” in 4 GEP’s, based on simple conceptual exploration model with conservative assumptions yield:**
 - potential power generation targets ranging from 300 to 720 MWe per prospect, 1750MWe in total
 - 40% of Victoria’s base load power
 - potential total annual gross revenues of A\$ 1.1billion
- **Suggests initial pilot plant of 1MWe with series of staged subsequent commercial power developments with a capacity of 50 MWe per plant**

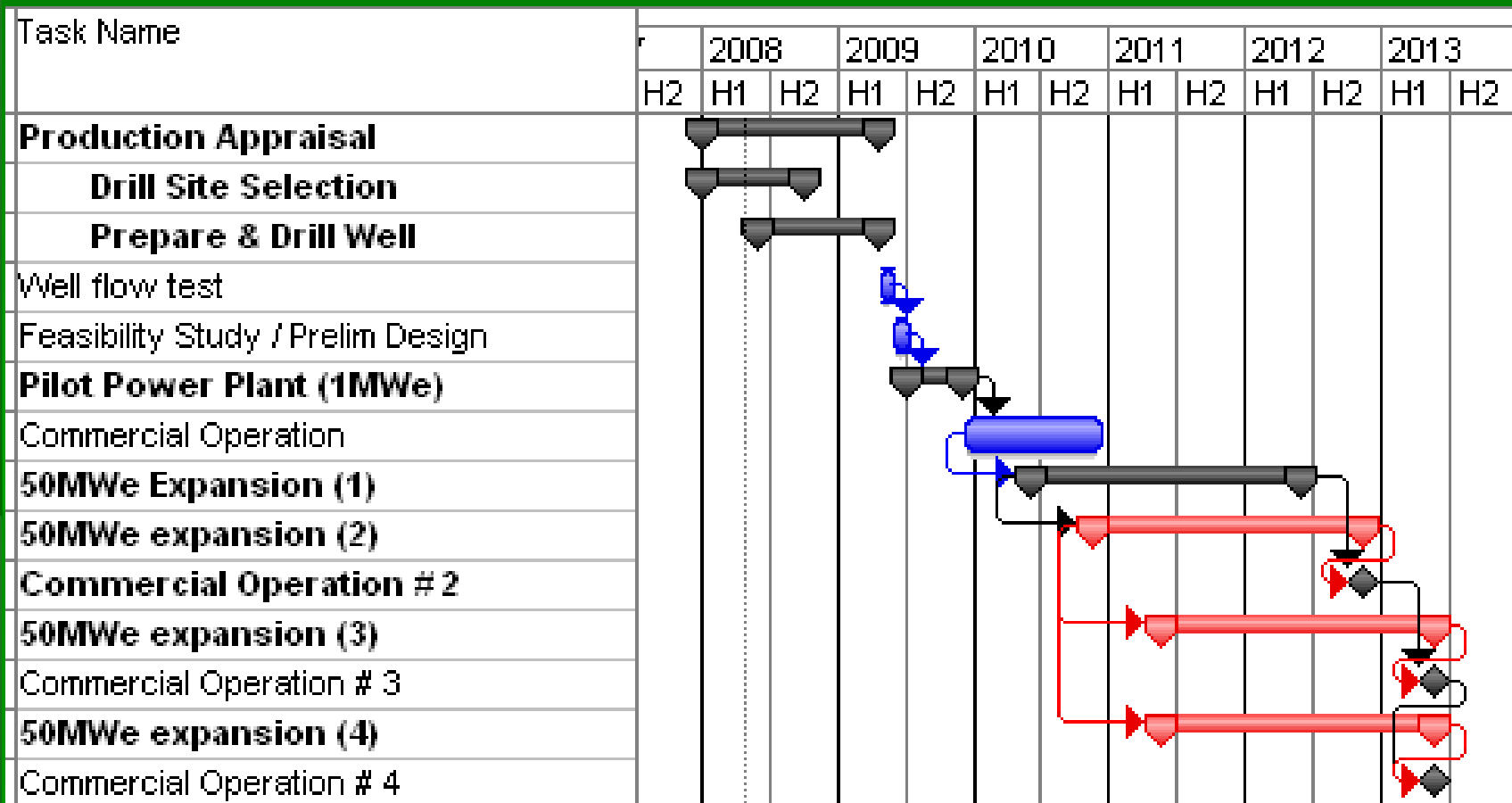
Current Status HRL Program

- O&G data from 4 GEP's evaluated and extended
- 4 geothermal discovery wells have been identified
- Koroit area prioritised for short track production appraisal drilling and testing program
 - have formed a drilling club to share mobe/demobe costs
 - drilling to commence early 2009
 - 200 station MT survey in progress for target selection
- Expect to progress directly to 1MW pilot plant
 - for installation and commissioning by end 2009
 - aiming to be first commercial geothermal in Victoria
- Currently seeking farmin partner
 - arrangements to be concluded by mid July 2009

Koroit Area: Priority Development Target



Anticipated Longer Term Program at Koroit: up to 4 x 50MWe by 2013

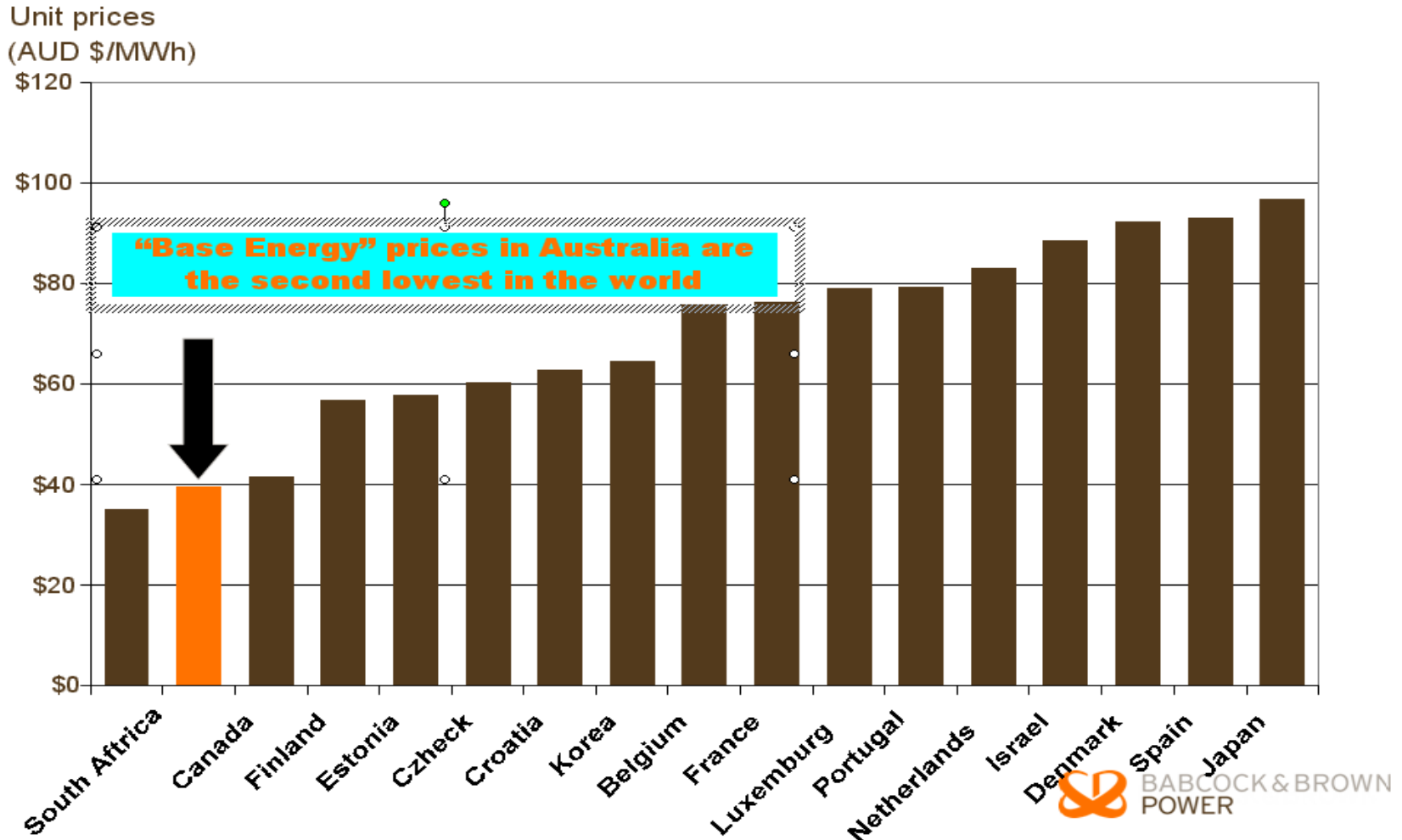


Market Considerations

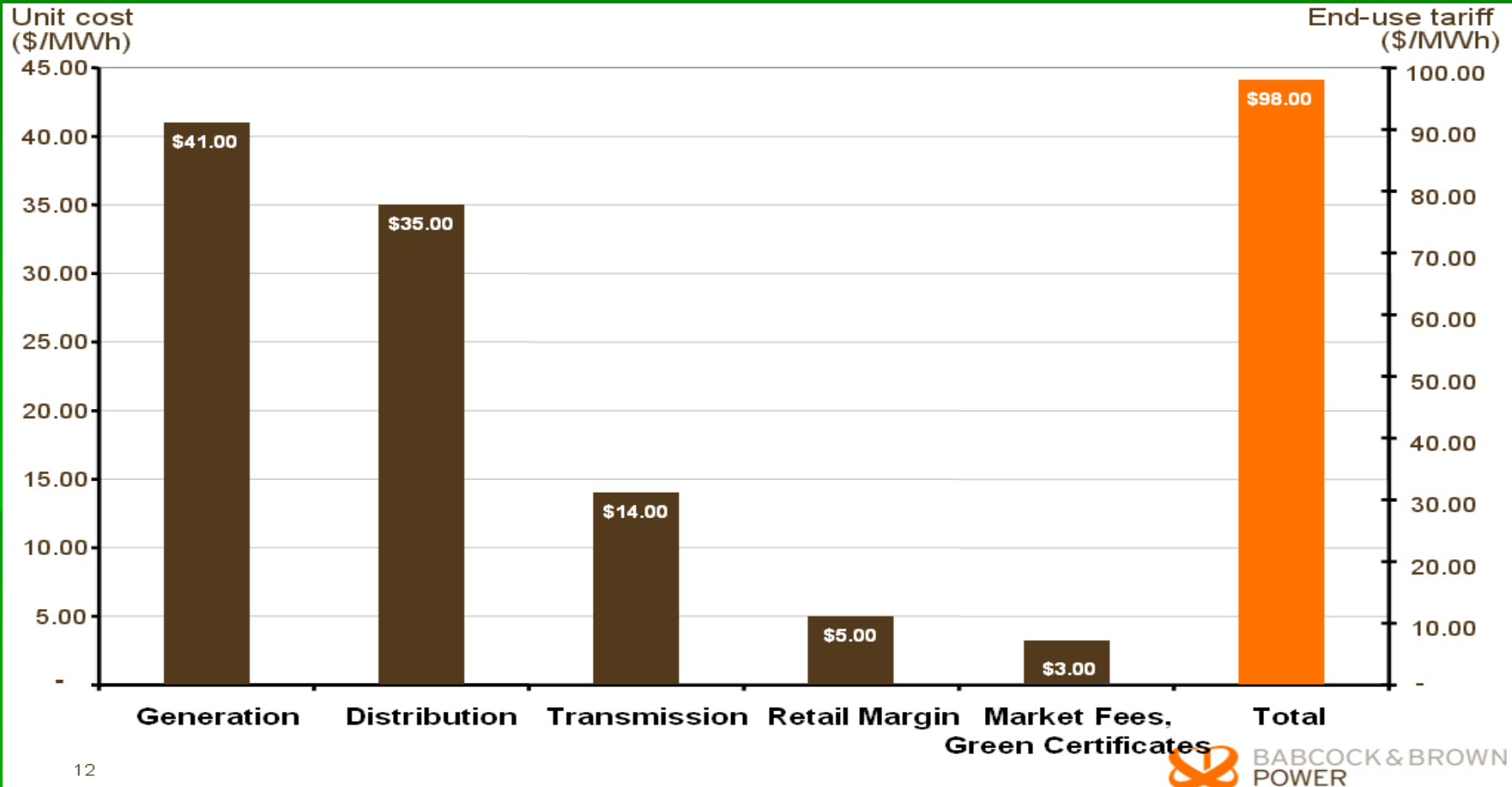
- **Good geothermal market in Victoria**
 - For both electricity and cascaded waste heat from power plant
- **Potential off-takers:**
 - Utilities
 - Local LV (22kV and 66kV) and HV
 - Industrial
 - Alcoa aluminum smelter
 - Dairy Industry (Goulburn Co-op)
 - Portland City (hot water)
 - Timber chip and pulp industry (drying)

Comparison of Australia Power Prices

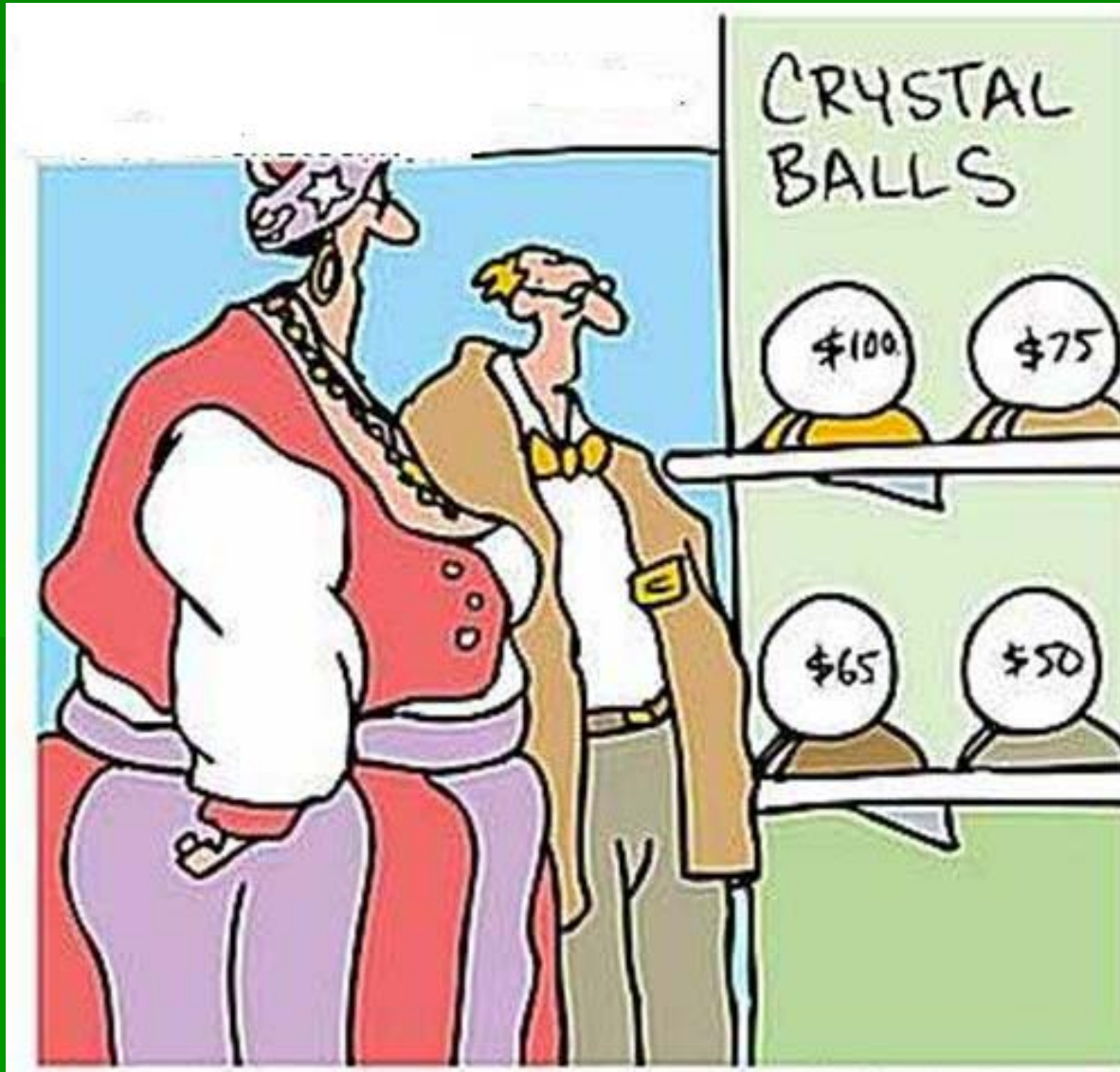
(source: Babcock and Brown Power)



Composition of average power price in Australia - 2007 (source BBP)



Development Costs / Costs of Power ?



HRL Development Assumptions

- **Production wells**
 - depths 3,500m
 - 12-1/4 inch holes to 3500m with 13-3/8 inch PCsg
 - shallow down-well electric production pumps
 - 4 MWe per well production rates
 - 16 wells for 65MWe gross / 50MWe net development
- **Injection wells**
 - depths 1500m
 - 13 wells required for 50MWe net plant
- **Power Plant**
 - Organic Rankine binary cycle plant
 - 140C inlet T / 80C outlet T
 - short local transmission line included
 - interconnection costs included



Key financial assumptions

- **Assume Project Finance**
 - Debt to equity 70:30
 - Loan interest rate 10% p.a.
 - Loan term 10 years
- Discount rate 10% .
- Inflation rate 2% p.a.
- Corporate tax rate 30%
- Depreciation 10% p.a.
- IRR of 10%

Assessed Costs for HRL 65MWe (gross) development

- **Capital Cost**
 - \$US300m
- **Specific Capital Cost**
 - \$US 4,600 / kWe
 - (wells, power plant, transmission)
- **Power tariff**
 - \$100 to \$110 / MWh
 - LCOE over 25 years to yield 10% IRR

Incentives – State Level

- **Victoria Geothermal Act has no royalty**
- **VRET Scheme (Jan 2007)**
 - State government is committed to reducing Victoria's greenhouse gas emissions to 60% by 2050
 - mandates Victoria's consumption of electricity generated from renewable sources be increased to 10% by 2016
 - objectives to encourage additional generation of electricity from renewable sources.
- **Renewable energy fund of \$72million (April 08)**
 - ex Clinton Foundation
 - to assist large-scale sustainable demonstration energy projects, including geothermal



Incentives - Federal Level ..1

- Mandatory Renewable Energy Target (MRET) policy to be introduced to reduce the effects of climate change caused by greenhouse gas emissions
 - Aiming for 2% of Australia's power supply from renewable sources by 2010 and 20% or 42,000 (60,000 ?) Gigawatt hours by 2020.
 - MRET expected to replace VRET

Incentives - Federal Level ..2

- **Emissions trading scheme to be introduced 2010**
 - Renewable Energy Certificates (RECs) to be issued to eligible parties
 - RECs are sold by the holder to other registered groups and add to the renewable power generators income.
 - fossil fuel generators will need to add the cost of emission certificates to their generating costs
 - a maximum penalty for a power generator not complying with the emission targets is \$40 MWh for the power they sell
- **These changes are expected to:**
 - increase power prices, favouring renewables
 - cause a major shift in investment towards renewable energy sources as it becomes more competitive

Incentives - Federal Level ..3

- Federal government is also in advanced stages of planning for:
 - a \$500 million Renewable Energy grant fund
 - includes a \$50million drilling fund for geothermal production wells
- Objectives are to:
 - encourage early investment into renewable energy demonstration projects
 - expand the range of renewable technologies

Closing

- Interest in geothermal energy in Australia is growing at a very rapid pace
 - extensive effort is being applied to developing the technology required for commercial production from high temperature geothermal reservoirs in granites
 - development of moderate temperature sedimentary geothermal systems is now moving into production appraisal phase
- High level of support for fledgling geothermal industry from both Federal and State Governments
- It is expected the REC mechanism will allow geothermal to be competitive, even in the traditionally low cost Australian power market

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