



**Chief Scientist &
Engineer**

Questions of Power in NSW

The Four Societies Annual Meeting

THURSDAY 27 FEBRUARY 2014

Mary O'Kane, NSW Chief Scientist and Engineer

With remarks on ...

energy

Australia (not just NSW)

& some other countries even though ...

And thanks to ...

Grattan Institute

Energy Knowledge Hub (Newcastle)

NSW universities (incl Warren Centre)

ATSE (esp Martin Thomas)

& many individuals



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Why a talk about questions?

Because posing the right questions carefully can speed the time to a solution substantially



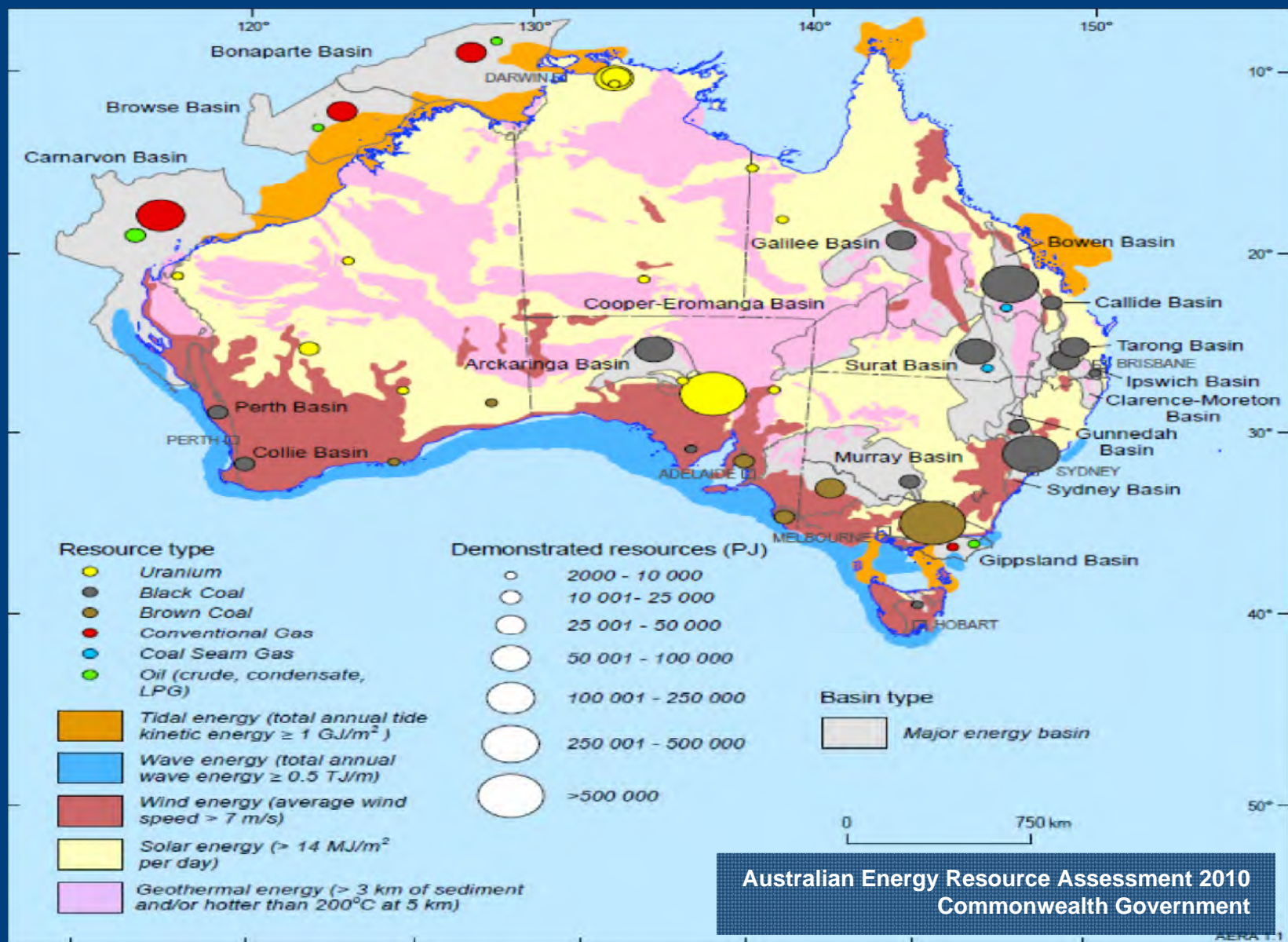
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Before questions,

some context



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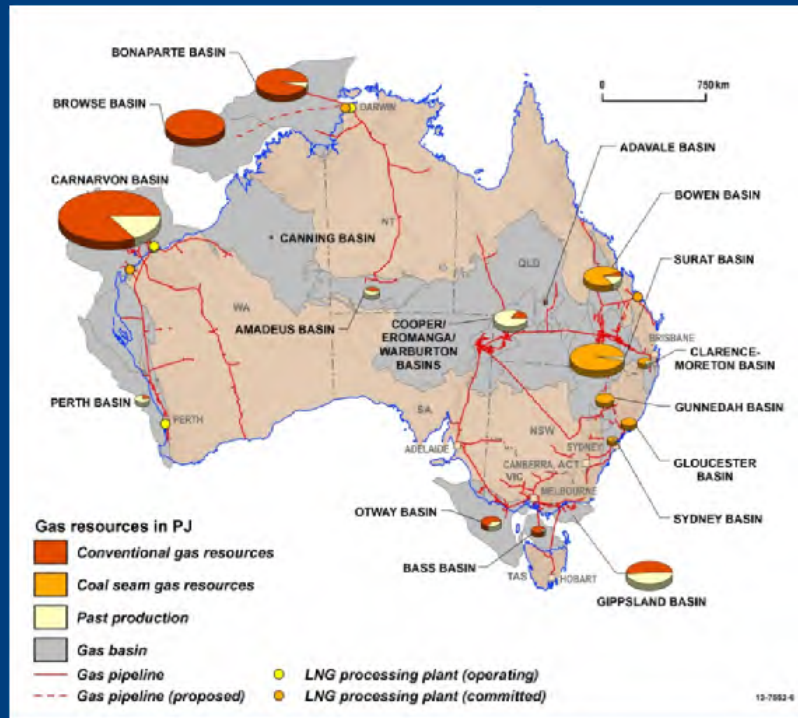


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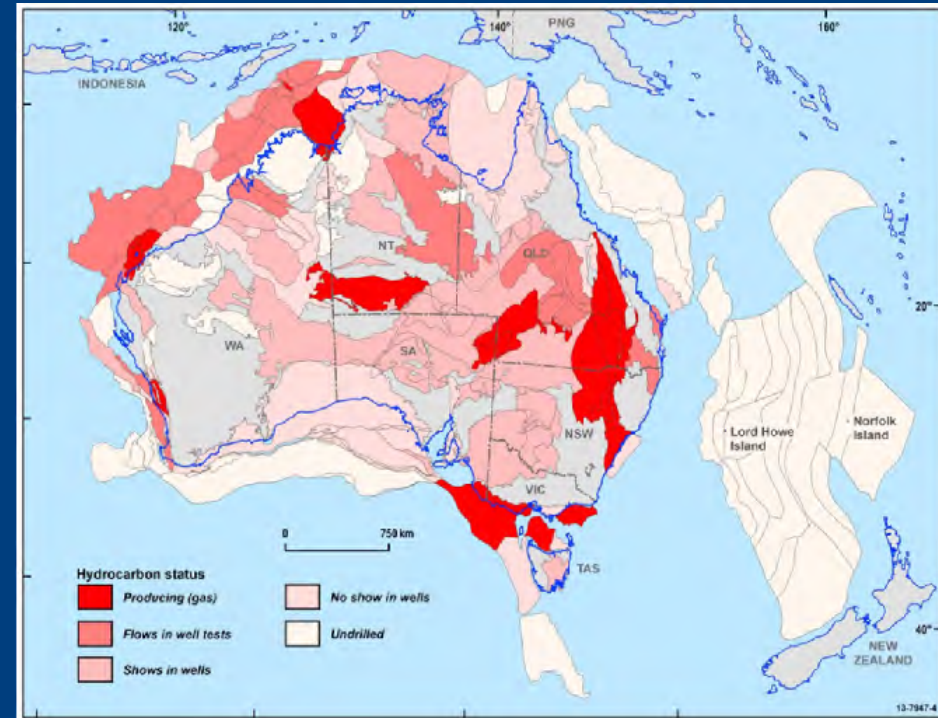
Australia's Oil & Gas Resources & Infrastructure

Clinton Foster, Marita Bradshaw & Andrew Stacey - Geoscience Australia

Current Resources



Opportunity space for discovery of more resources



Stakeholder Roundtable: *Transport Fuels for Australia's Gas Resources* 19 February 2014



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Australia in the World Energy Market

- Australia is **ninth-largest energy producer** = 2.7% of total global energy production
- Net energy **exporter** overall ... but net importer of oil and refined petroleum (gas rich; oil poor)
- Energy exports: 13,986PJ = \$77 billion (2011/12)
- Richly endowed with natural energy resources:
 - 38% of world's uranium**
 - 9% of coal**
 - 2% of natural gas**
- We are world's 20th largest consumer of energy

Australian in the World Energy Market

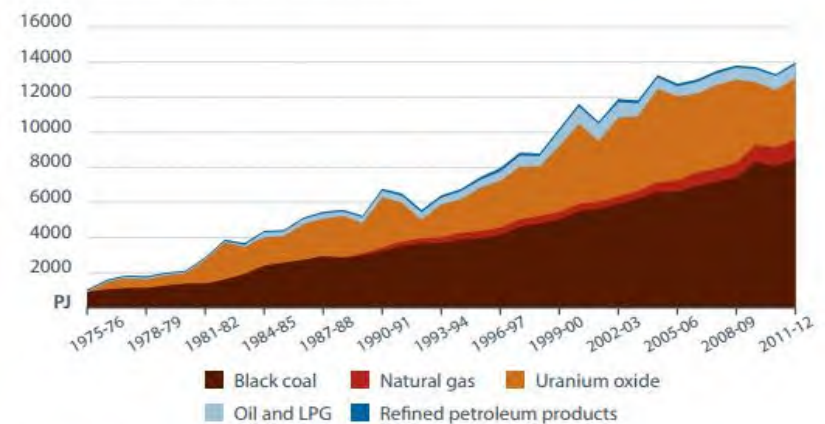
- Energy Production and Exports by Fuel Type

Australian energy production, by fuel type

	PJ	growth%		share %
	2011-12	2010-11 to 2011-12	5 year average annual growth	
Black coal	9 672	5.3	2.4	55.4
Brown coal	735	5.7	0.6	4.2
Oil and LPG	994	-6.2	-1.4	5.7
Gas	2 270	8.4	8.3	13.0
Uranium oxide	3 525	6.1	-9.3	20.2
Renewables	265	-7.3	-2.8	1.5
Total	17 460	4.9	-0.3	100

Source: 2013 AES

Australian energy exports, by fuel type



Source: 2013 AES

Source: BREE 2013 Australian Energy Statistics



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Australia's Domestic Energy Market

- Total energy production: 17,640PJ (+5%)
- Exports: 13,986 PJ (+5%)
- Imports: 1961 PJ of liquid fuels (+3%)
- Domestic consumption: 6,194 PJ (+2%)
- Electricity generation up slightly to about 914 PJ or 254,000 GWh in 2011–12

Australia's Domestic Energy Market

- **State-by-State Energy Consumption in 2011/12**

New South Wales	1652PJ	-1.2	26.7%
Victoria	1547PJ	+4.8	25.0%
Queensland	1353PJ	+3.5	21.8%
South Australia	391PJ	+0.6	6.3%
Western Australia	1015PJ	+1.3	16.4%
Tasmania	114PJ	+3.2	1.8%
Northern Territory	124PJ	+3.4	2.0%
Total	6194PJ	+2.0	100%

Source: BREE 2013 Australian Energy Statistics



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Australia's Domestic Energy Market

- Energy Consumption by Industry

Table 5: Australian total final energy consumption, by industry

	PJ	growth %	share %
	2011-12	2010-11 to 2011-12	2011-12
Agriculture	95.8	1.5	2.4
Mining	536.2	1.7	13.5
Manufacturing and construction	995.2	-3.9	25.1
Transport	1512.4	2.0	38.2
Commercial	311.2	8.8	7.9
Residential	453.2	0.3	11.4
Other	58.5	-11.4	1.5
Total	3962.5	0.5	100

Source: 2013 AES Table B.

Source: BREE 2013 Australian Energy Statistics



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Australia's Domestic Energy Market

- Electricity Generation in Australia up slightly to 914 PJ in 2011/12
- **Generation in National Electricity Market (NEM) declining** since 2008/09
- **Off-grid generation increasingly rapidly**, which has been largely supported by growth in the mining sector

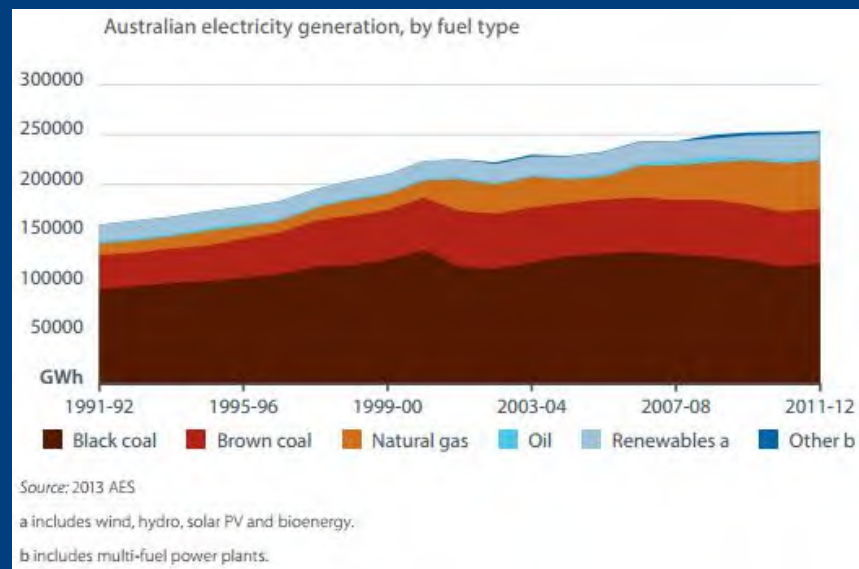
Source: BREE 2013 Australian Energy Statistics



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Australia's Domestic Energy Market

• Electricity Generation in Australia



Australian electricity generation, by fuel type

	GWh	growth %	share %
	2011-12	2010-11 to 2011-12	5 year average annual growth
Fossil fuels			
Black coal	120 302	2.9	-2.3
Brown coal	55 060	-0.4	-0.2
Gas	48 892	-0.2	9.8
Oil	3 070	-0.8	-10.5
Other a	2 500	-8.0	83.0
Renewable energy			
Bioenergy	2 343	11.5	-15.1
Wind	6 113	5.3	19.5
Hydro	14 083	-16.2	6.8
Solar PV	1 489	75.1	95.2
Total	253 851	0.5	1.0

Source: 2013 AES

a Includes multi-fuel fired power plants

Source: BREE 2013 Australian Energy Statistics



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2014 Commonwealth Energy White Paper

From Terms of Reference

The White Paper will consider:

- Policy and regulatory reform
- The appropriate role for government in energy sector
- Opportunities to drive the more productive and efficient use of energy
- Energy related distribution infrastructure
- Alternative transport fuel sources
- Workforce issues
- Emerging energy technologies & new energy sources
- Future growth in exports of energy products

2014 Commonwealth Energy White Paper

Issues Snapshot:

- The Security of Energy Supplies
- Regulatory Reform and Role of Government
- Growth and Investment
- Trade and Industrial Relations
- Workforce Productivity
- Driving Energy Productivity
- Alternative and Emerging Energy Sources and Technology



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2014 Commonwealth Energy White Paper

The Security of Energy Supplies

- How can community expectations be better understood and reflected in reliability standards?
- What is the value of developing fuel reserves to meet Australia's international oil security obligations, and augment domestic security?
- How can we increase new gas sources to meet demand and measures to enhance transparency in market conditions?
- What issues does the regulation of energy infrastructure pose?

2014 Commonwealth Energy White Paper

Regulatory Reform & Role of Government

- What are the priority issues, barriers or gaps within the COAG energy market reform agenda?
- What are the possible approaches to and impacts of a review of tariff structures?
- How can we promote greater price transparency in gas markets?
- Are there areas where further privatisation of government-owned assets would contribute to more effective regulatory frameworks and better outcomes for consumers?

2014 Commonwealth Energy White Paper

Growth and Investment

- What commercial or market initiatives could enhance growth and investment in the energy and resources sectors?
- How do we streamline approvals processes without compromising proper environmental and social safeguards?
- Can we further reduce regulatory burdens while maintaining appropriate levels of disclosure and transparency in energy markets?
- What are the impacts of variable land access policy and how could we better inform and engage the community on development in the energy sector?



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2014 Commonwealth Energy White Paper

Trade & International Relations

- How can we grow the export of value-added energy products and services?
- How can we removing unnecessary barriers to continued foreign investment in energy sector?
- How can we strengthen support for access to export markets?
- How can we support businesses to maximise their energy export opportunities?



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2014 Commonwealth Energy White Paper

Workforce Productivity

- What are our current skills shortages and how can these be addressed?
- Do our industry and education sector-led programs have the capacity to meet long-term training and skills development needs of the energy and resources sectors?
- What are the long-term training and skills development needs for alternative transport fuel, renewable energy, energy management and other clean energy industries?

2014 Commonwealth Energy White Paper

Driving Energy Productivity

- How could the current suite of energy efficiency measures be enhanced to provide even greater energy efficiency or are there new measures that would enhance energy productivity?
- Could demand-side participation measures be used to encourage energy productivity and reduce peak energy use?
- How could we improve energy use efficiency in the transport sector?

2014 Commonwealth Energy White Paper

Alternative and Emerging Energy Sources and Technology

- How can we encourage a lower emissions energy supply that avoids market distortion or causes increased energy prices?
- Is there a need to review existing network tariff structures in the face of rapidly growing deployment of grid-backed-up distributed energy systems, to ensure proper distribution of costs?

2014 Commonwealth Energy White Paper

Alternative and Emerging Energy Sources and Technology

- Should we explore additional cost-effective means - beyond current mandatory targets and grants - to encourage further development of renewable and other alternative energy sources and their effective integration within the wider energy market?
- How can we progress the uptake of high efficiency low emissions intensity electricity generation?

2014 Commonwealth Energy White Paper

Alternative and Emerging Energy Sources and Technology

- What are the barriers to increased uptake of LPG in private and commercial vehicles and CNG and LNG in the heavy vehicle fleet?
- What are the barriers to the increased uptake of electric vehicles and advanced biofuels?

How do others rate us?

In IEA 1974-2014 Energy Policy Highlights, Australia was nominated for its:

- Energy Efficiency Opportunities Program
- New packet of measures making electricity market more competitive

We asked Tony Wood, Grattan Institute, what he thought the big questions were for Power in NSW.

He posed 6 questions.

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Tony Wood's take on the Big Power Questions

- The world has many more times the gas and coal we can ever burn, and yet companies are looking for more. But peak fossil fuels seem about to recede. How can this be true?
- Australia does not have a comprehensive climate change policy - nor does either side of politics. What does this mean going forward?
- Are falling demand and rising intermittent supply a real threat to timely investment in generation capacity?

Tony Wood's Take on the Big Power Questions

- How can the capacity of the electricity system meet more frequent periods of very high summer demand?
- Has Australia got the right balance of competitive markets and regulation to deliver the best outcome for both consumers and suppliers?
- Surely the answer lies in new technologies?

Questions raised by US Department of Energy's
Advanced Research Projects Agency – Energy
Energy Innovation Summit - February 2014

Technology Development: Pivoting to Avoid Pitfalls

- Benefit of having R&D grounded in commercial relevance
- In-depth exploration of customer needs and cost-benefit trade-offs within technology development often leads to surprising discoveries that require a rethink in direction



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Technology Scaling-Up: Transitioning Science into Production

- Once the technology is validated, the entrepreneur must meet the next great challenge of successfully scaling-up their innovations.
- How do they choose initial markets; secure funding; develop advisor relationships and leverage effective strategy and traction in market; manage supply chain and balance internal manufacturing vs. external contracting; how can instincts that got them to this point work as an advantage rather than a disadvantage?



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Questions raised by US Department of Energy's
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Re-envisioning the Grid from the Ground Up

- If you could start from scratch, given today's technical capabilities, how would you design the grid?
- If given infinite resources, what are the three things you would do to address the growing challenges related to the transmission and delivery of electricity?
- How can we use what we have learned here to modernise our existing grid infrastructure or better direct the development of future grid-related technologies?



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Questions raised by US Department of Energy's
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Microgrids: Why are They Tough and Will They Matter?

- What the enablers and challenges of different types of Microgrids?
- What are the important ways in which Microgrids are different – from performance requirements, size and regulatory requirements?
- How do technologies get sourced and incorporated into Microgrids?
- Can a key technology or regulatory development usher in a tipping point in Microgrid adoption?



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Will Big Data mean Big Energy for the 21st Century?

- Improvements in device efficiency can ultimately lead to a net rise in energy use when technologies create new energy services
- Big Data has the potential to revolutionise every part of our economy, offering high efficiency and optimisation for existing industries, and enabling transformative new approaches
- Will the power of information serve to curb energy use for future generations ... or will Big Data mean big energy for the 21st Century?



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**Beyond Washington:
How US States are Taking Charge on Energy**

- Many states have established new funding and partnership models to move energy technologies to scale and drive both energy goals and economic development
- Is this approach being used in Australia? If so, how could it be improved?

Questions raised by US Department of Energy's
Advanced Research Projects Agency – Energy
Energy Innovation Summit - February 2014

Capturing America's Natural Gas

- New technologies have dramatically expanded natural gas production in the US
- How is ARPA helping to develop beneficial new applications for natural gas and work to reduce the impacts of increased natural gas production?



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Questions raised by US Department of Energy's
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**Doing More with Less:
Opportunities for Increased Energy Efficiency**

- In the US, inefficiencies in the flow of energy result in over 60% of domestic energy being wasted.
- What are potential emerging opportunities to significantly impact energy efficiency across broad sectors in order to better utilise energy and material resources more efficiently?

Questions raised by US Department of Energy's
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Generation for the Next Generation

- What technologies are being created for low or zero emissions generation of electricity, and how can we increase penetration of these technologies into the grid to move toward a low-carbon future for electricity?



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Questions raised by US Department of Energy's
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Driving Deployment: A Global Perspective on Emerging Clean Energy Policy Drivers

- What are the best practices, challenges and interrelationships of energy policy tools in accelerating energy technology innovations, demonstrations, and deployment, and resulting opportunities?

Think about energy policies – including feed-in tariffs, tax incentives, rebates, trade and quote, Renewable Portfolio Standards, RECs, and tendering



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New Models for Breakthrough Energy R&D

- What gaps are there in the current energy innovation ecosystem, and how can we unleash new game-changing energy research?



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Combinatorial Discovery in Energy: The Quest for the Next Big Hit

- Has combinatorial, high-throughput R&D lived up to the hype?
- What are keys to success when using this method?
- What are strategies to remove bottlenecks in synthesis, testing and informatics to accelerate the pace of discovery?



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So what about...?

- Nuclear
- Geothermal & other renewables
- Energy efficiency
- Grid technology/geometry
- Energy storage
- Downsides of various technologies
- Direct electricity exports e.g. to Indonesia

How good/relevant is our energy R&D?

- Coal?
- CSG?
- Hydro? *[fish & micro hydro]*
- Solar PV? *[Martin Green as Sun King]*
- Geothermal? Biomass? Wave/tidal?
- Grids & different configurations *[King Island? Mining?]*
- Storage?
- Heating/Cooling? Energy Efficiency? Transport fuels? Energy substitution?

What characterises the power/energy system we want?

- ...in 2 years?
 - ...in 5 years?
 - ...in 30 years?
 - ...in 50 years?
-
- What's our process for realising this?
 - How do we modify our desired characteristic list without unbearable disruption? Plug & play?

What are the most important characteristics?

- Must have
- Nice to have
- Don't want

Who holds the conversation(s)?

- How do we monitor progress?
- How do we experiment safely?
- How do we become good at scaling up?
- Who pays for what? Can we be more innovative in funding mechanisms (analog of HECS)?
- Energy equity?

Australia is endowed with great energy resources. How do we use this to have the best power/energy system possible?

Could we become expert at posing problems & seeking solutions around the world? And then translating them here?

Or, where necessary, building from scratch here & exporting technologies & expertise?



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Other questions?



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