Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA



The changing nature of Electricity Supply Systems globally and in Australia

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Future of Electricity Forum

Engineers Australia Convention

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Past and present - energy priorities

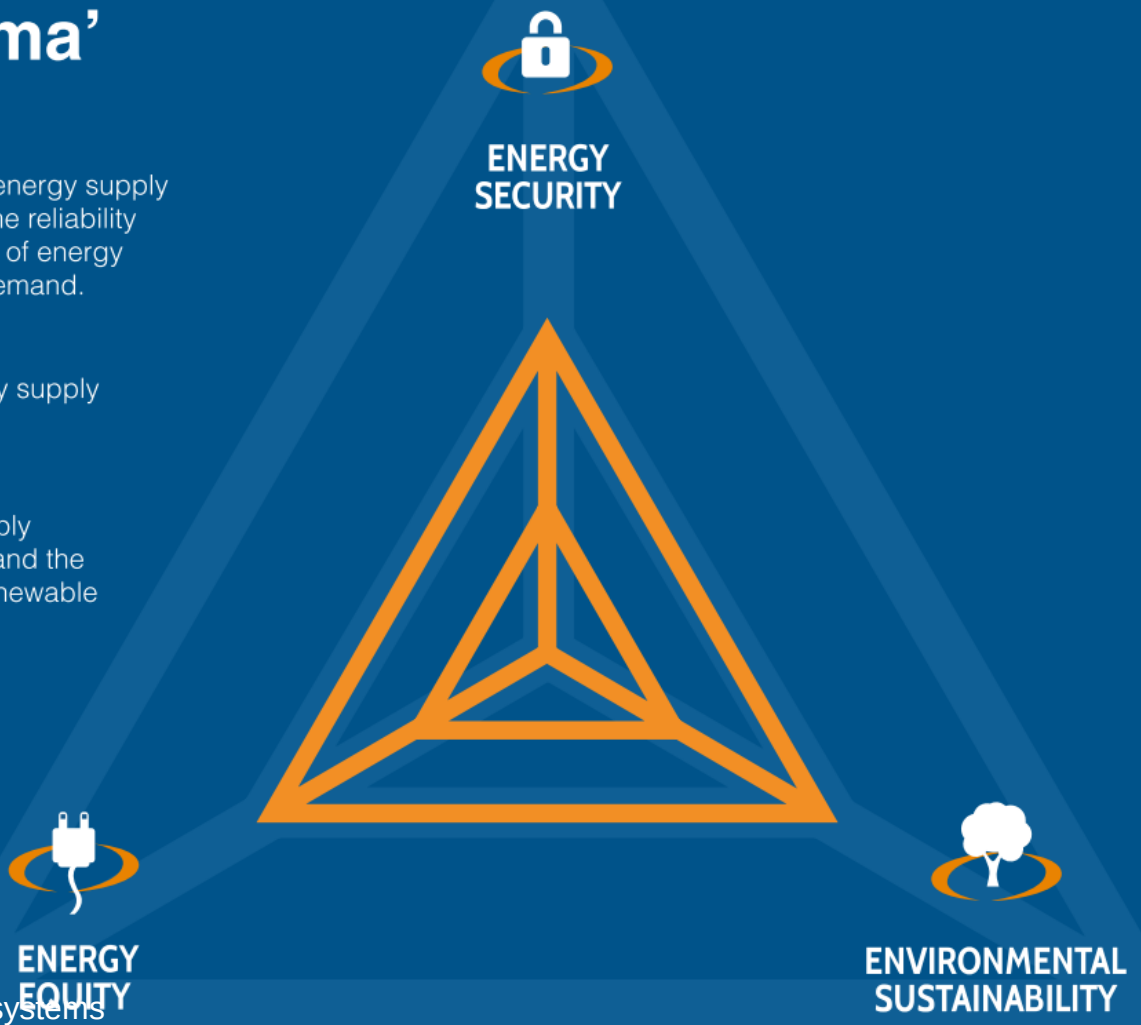
(World Energy Council, 2014)

Balancing the 'Energy Trilemma'

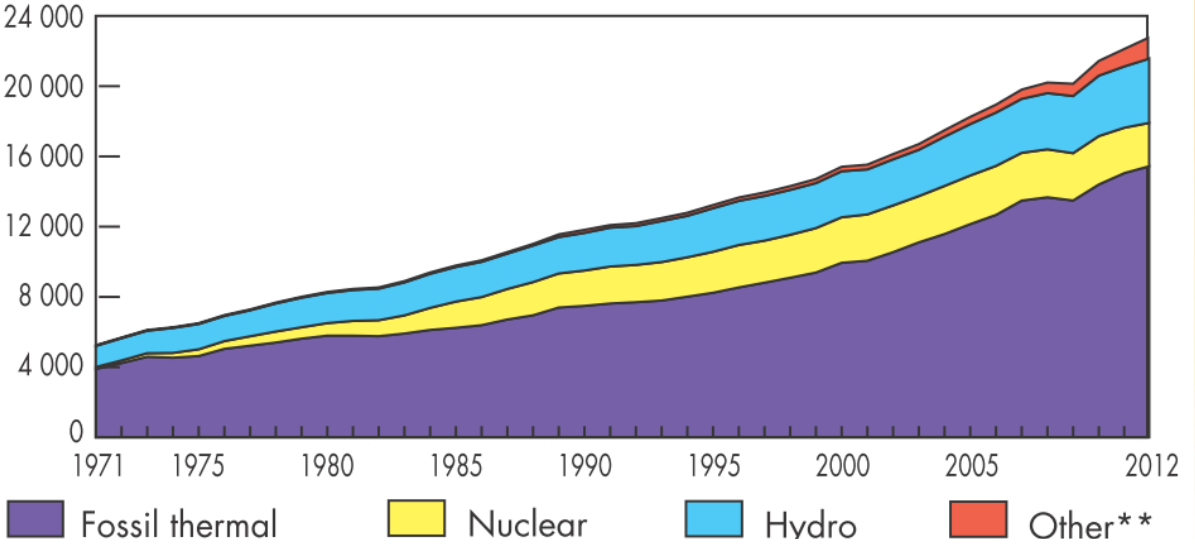
Energy Security
The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

Energy Equity
Accessibility and affordability of energy supply across the population.

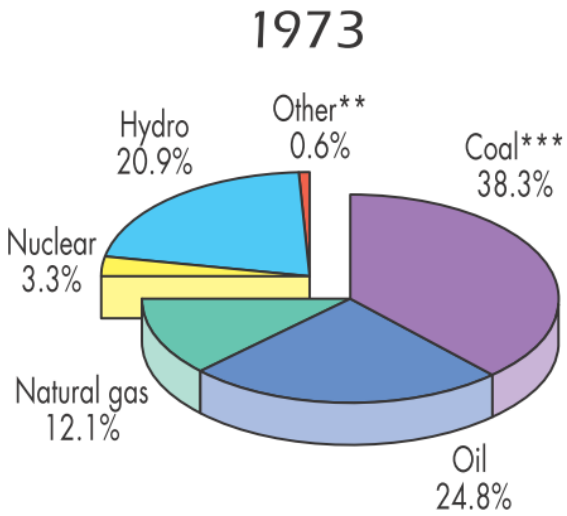
Environmental Sustainability
Encompasses the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.



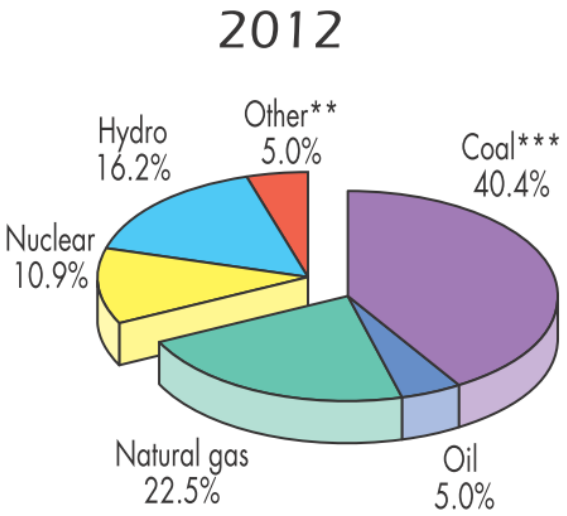
Past and present – global electricity



(IEA, 2014)

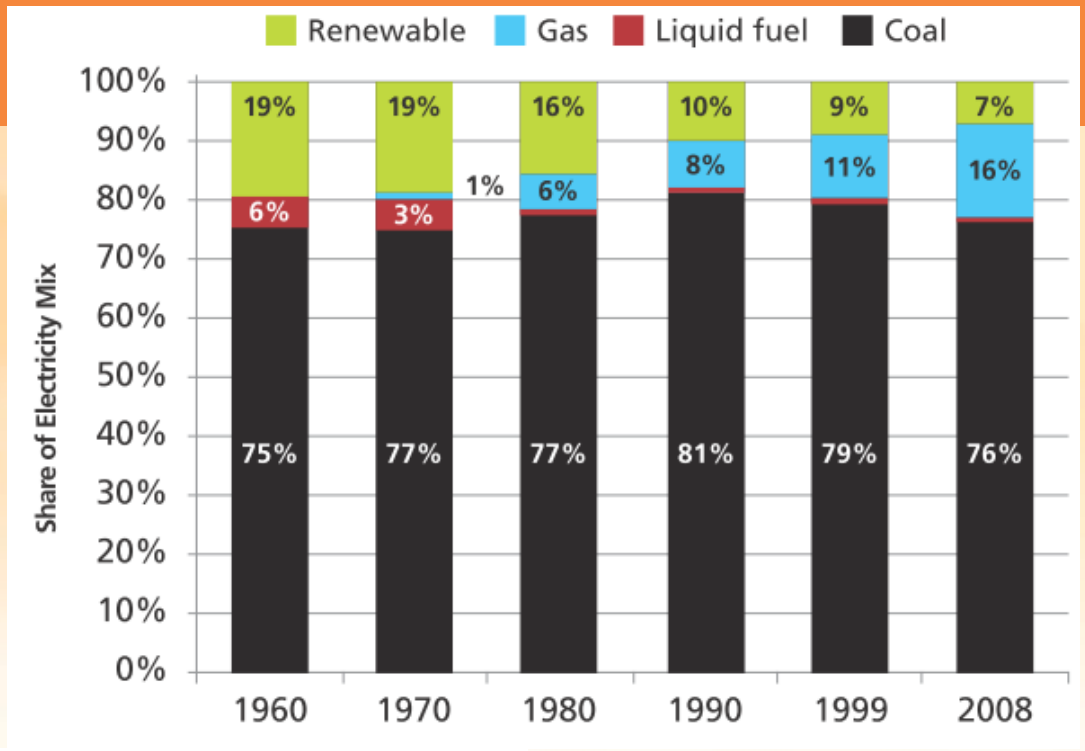


6 129 TWh

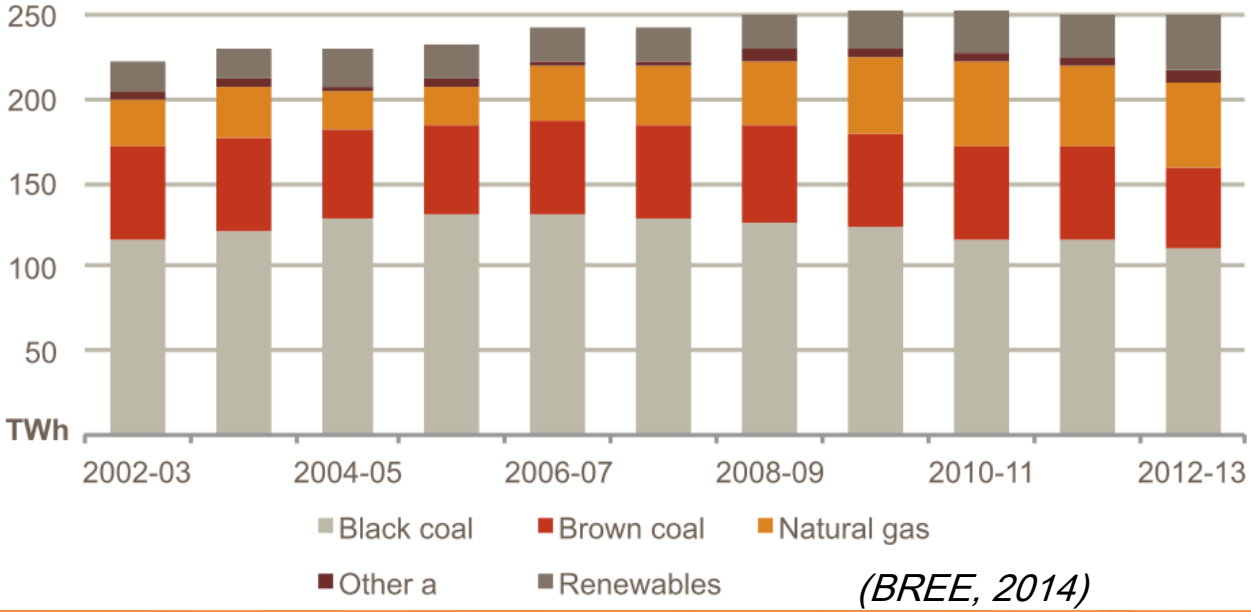


22 668 TWh

Past and present - Australian electricity supply



(Env. Victoria, 2009)



(BREE, 2014)

Possible recent reorienting of priorities

We must seize the opportunity for a clean energy future.
Let me be straight: our ongoing failure to realise the full potential of clean energy technology is alarming. Midway through 2012, energy demand and prices are rising steadily, energy security concerns are at the forefront of the political agenda, and energy-related carbon dioxide (CO_2) emissions have reached historic highs. Under current policies, both energy demand and emissions are likely to double by 2050.

To turn the tide, common energy goals supported by predictable and consistent policies are needed across the world. But governments cannot do this alone; industry and citizens must be on board. The public needs to understand the challenges ahead, and give the necessary support and mandate for policy action and infrastructure development. Only decisive, effective and efficient policies can create the investment climate that is ultimately needed to put the world on a sustainable path.

The good news is that technology, together with changed behaviour, offers the prospect of reaching the international goal of limiting the long-term increase of the global mean temperature to 2°C. By reducing both energy demand and related greenhouse-gas (GHG) emissions, strategic application of clean energy technologies would deliver benefits of enhanced energy security and sustainable economic development, while also reducing human impact on the environment.

(IEA, *Energy Technology Perspectives*, 2012)

Significant regions of world currently have local energy deficits… *hence associated energy security concerns*

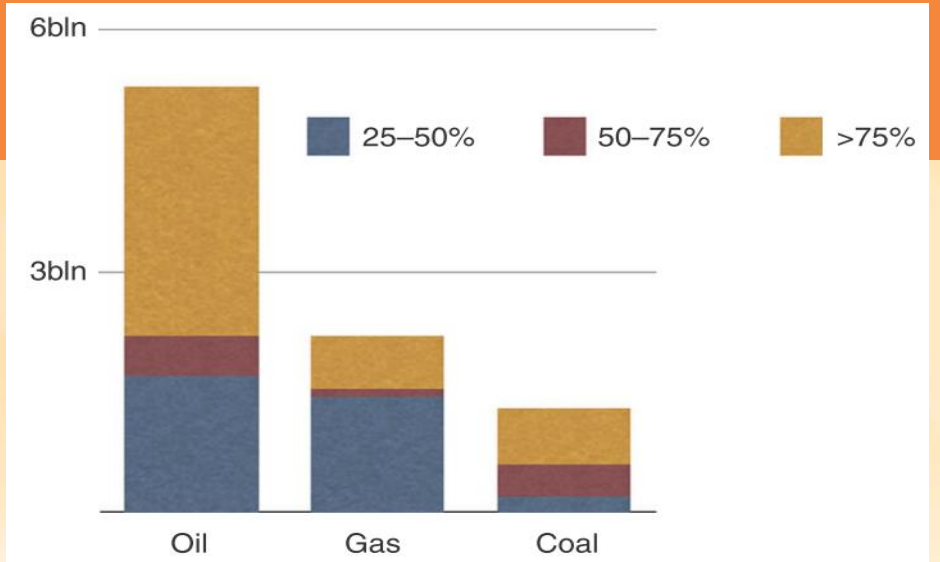
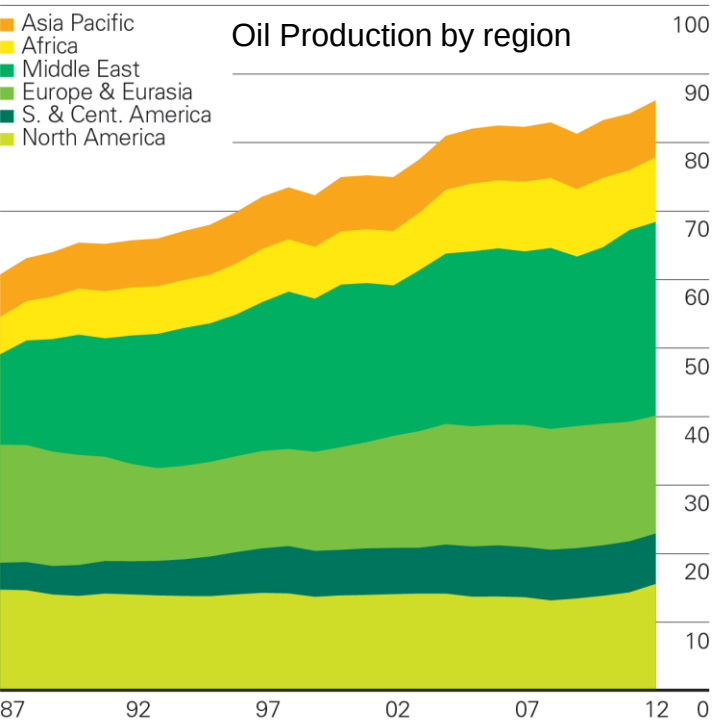
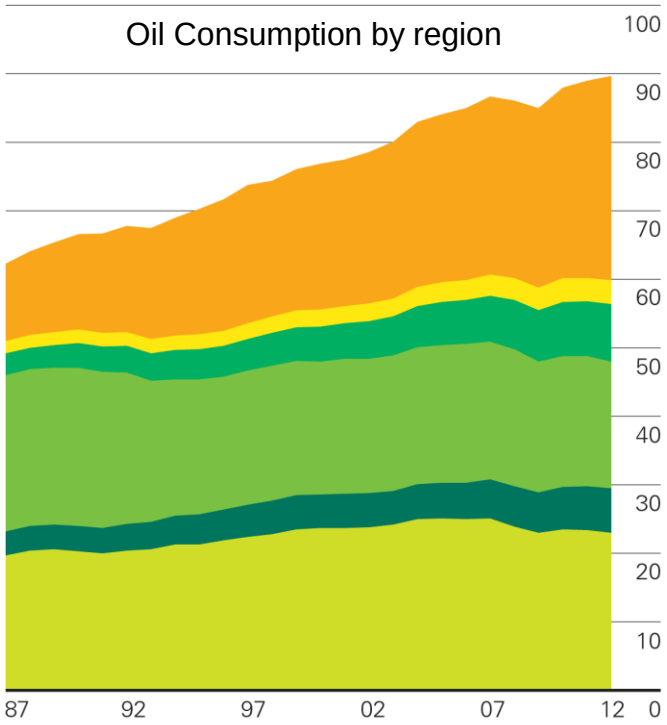


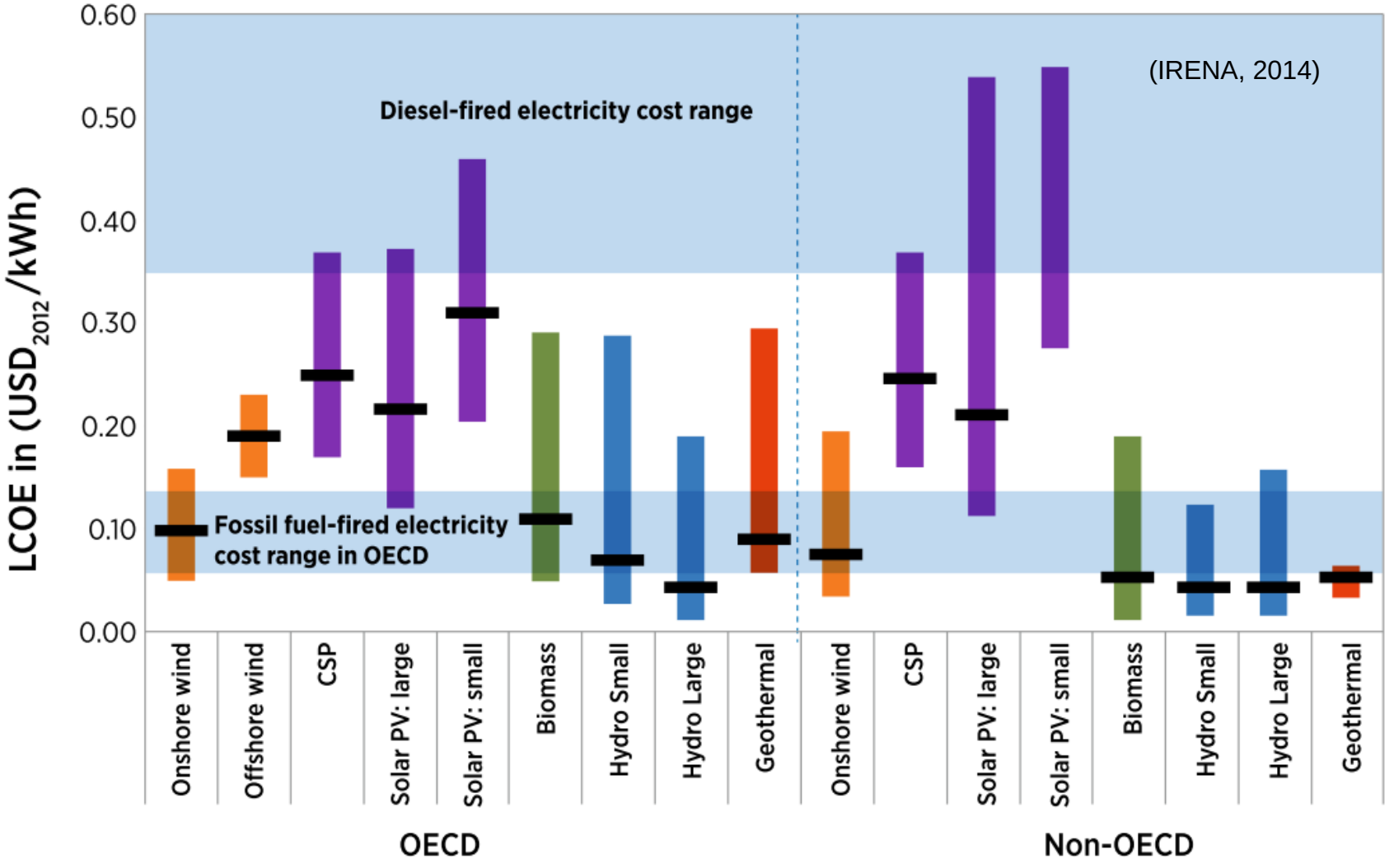
Figure TS-5 | Number of people in countries that are dependent on imported

(*BP Statistical Review*, 2014)



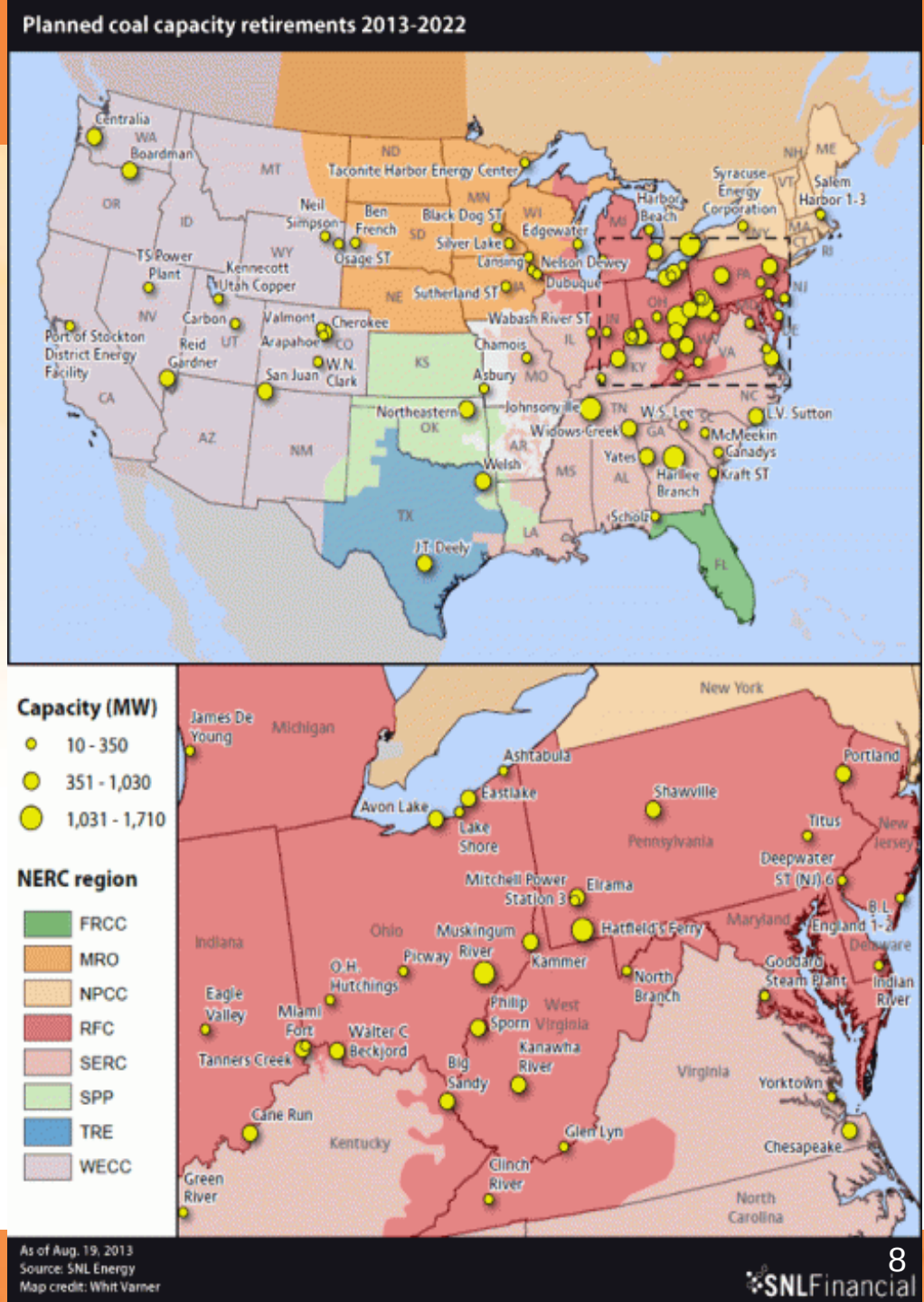


RE certainly becoming more competitive



Non-climate enviro impacts also becoming key drivers

"China's State Council has announced that it is banning the construction of new coal-fired power plants near Beijing, Shanghai and Guangdong. The goal is to cut air pollution in the country's eastern megalopolises. The hope is that by 2017 Beijing residents will be breathing in 25% less fine particulate matter than in 2012."



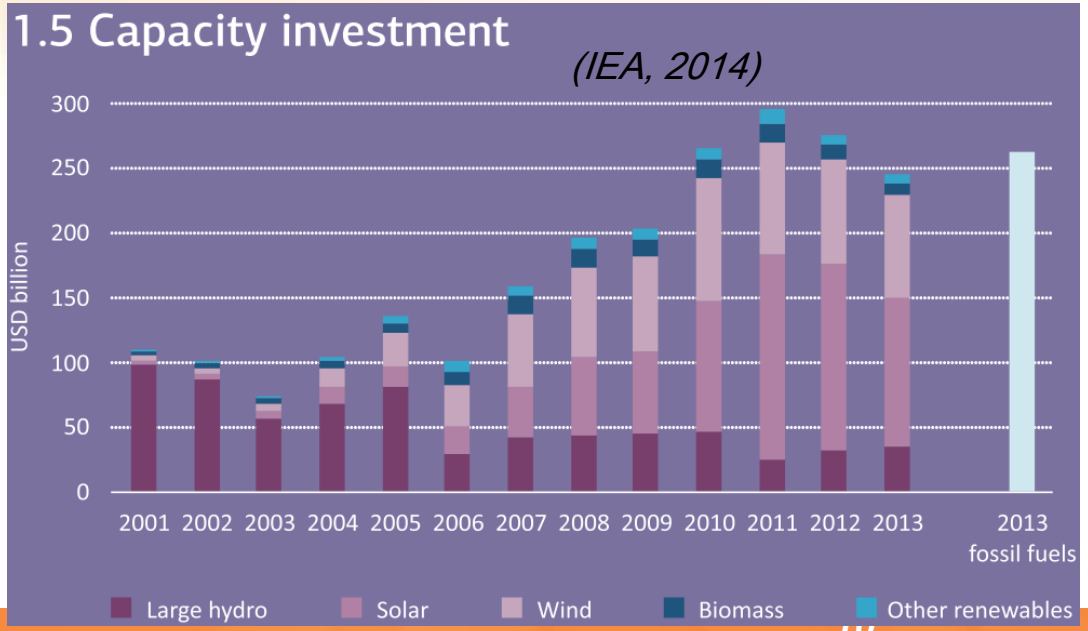
An elephant in the room – Climate Change

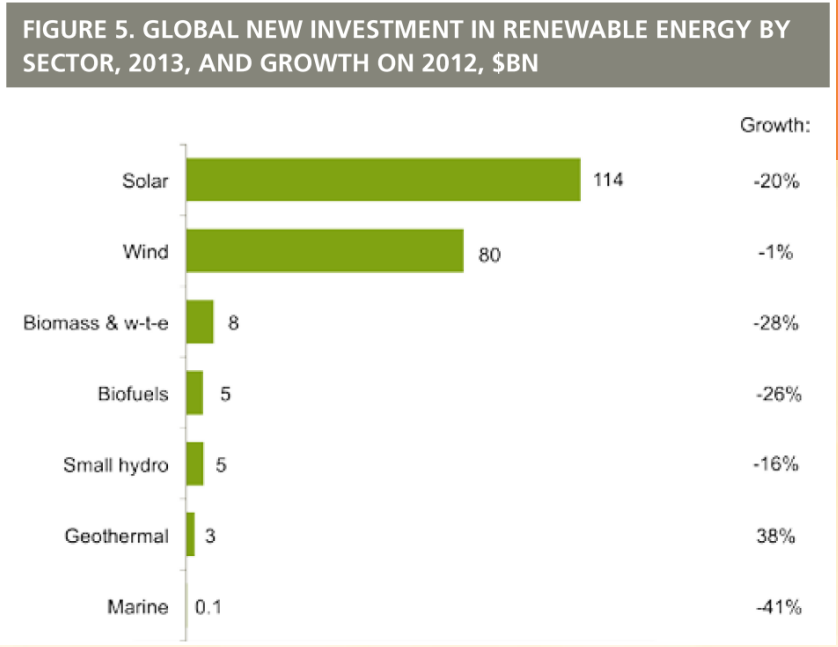
- Currently a lack of domestic and international progress, apparent loss of public and political interest and will in some jurisdictions… but this may be changing
- … and even a dead elephant in the room is a problem

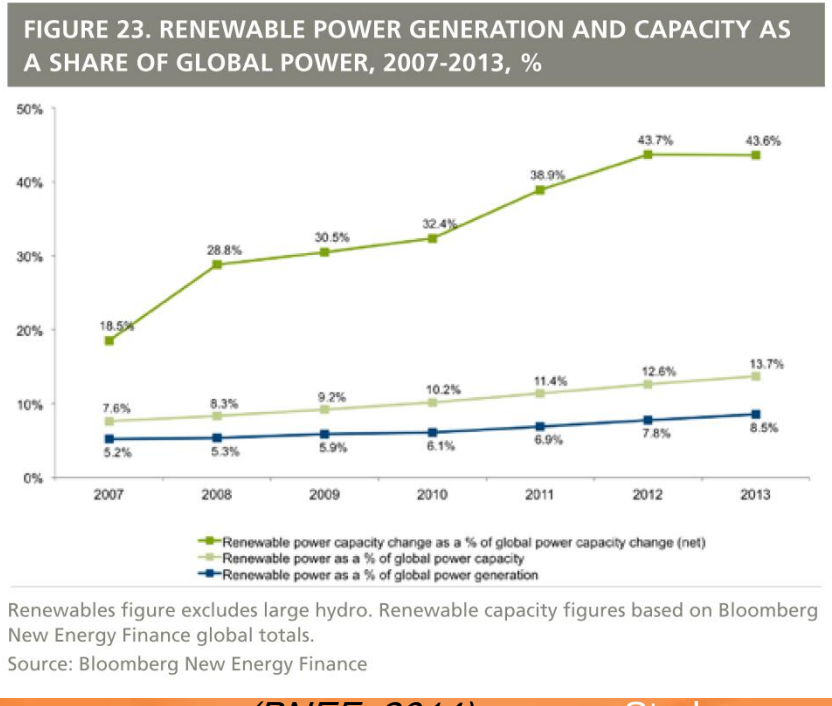
RE key in recent global changes

… although progress may be faltering and still a long way to go

Other key success is falling demand in some OECD countries



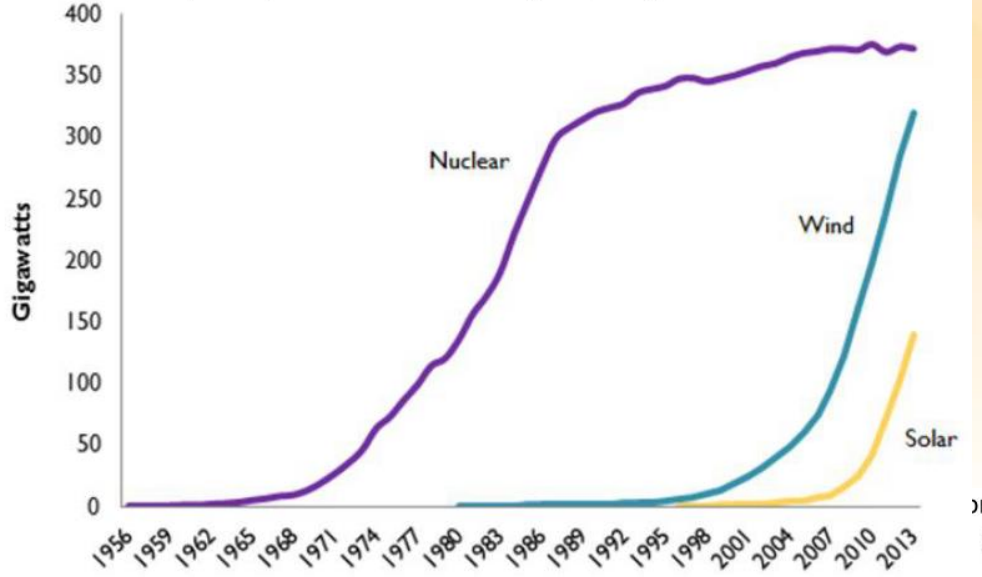




(BNEF, 2014)

Particular progress with wind and PV

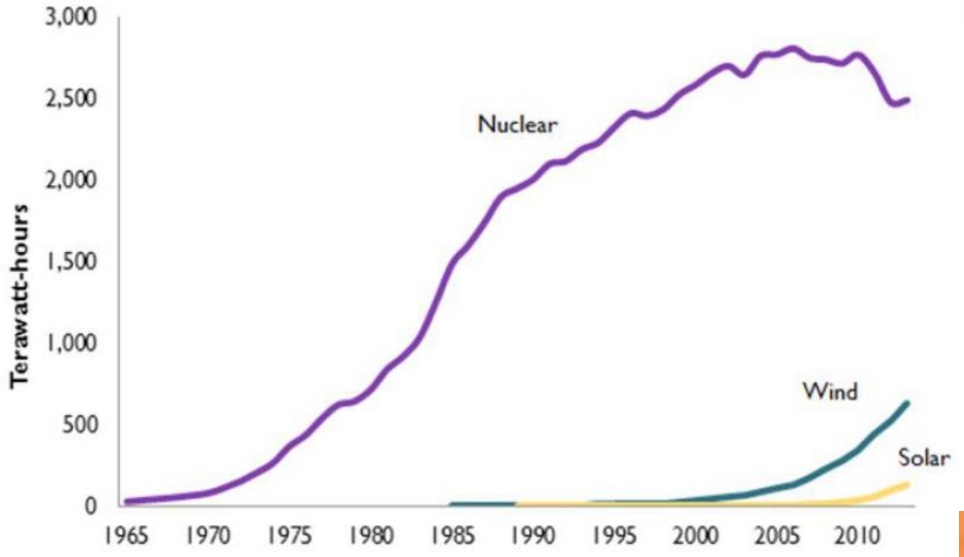
World Nuclear, Wind, and Solar Generating Capacity, 1956-2013



Source: Worldwatch Institute

(WorldWatch, 2014)

orld Nuclear, Wind, and Solar Electricity Consumption, 1965-2013



Source: BP

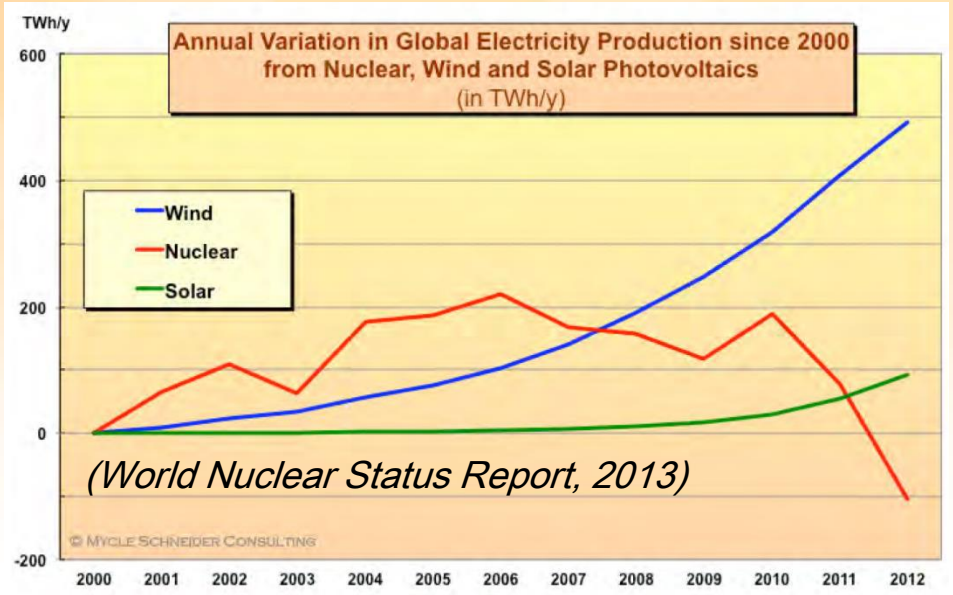
Some alternatives struggling at present

CARBON CAPTURE AND STORAGE

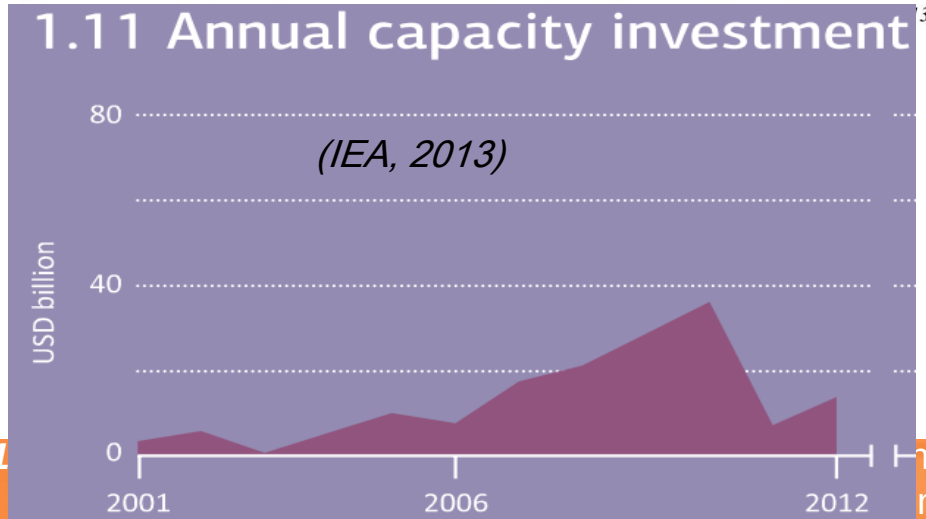
CCS is another area of technology that could help to curb emissions, if applied to coal- or gas-fired power stations or to carbon-intensive industrial plants such as cement works. Progess with carbon capture has, however, been disappointing in recent years. Five projects at demonstration scale (1MtCO2/yr) have started construction or operations but this is still short of 2005 G8 targets of 20 operational projects by 2020.

In 2013, investment fell to just $1.8 billion, down 59% from 2012's $4.3 billion. Last year's total was split between government and corporate R&D spending, steady at $1.6 billion, and asset finance, at just $128 million compared to $2.7 billion the previous year.

(BNEF, 2014)



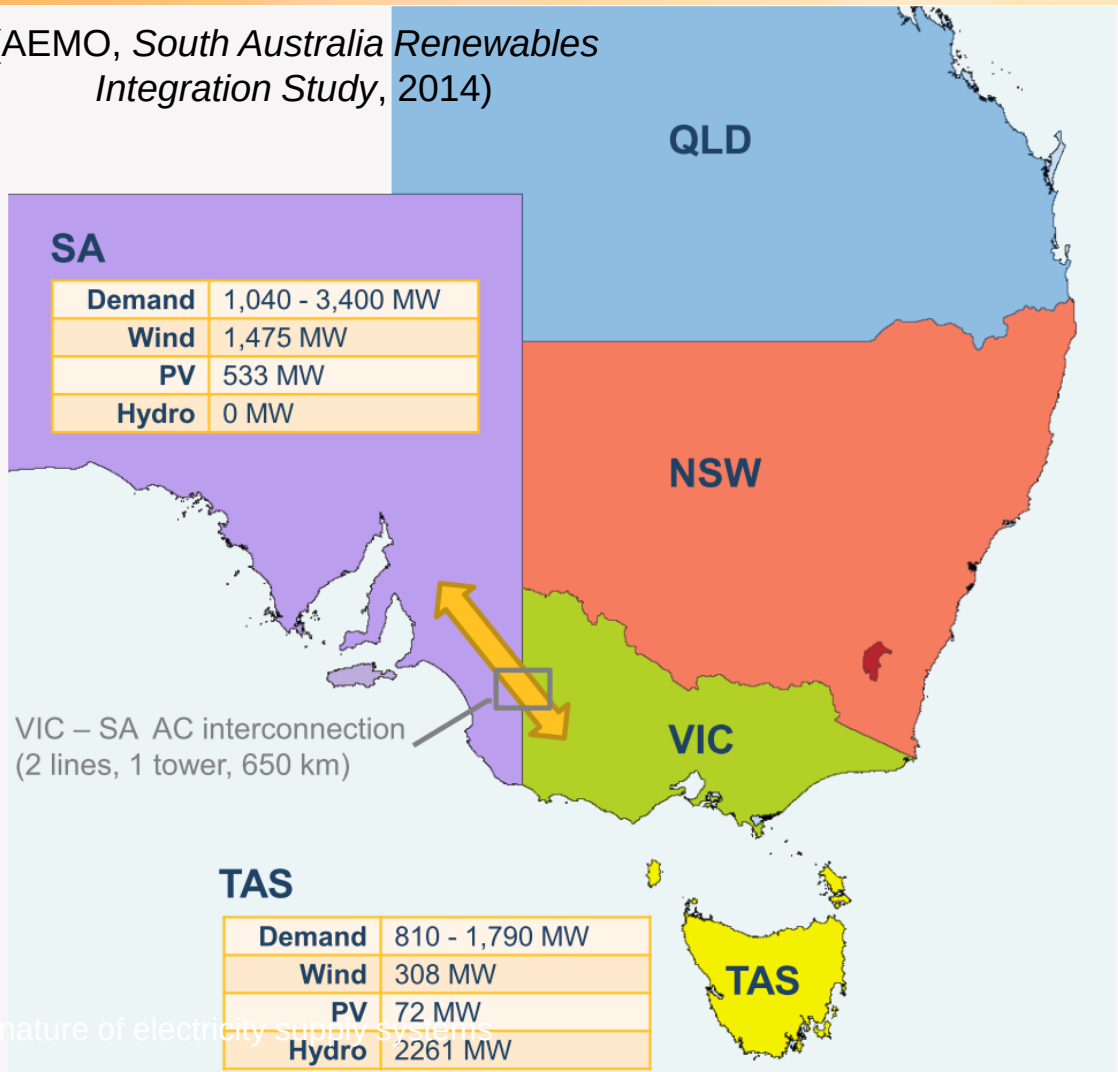
(World Nuclear Status Report, 2013)



(IEA, 2013)

Possible RE challenges and opportunities ahead- South Australia a world leading example

(AEMO, *South Australia Renewables Integration Study*, 2014)



QLD

Demand	4,100 - 8,900 MW
Wind	0 MW
PV	1,151 MW
Hydro	652 MW

NSW

Demand	5,120 - 14,740 MW
Wind	431 MW
PV	775 MW
Hydro	2650 MW

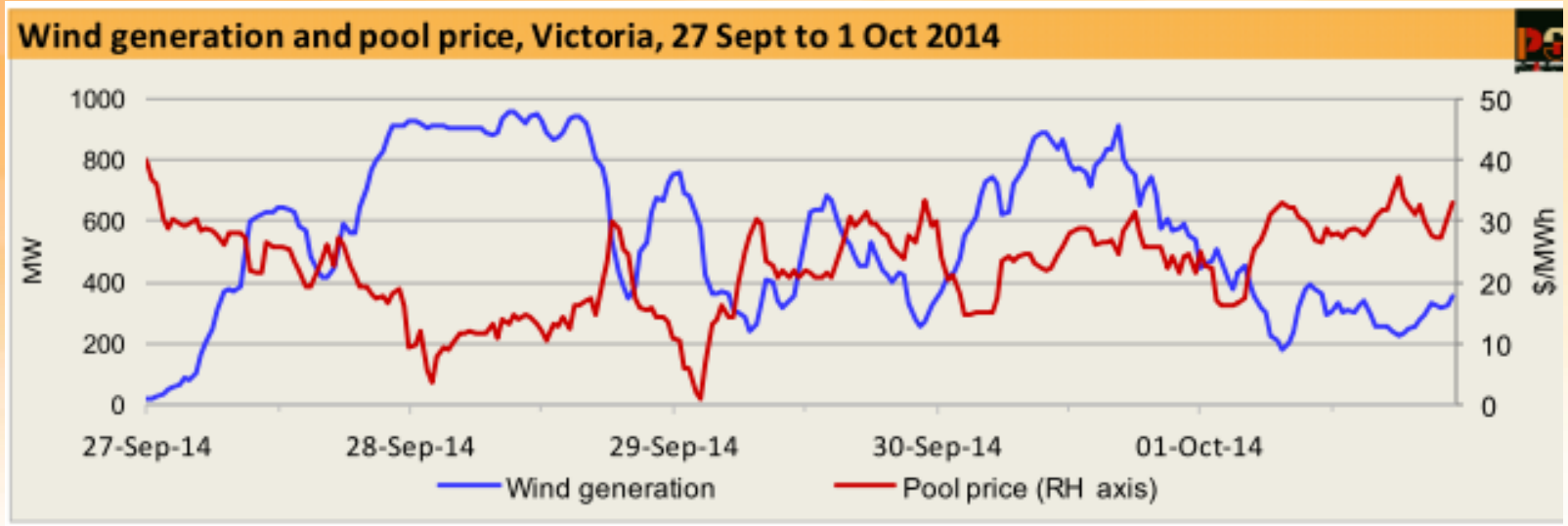
VIC

Demand	3,780 - 10,490 MW
Wind	1,015 MW
PV	625 MW
Hydro	2237 MW

NEM total

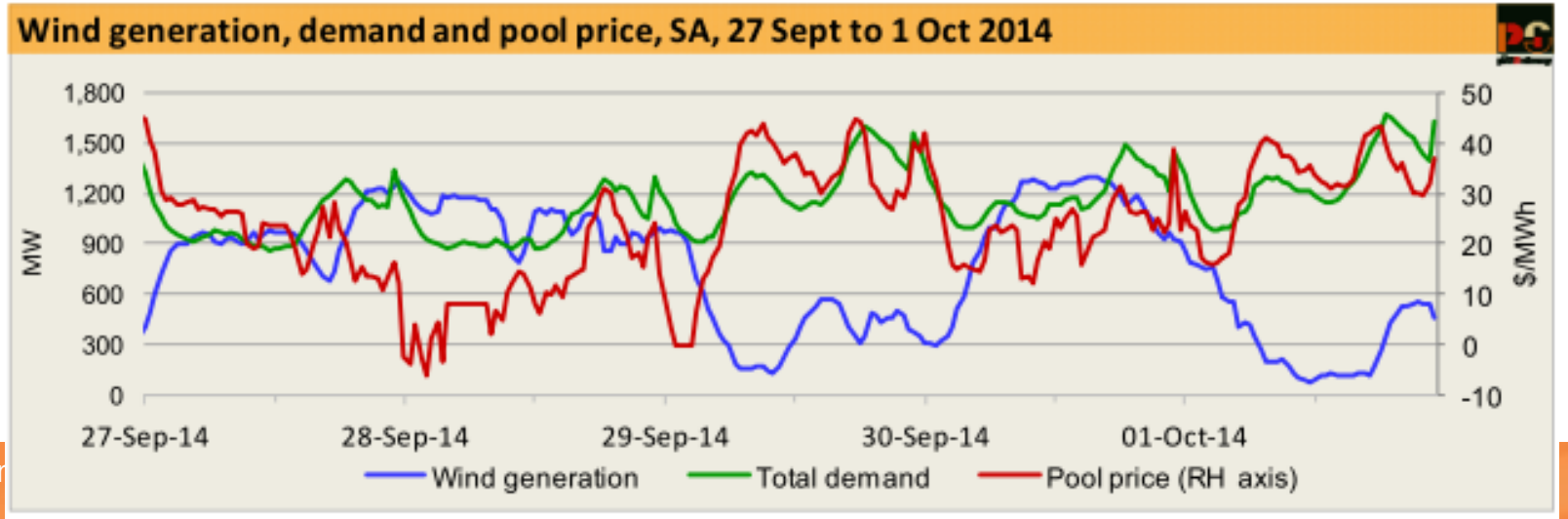
Demand	15 GW – 30 GW
Wind	3,334 MW
PV	3,156 MW
Hydro	7,800 MW

NEM appears to be managing to date



(Pitt and Sherry, *CEDEX*, 2014)

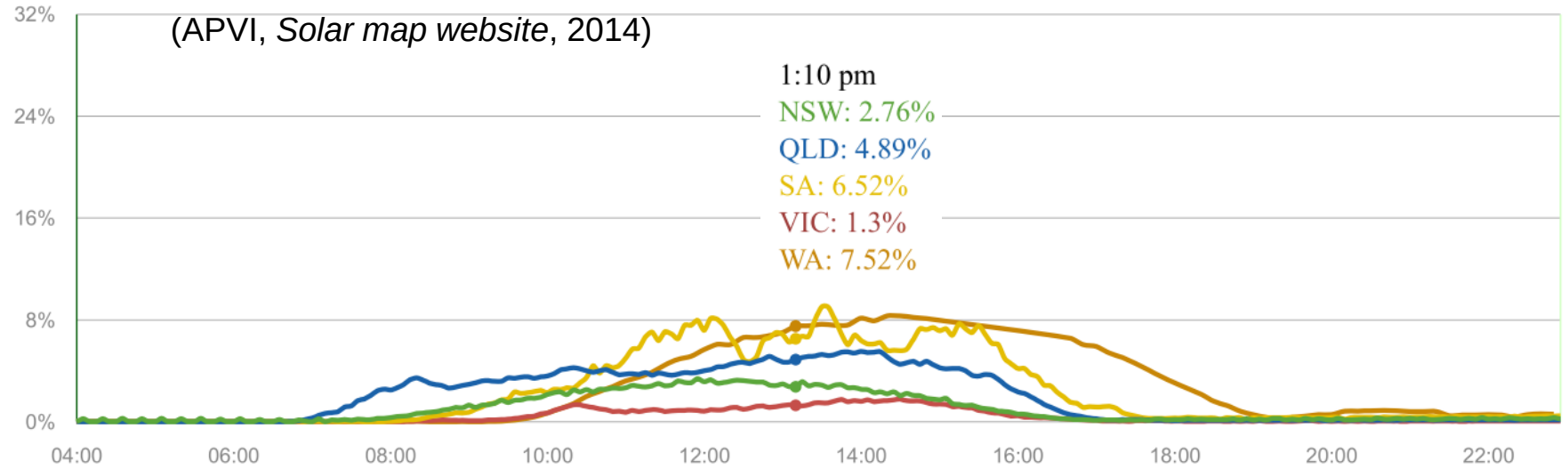
FIGURE 5

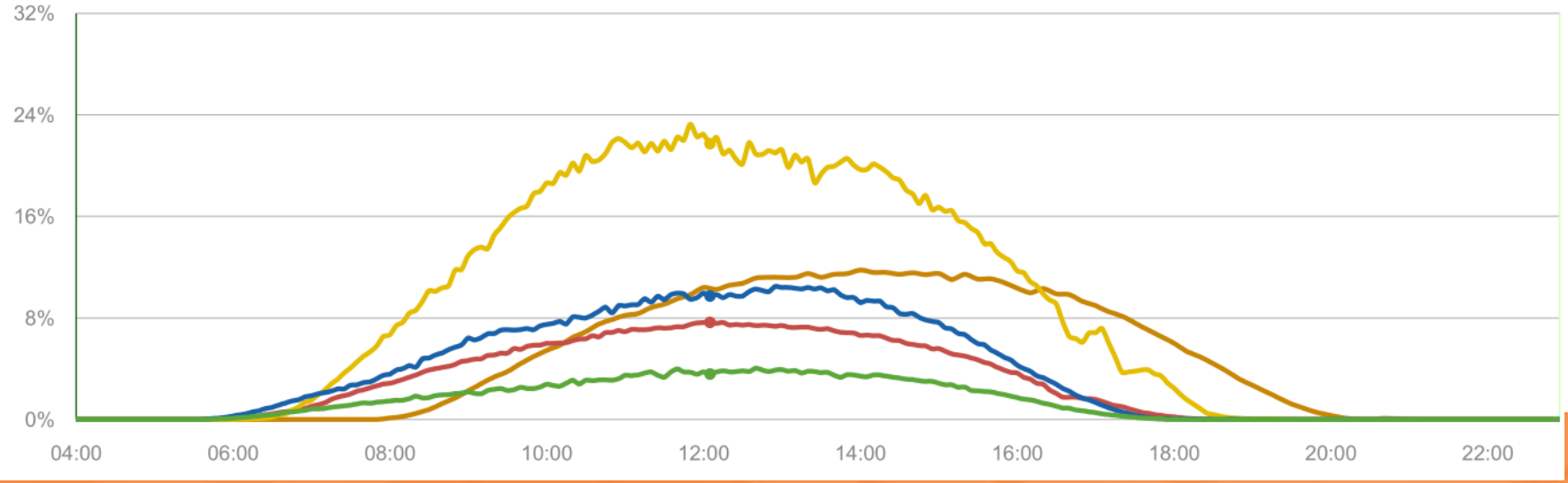


Distributed PV also becoming significant

(eg. 24 June 2014 and 5 October 2014)

(APVI, *Solar map website*, 2014)

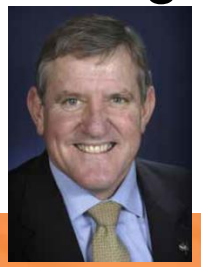




What comes next?

- "Prediction is very difficult, especially if it's about the future."
  - Nils Bohr, Nobel laureate in Physics
- "The best qualification of a prophet is to have a good memory"
  - Marquis of Halifax,
- "If you have to forecast, forecast often"
  - Edgar R. Fiedler in *The Three Rs of Economic Forecasting*

- “Many of us who keenly observe the energy sector can take a pretty good guess at what our next big challenges are”
  - Senator MacFarlane, 10th September 2014



An earlier predictive effort

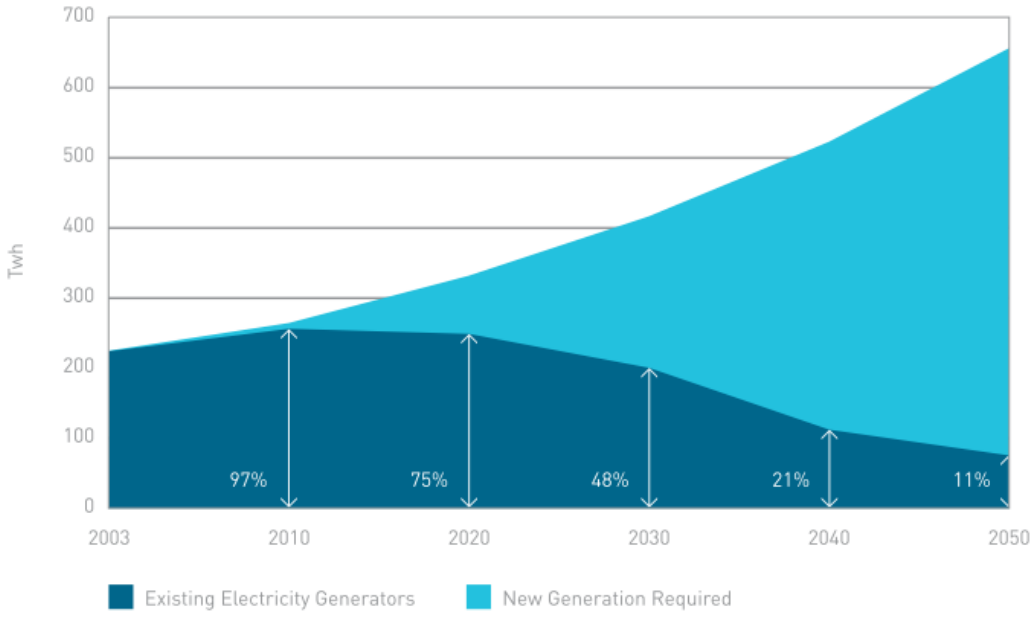
A NATIONAL STRATEGY TO DELIVER PROSPERITY, SECURITY AND SUSTAINABILITY

To achieve energy prosperity, security and sustainability, the government has put in place policies to:

- attract investment in the efficient discovery and development of our energy resources for the benefit of all Australians
- deliver a prosperous economy while protecting the environment and playing an active role in global efforts to reduce greenhouse emissions
- encourage development of cleaner, more efficient technologies to underpin Australia's energy future
- develop effective and efficient energy markets that deliver competitively priced energy, where and when it is needed into the future
- minimise disruptions to energy supplies and respond quickly and effectively when disruptions occur
- establish an efficient energy tax base, restricting fuel excise to end use and applying resource rent taxes to offshore projects
- ensure Australia uses its energy wisely.

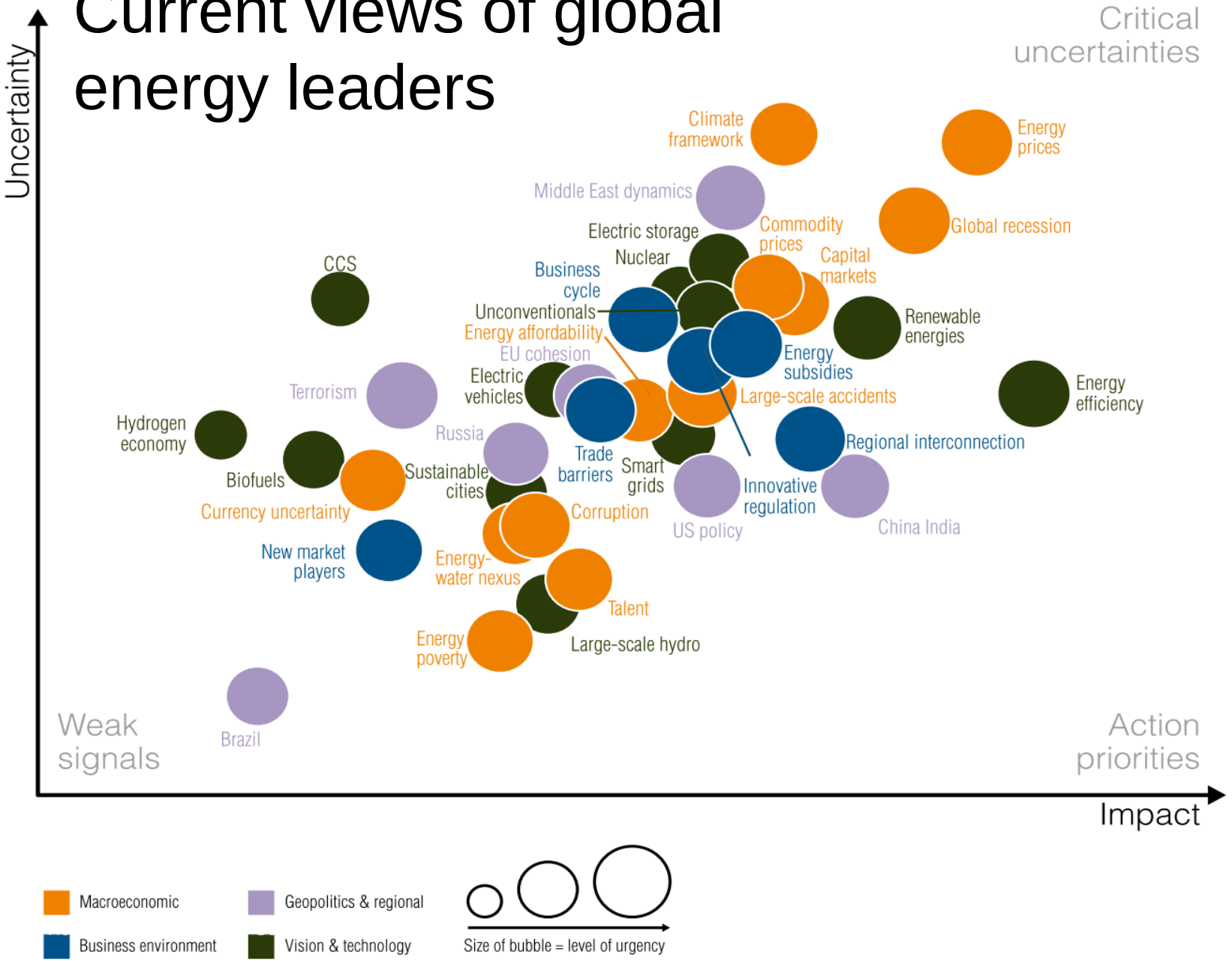
- Virtually no discussion of potential:
  - CSG (CSM)
  - East Coast LNG export
  - Falling demand
  - Falling costs and growing penetrations of Wind, PV

Figure 3: Demand/Supply balance for electricity—Medium electricity demand scenario



WEC's World Energy Issues Monitor 2014: highlighting 37 issues and their perceived impact, uncertainty, and urgency for global energy leaders and experts globally

Current views of global energy leaders



Climate protection requires major global… and hence Australian emissions reductions

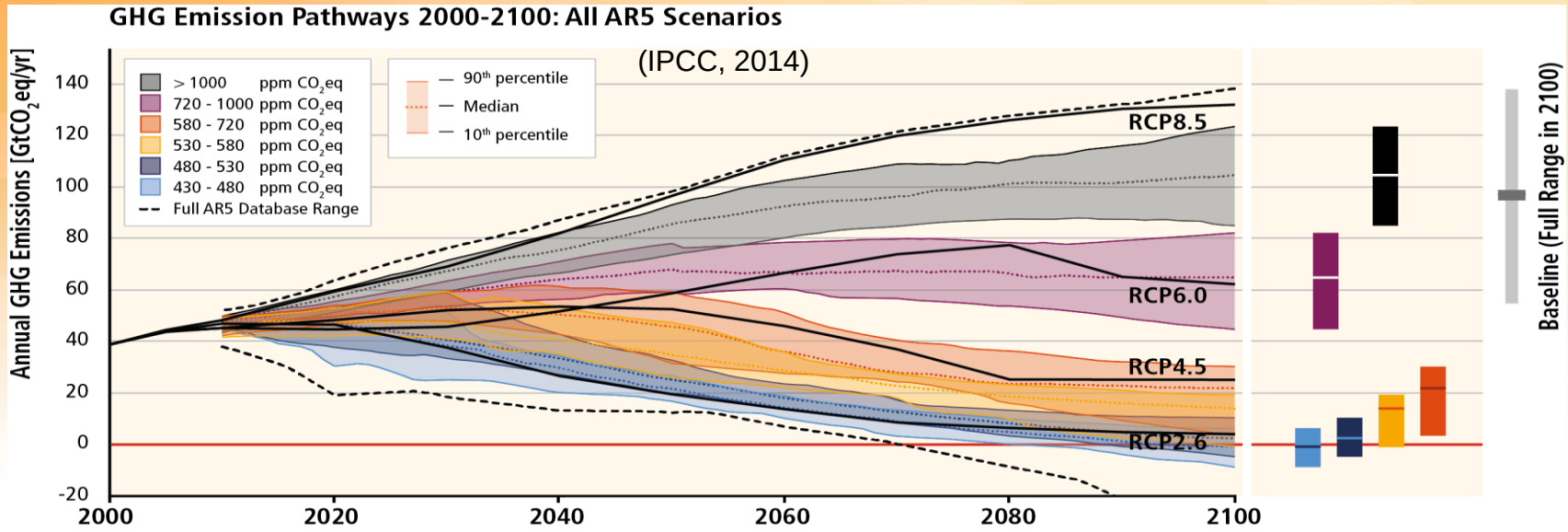
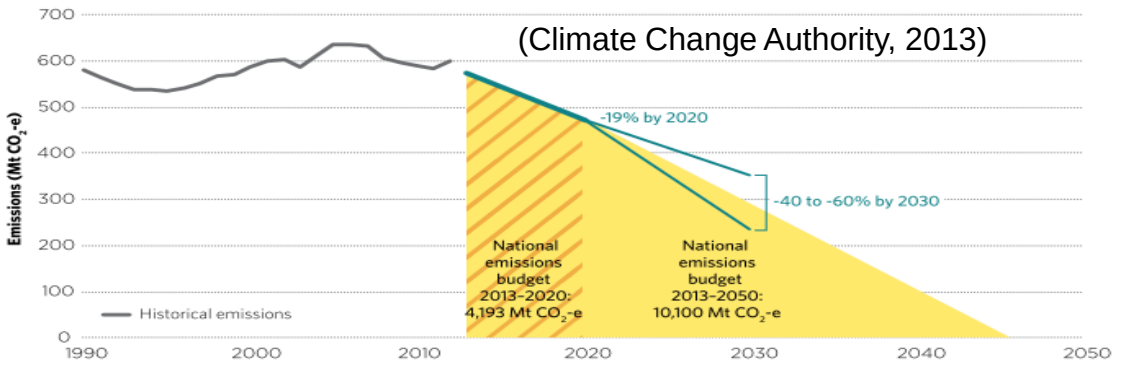


FIGURE 9.3: RECOMMENDED GOALS FOR AUSTRALIA

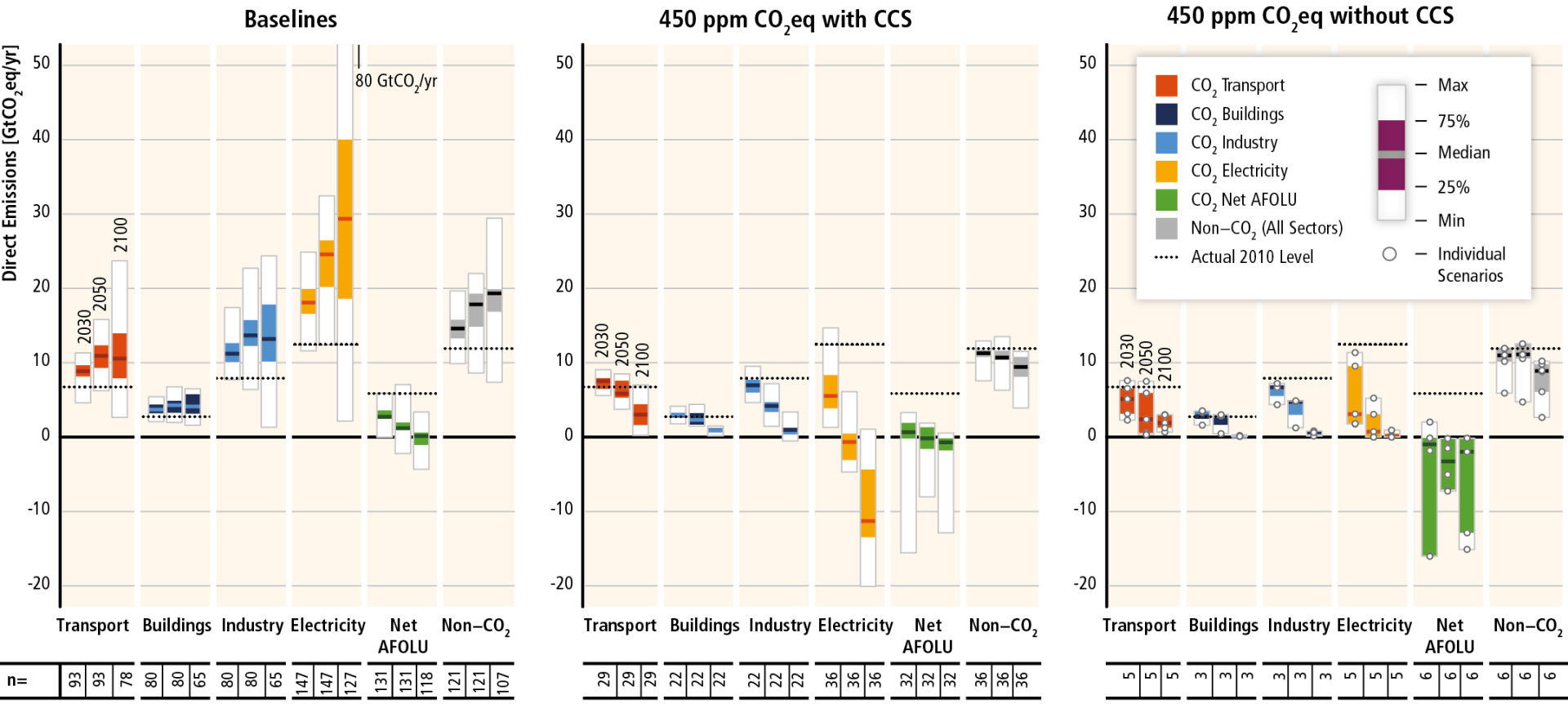


Note: Assumes both the Authority's 2020 target recommendations are accepted—a 15 per cent target plus an additional 4 percentage points from carryover—giving an effective target of 19 per cent.
Source: Climate Change Authority

With major job ahead for electricity sector

Direct Sectoral CO_2 and Non-CO_2 GHG Emissions in Baseline and Mitigation Scenarios with and without CCS

(IPCC, 2014)



Much more to be done

Table I.1 Summary of progress *(IEA Technology Perspectives, 2013)*

On track?	Status against 2DS objectives	Policy Recommendations
Renewable power	On track to meet 2DS objectives in terms of absolute generation and investment levels. Concentrating solar power, offshore wind, enhanced geothermal not advancing quickly enough.	▪ For more mature markets and technologies, policies to enable greater market and system integration of higher penetrations of variable renewables are vital. ▪ For less developed markets and technologies, strategies should focus on market expansion or stimulating early-stage deployment. ▪ Policies must be predictable and transparent. ▪ Markets must be designed to allow recuperation of capital cost of investments. This is particularly important for technologies with very low marginal costs.
Nuclear power	Projected 2025 capacity 15%-32% below 2DS objectives. Both new-build activity and long-term operation of existing reactors required to meet 2DS goals.	▪ More favourable electricity market mechanisms and investment conditions required to de risk investments and allow investors to recuperate high upfront capital cost. ▪ Post-Fukushima safety upgrades should be quickly implemented to foster public confidence.
Gas-fired power	Share in thermal generation has increased at the expense of coal in some regions, but not all.	▪ Higher carbon prices and other regulatory mandates are required to drive coal-to-gas switching outside the United States. ▪ Development of unconventional gas resources would help bring down gas prices and potentially trigger coal-to-gas switching in regions that currently rely heavily on coal. Scaling up unconventional gas extraction requires careful regulation and monitoring, in order to avoid adverse effects on the environment.
Coal-fired power	Growth is outpacing increases in generation from non-fossil energy sources. Projected global coal demand exceeds 2DS levels by 17% in 2017, higher than 6DS pathway.	▪ Governments must explicitly recognise the impact of increasing coal-fired power generation. ▪ To reduce the impact of increasing coal use, ultra-supercritical units should be installed unless there is strong reason not to do so. ▪ Pricing and regulation that reduce CO_2 emissions, control pollution and reduce generation from inefficient units are vital.
CCS	Capture capacity of projects currently operational or in pipeline is only 25% of 2DS 2020 target. Still no large-scale integrated projects in power sector; and few in industry.	▪ Governments must show real financial and policy commitment to CCS demonstration and deployment. ▪ Near term policies should be supported by credible long-term climate change mitigation commitments. ▪ Recognise the large investments and long-lead time required to discover and develop viable storage capacity. ▪ Address CO_2 emissions from industrial applications and introduce CCS as a solution.
Industry	Reasonable progress in improving energy efficiency, but there remains significant potential to deploy best available technology and optimise processes.	▪ Implement policies to ensure that new capacity is developed with best available technology and that industrial plant refurbishment projects are promoted to meet energy efficiency targets. ▪ Measures to facilitate access to financing are vital. ▪ Particular efforts are needed to improve energy efficiency in light industry and SMEs. ▪ To avoid technological lock-in of inefficient technology in developing countries, technology transfer efforts must be enhanced.

Not on track Improvement, but more effort needed On track, but sustained deployment and policies required

Where next?

"The best way to predict your future is to create it!"

Abraham Lincoln

"That depends…"

Many opportunties to improve on likely outcomes… but clean energy will ultimately be a global success or failure