Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA

Possibilities for 100% renewables in Australia's electricity sector

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How and when can Australia go 100% renewable?

AIE Sydney Branch Meeting
12 May 2014

Growing interest in future high RE electricity sector

- Many drivers including
  - climate change and other environmental impacts
  - energy security (most countries see fossil fuel $ as economic liabilities)
  - falling costs for some key renewable technologies, deployment success
  - poor progress with some of the 'alternatives'
- Some key questions
  - *Technical feasibility?* – can high (even 100%) renewables mixes utilizing highly variable and somewhat unpredictable solar and wind reliably meet demand at all times and locations
  - **If yes,** is it an *ethical* course of action and will if facilitate broader sustainability objectives
  - **If yes,** *Economic feasibility?* – is 100% renewables economically worth doing given likely costs vs costs of inaction, other options
  - **If yes, how might we get there and what is required now**

Significant regions of world currently have local energy deficits

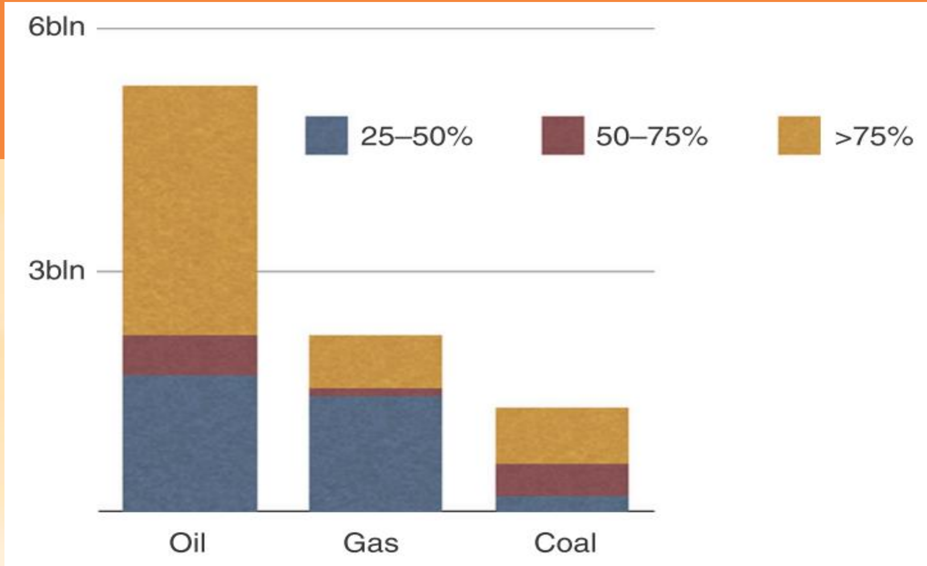
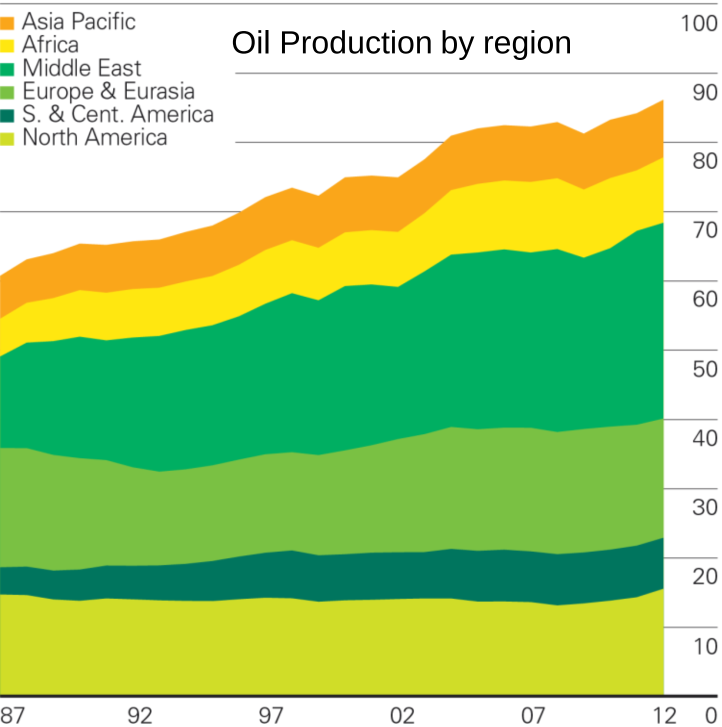
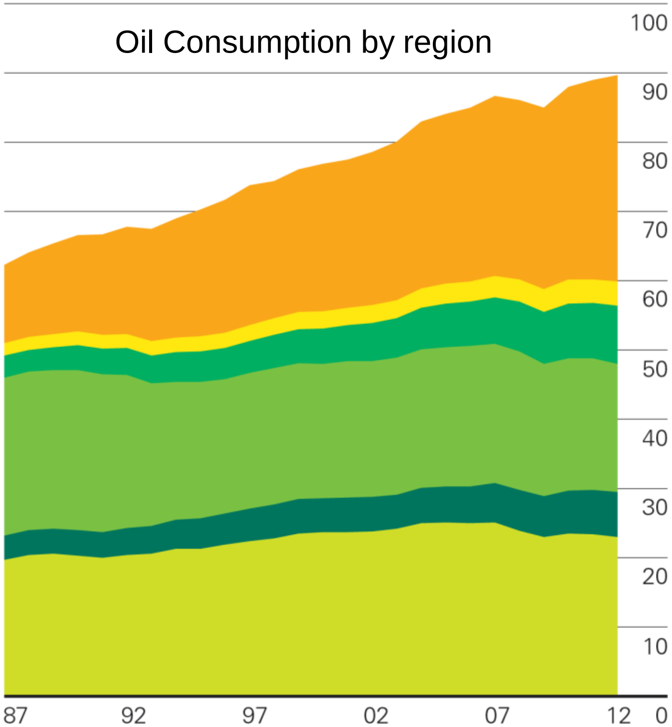
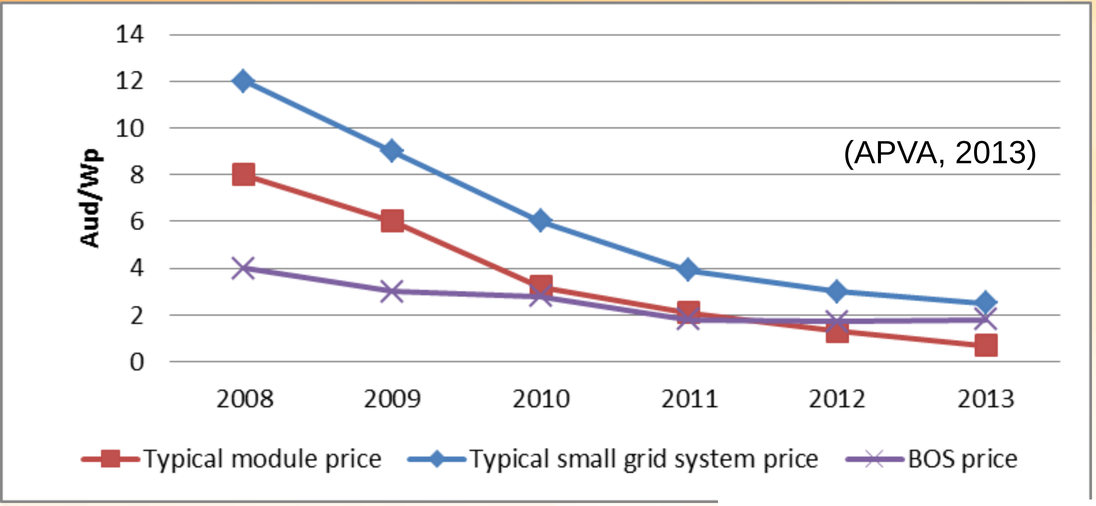


Figure TS-5 | Number of people in countries that are dependent on imported

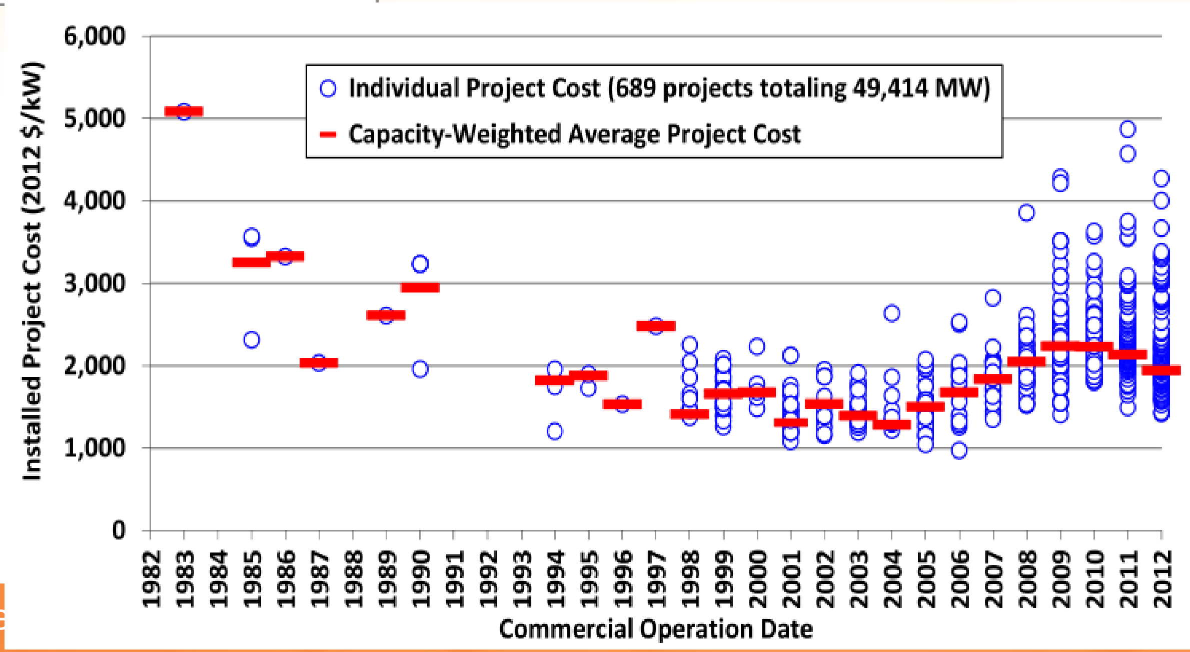




Some (but not all) key RE technology costs falling



… or not rising as fast as costs of some other options



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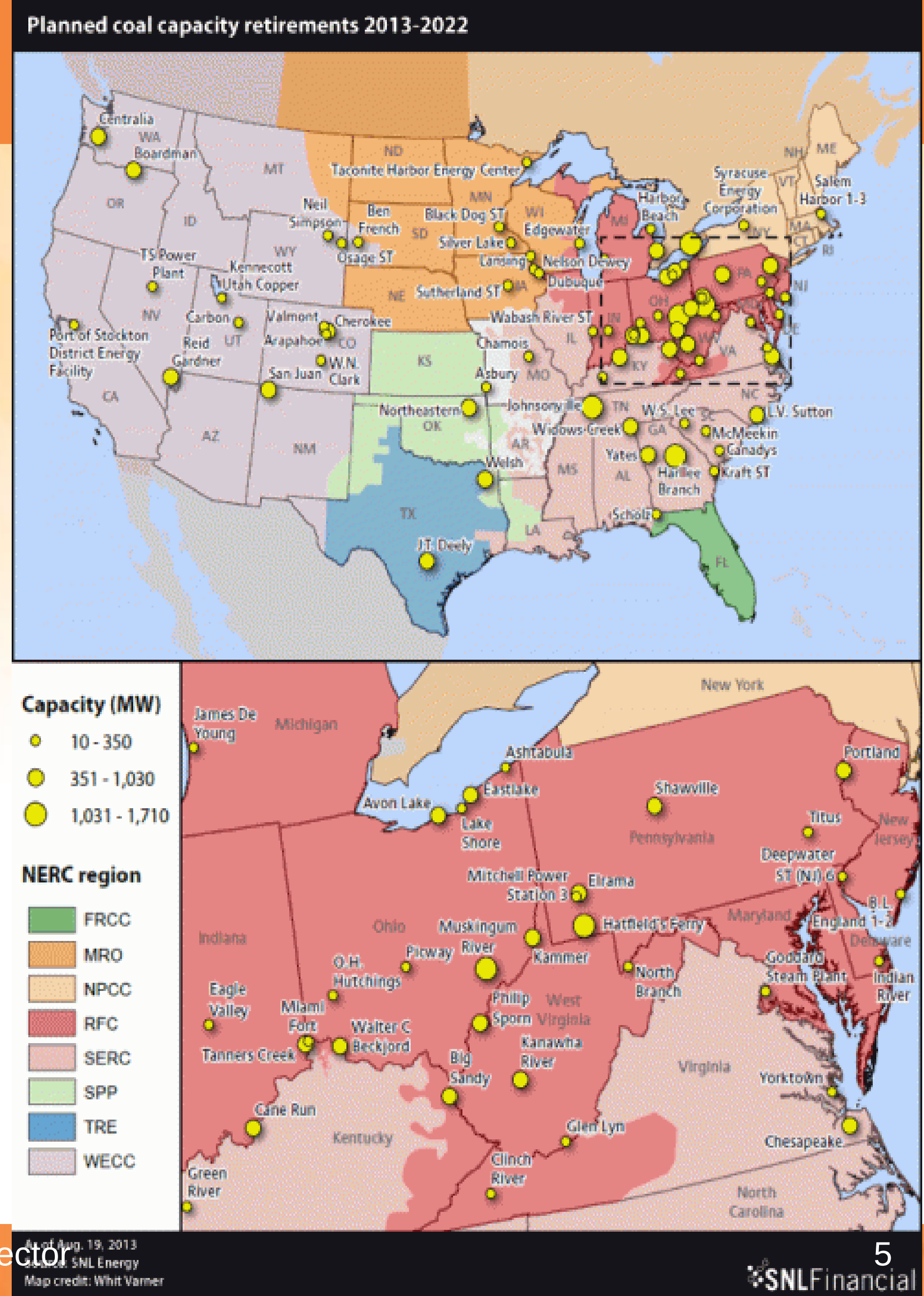
Non-climate enviro impacts also becoming key drivers

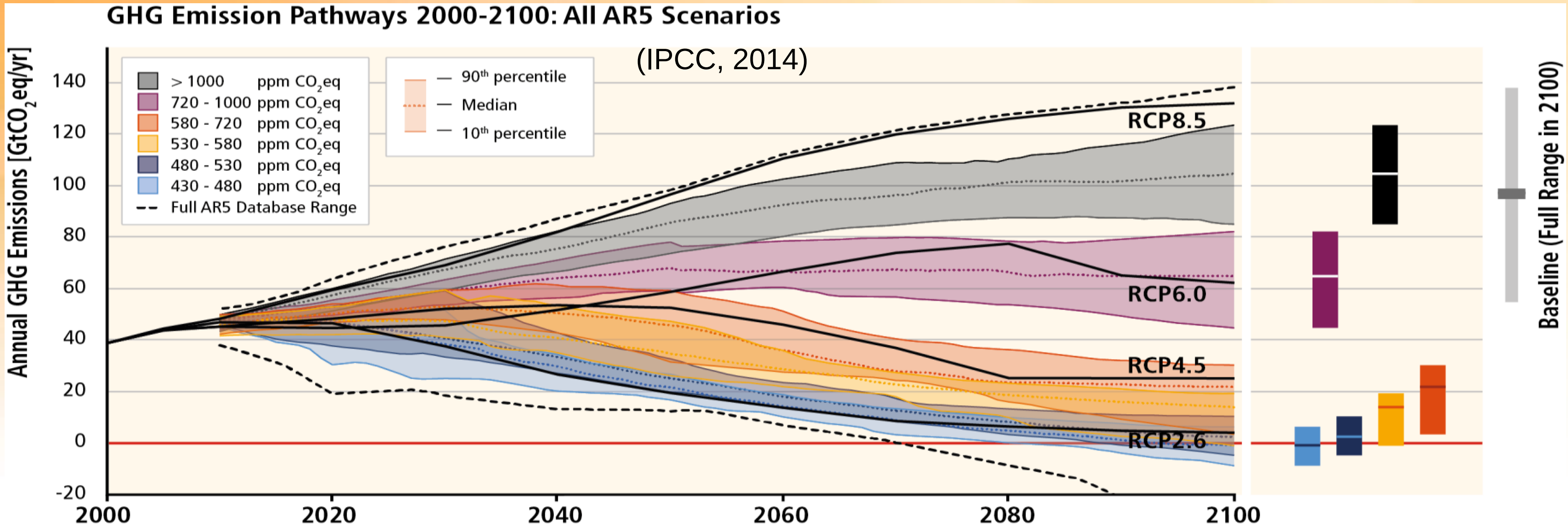
"China's State Council has announced that it is banning the construction of new coal-fired power plants near Beijing, Shanghai and Guangdong. The goal is to cut air pollution in the country's eastern megalopolises. The hope is that by 2017 Beijing residents will be breathing in 25% less fine particulate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

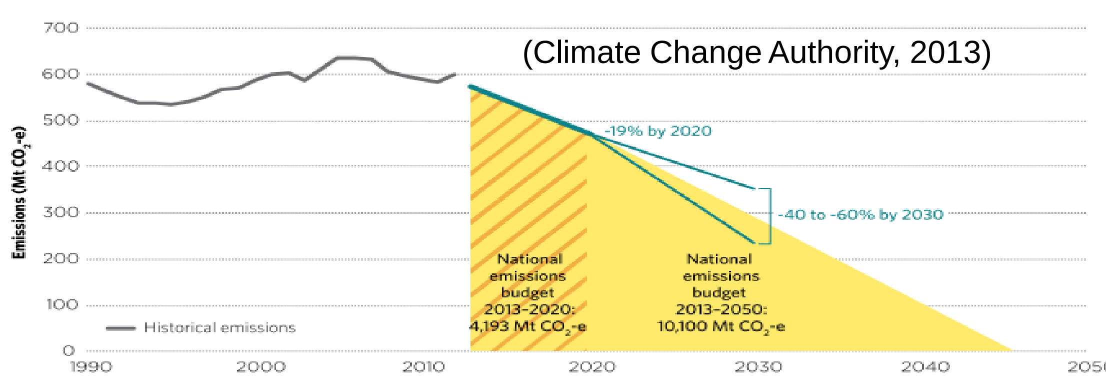


An elephant in the room – Climate Change

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

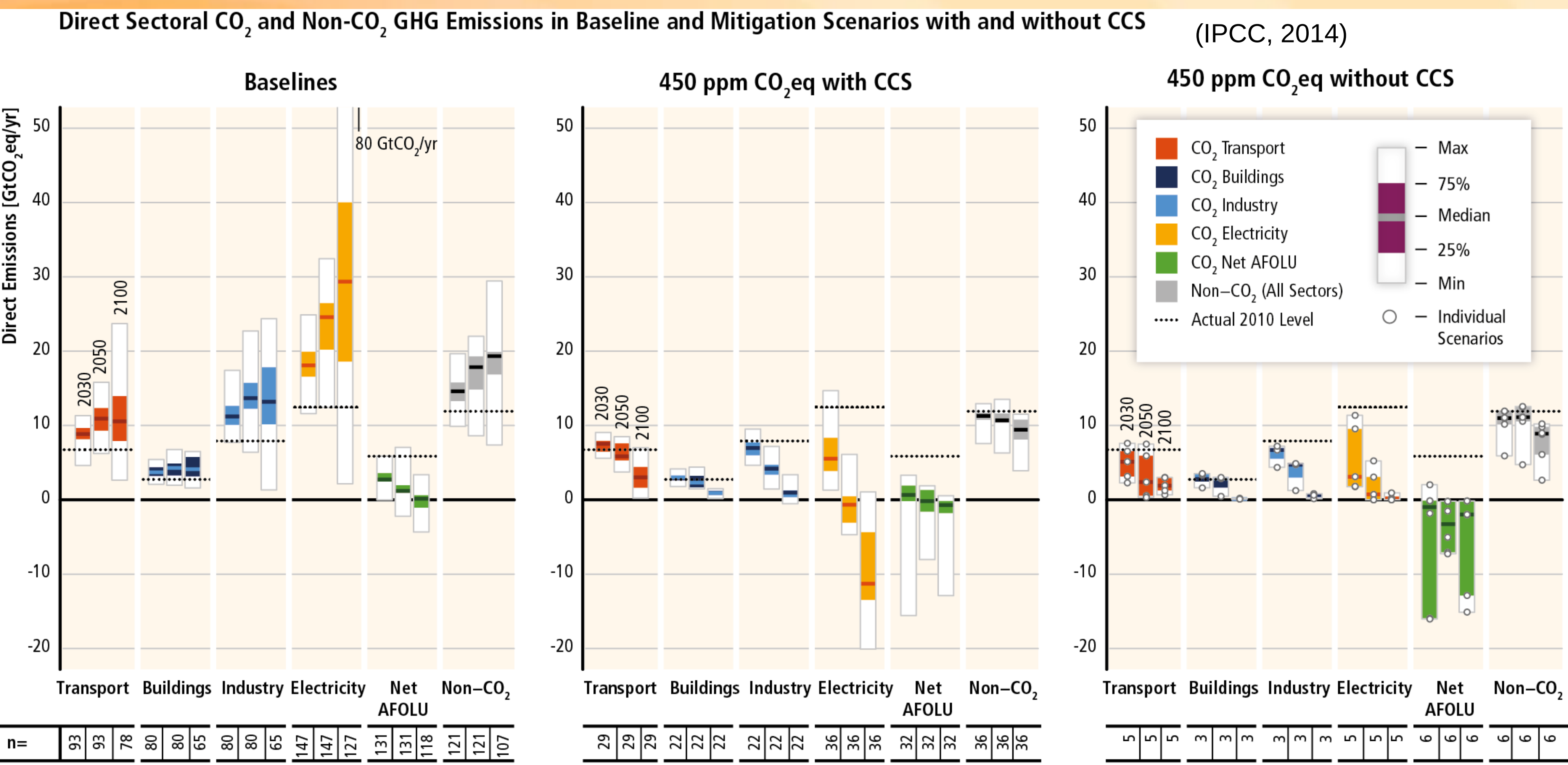
Climate protection requires major global… and hence Australian emissions reductions





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



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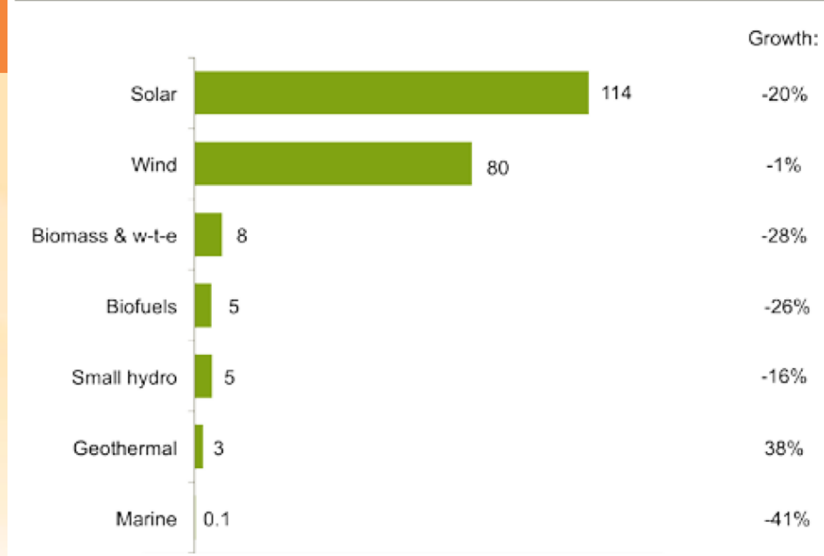
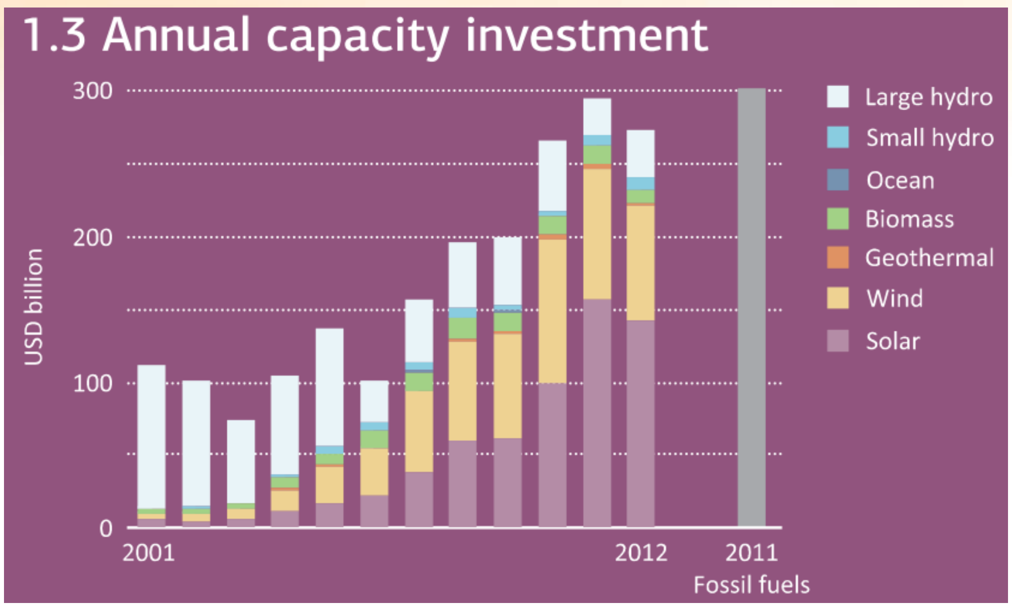
RE one of the few emission reduction successes to date

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

Other key success is falling demand in some OECD countries

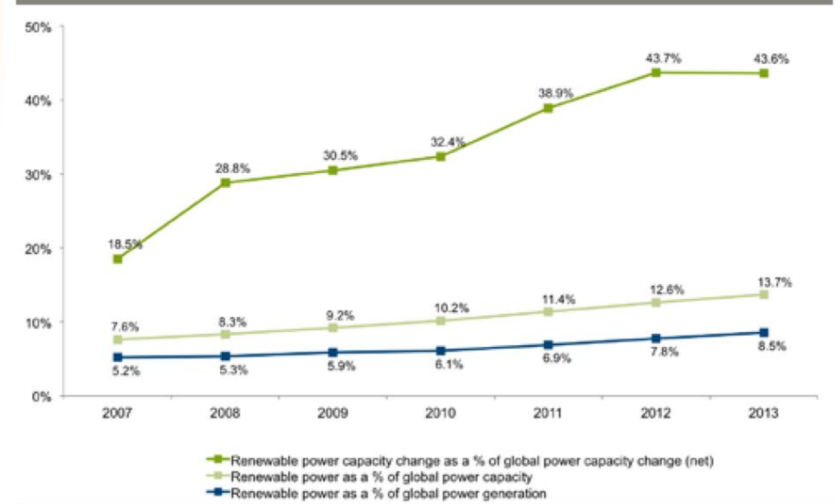
FIGURE 5. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2013, AND GROWTH ON 2012, $BN





(IEA, 2013)

FIGURE 23. RENEWABLE POWER GENERATION AND CAPACITY AS A SHARE OF GLOBAL POWER, 2007-2013, %



Renewables figure excludes large hydro. Renewable capacity figures based on Bloomberg New Energy Finance global totals.

Source: Bloomberg New Energy Finance

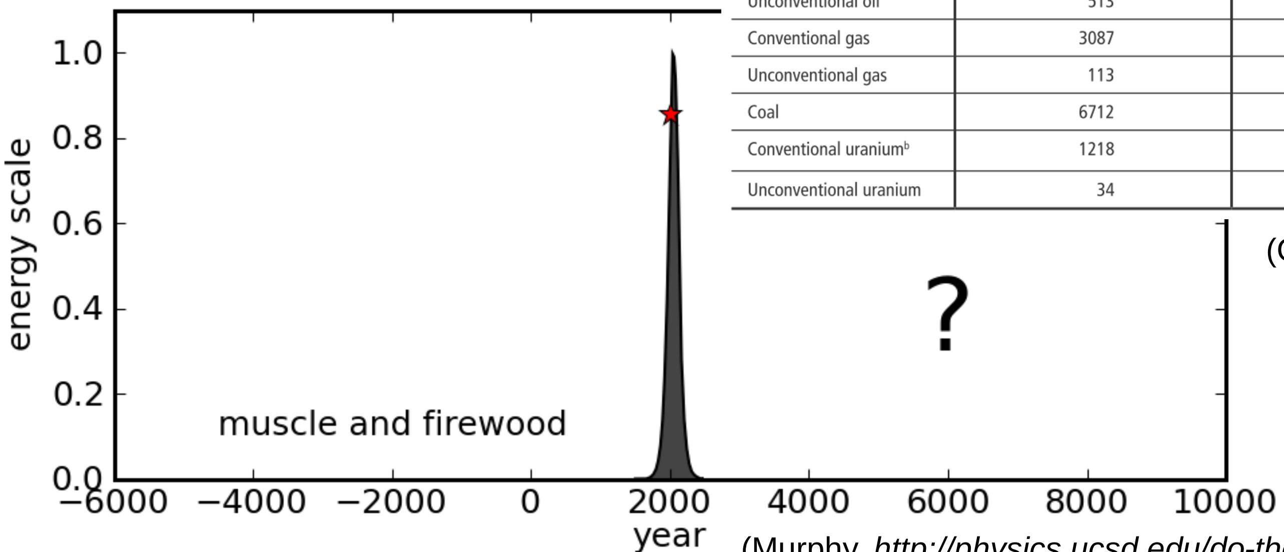
(BNEF, 2014)

Taking a longer-term perspective, 100% renewables a question of when.. and how

- *Our only technically feasible truly long-term option*
- *… although seemingly plenty of fossil fuels, other options*

	Historical production through 2005 [EJ]	Production 2005 [EJ]	Reserves [EJ]	Resources [EJ]
Conventional oil	6069	147.9	4900–7610	4170–6150
Unconventional oil	513	20.2	3750–5600	11,280–14,800
Conventional gas	3087	89.8	5000–7100	7200–8900
Unconventional gas	113	9.6	20,100–67,100	40,200–121,900
Coal	6712	123.8	17,300–21,000	291,000–435,000
Conventional uranium[b]	1218	24.7	2400	7400
Unconventional uranium	34	n.a.		7100

(Global Energy Assessment, 2012)



(Murphy, *http://physics.ucsd.edu/do-the-math/*, 2012)

Growing plans on transition pathways

DANISH MINISTRY OF
CLIMATE, ENERGY AND BUILDING

DK Energy Agreement, March 22 2012

- With the Energy Agreement of March 22, we have succeeded in obtaining broad political commitment to an ambitious green transition for Denmark that focuses on energy savings throughout society and promotes renewable energy in all sectors.
- This agreement implies a 12% reduction of gross energy consumption in 2020 in comparison to 2006; a share of 35% renewable energy in 2020; and 50% wind energy in Danish electricity consumption in 2020.
- The agreement is important for delivering on the political goal that Denmark's entire energy supply (electricity, heating, industry and transport) is covered by renewable energy in 2050.

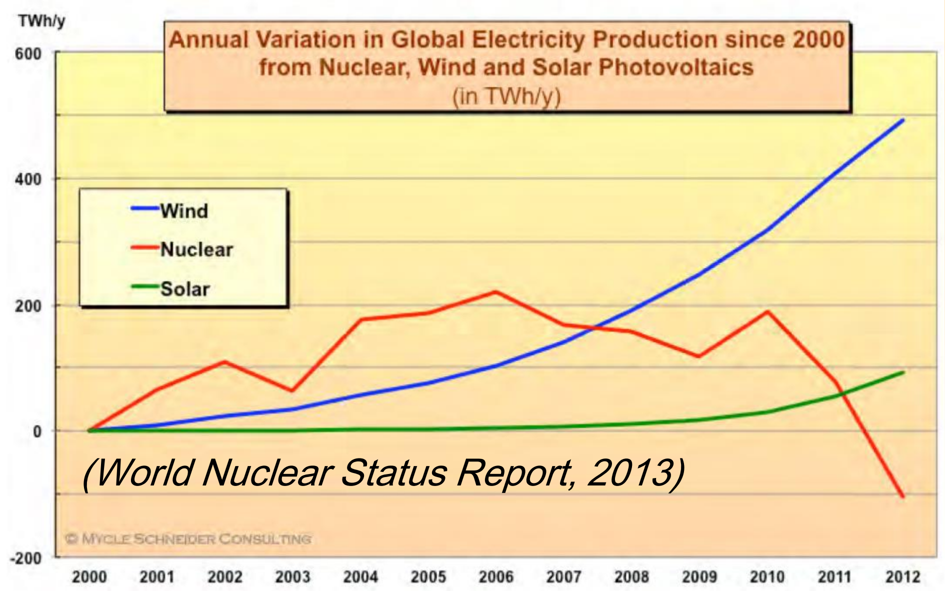
Some alternatives struggling at present

CARBON CAPTURE AND STORAGE

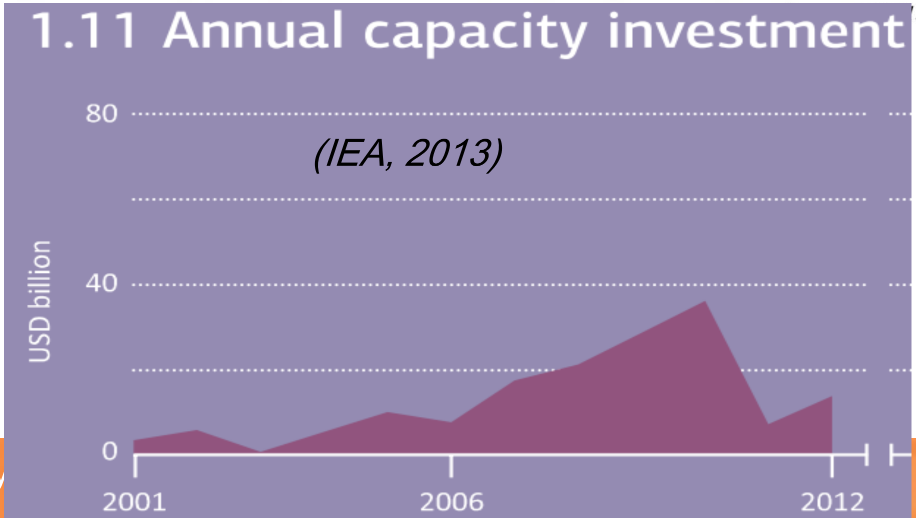
CCS is another area of technology that could help to curb emissions, if applied to coal- or gas-fired power stations or to carbon-intensive industrial plants such as cement works. Progess with carbon capture has, however, been disappointing in recent years. Five projects at demonstration scale (1MtCO2/yr) 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)



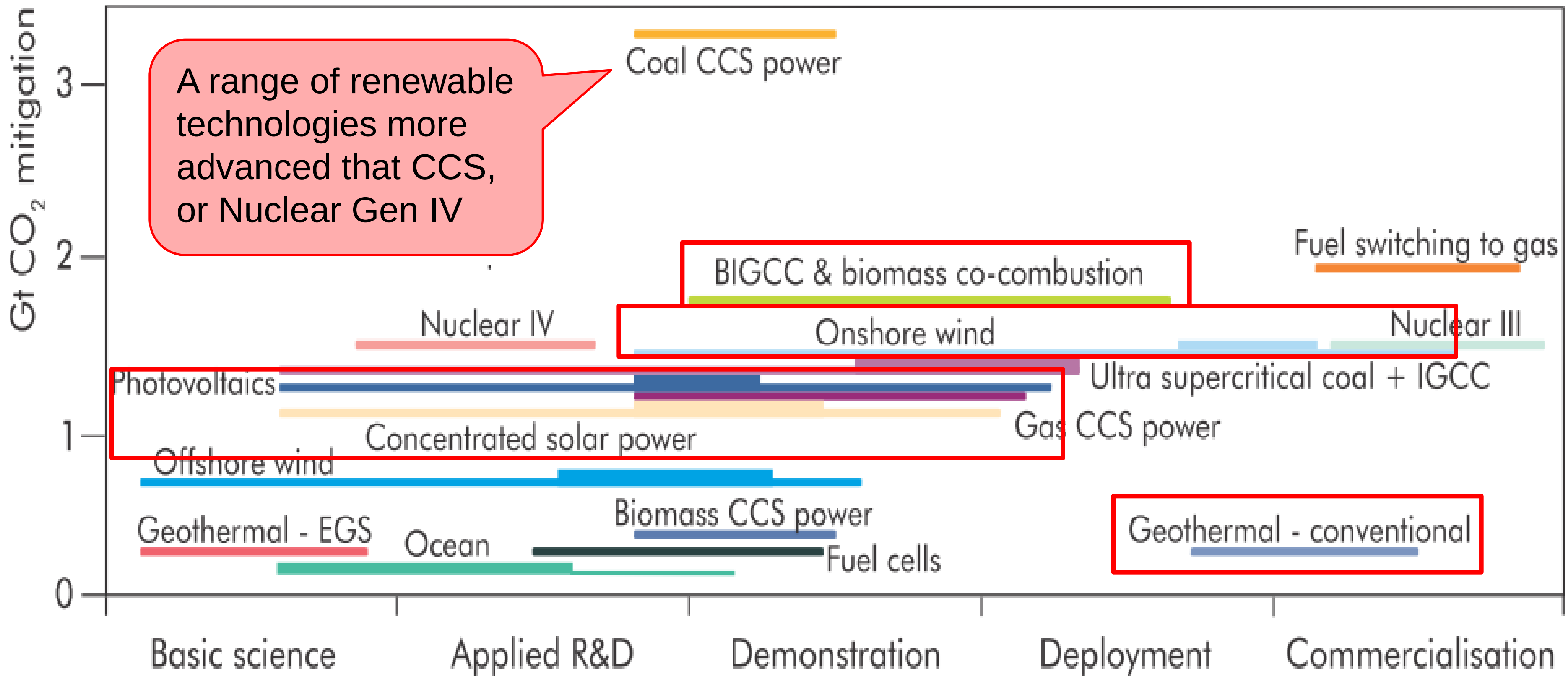
(World Nuclear Status Report, 2013)



(IEA, 2013)

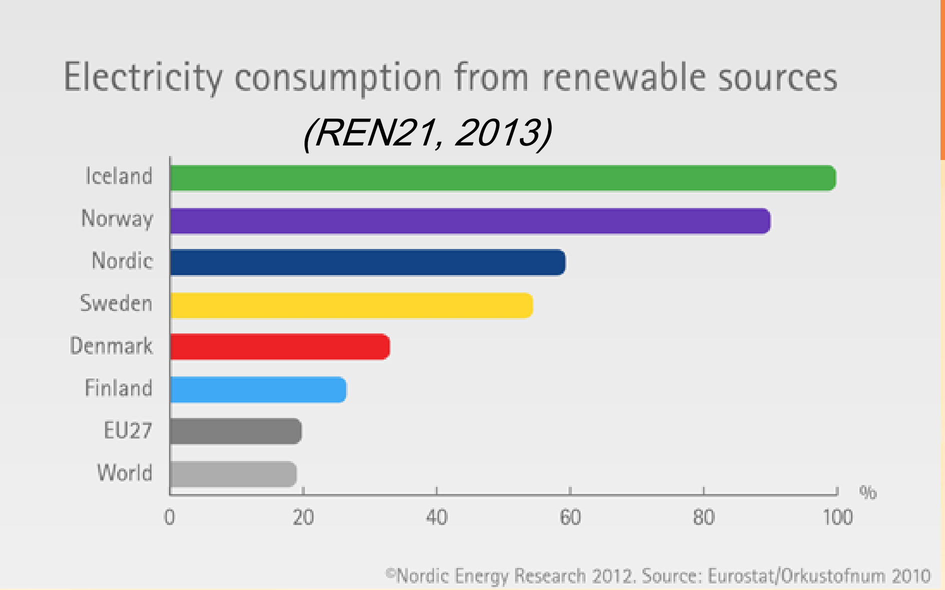
Technical feasibility: range of proven renewables

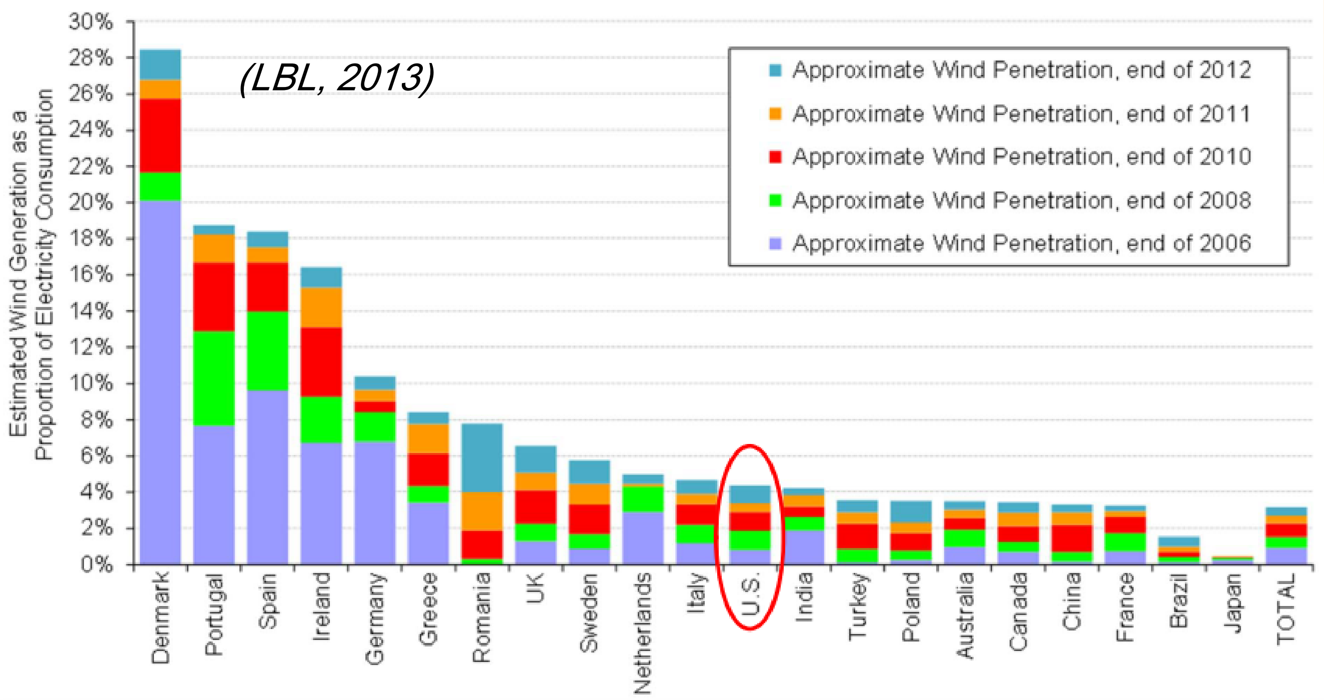
Figure 4.6 ▶ Near-term technology development priorities and CO_2 mitigation for power generation technologies (IEA, *Energy Technology Perspectives*, 2010)



Technical feasibility: ‘what exists is possible’

wind a significant contributor in growing number of electricity industries around the world





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High renewables for the NEM?

A significant change from current mix with some hydro, modest wind

Note missing PV, other non-registered renewables

Figure 1.4

Registered capacity in regions, by fuel source, 2011

(AER, *2012*)

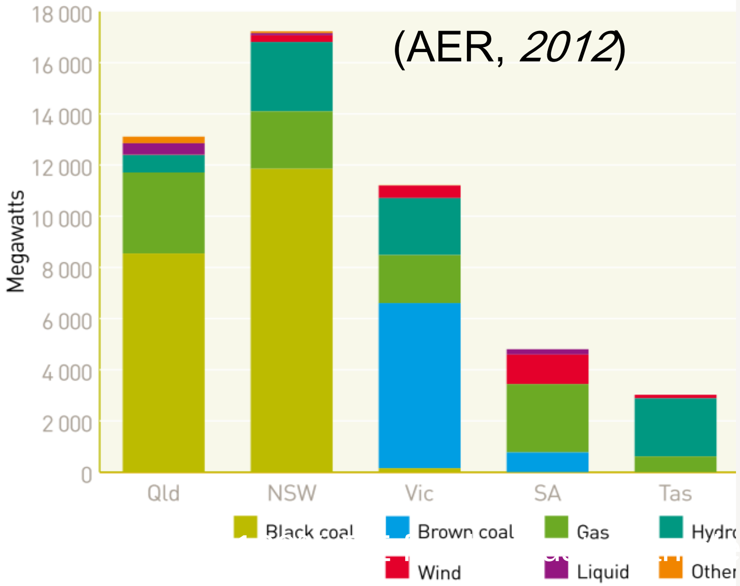
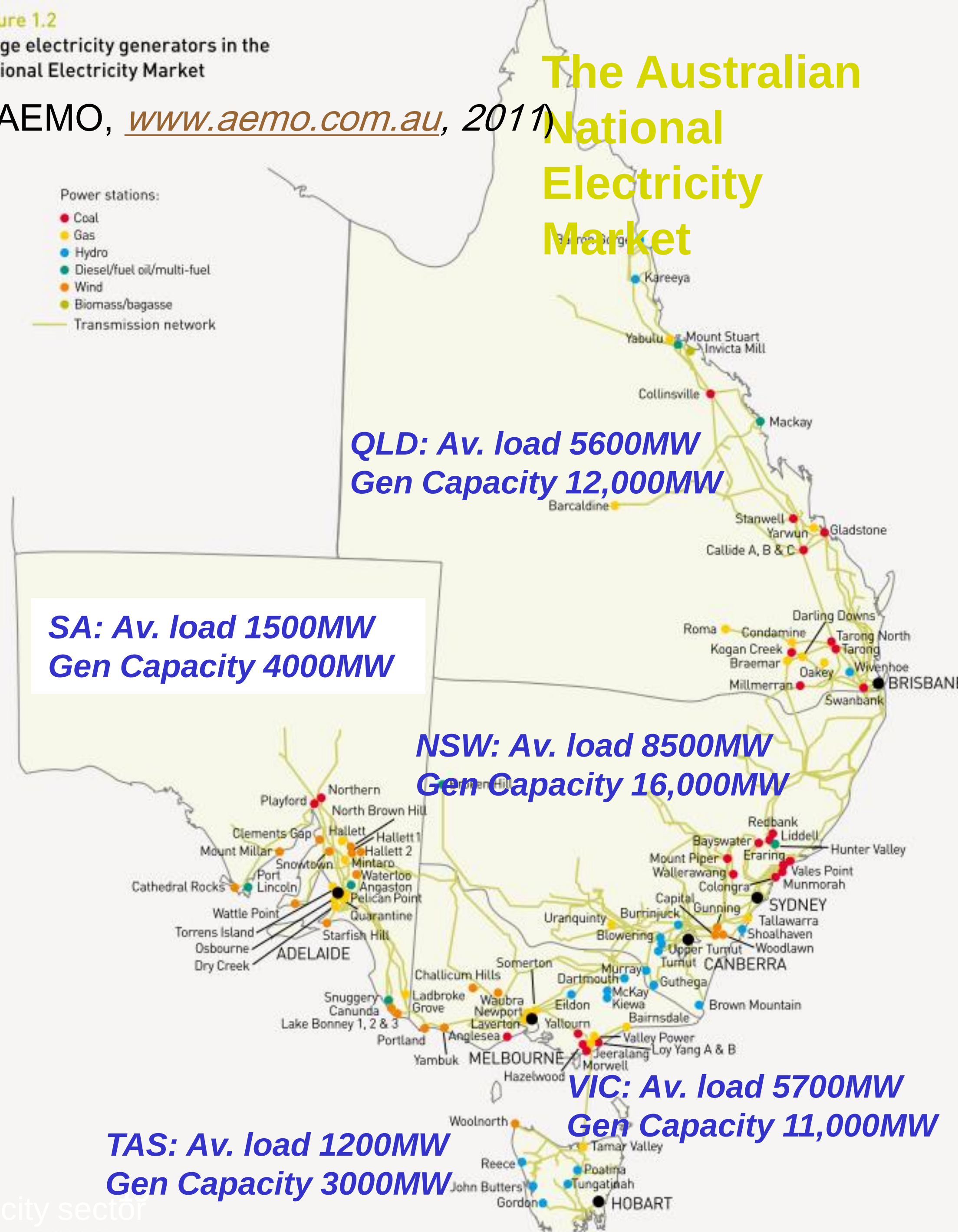


Figure 1.2

Large electricity generators in the National Electricity Market

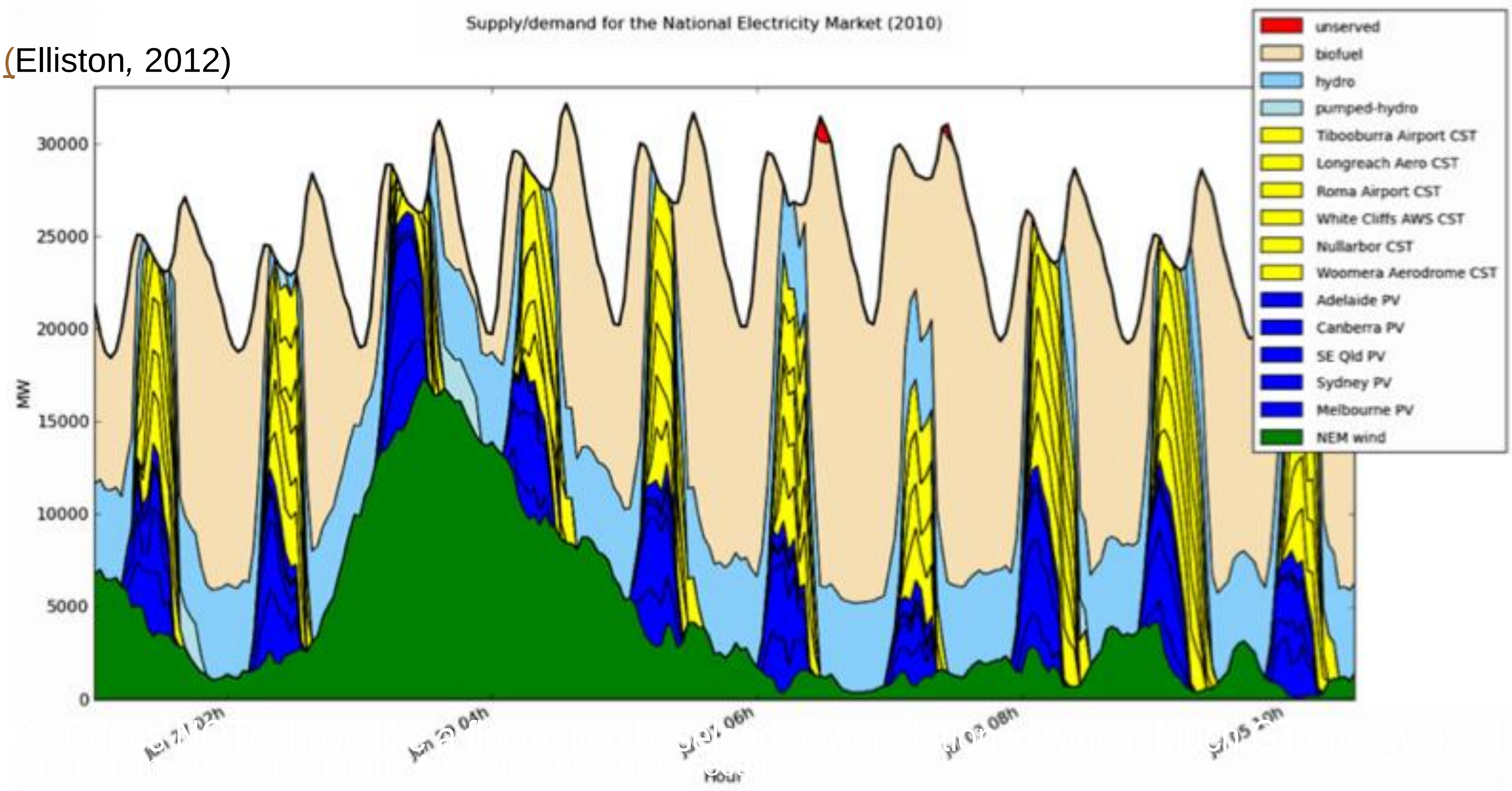
(AEMO, www.aemo.com.au, *2011*)

The Australian National Electricity Market



Technical feasibility?: Simulations based on hourly estimates of RE availability across the NEM versus demand – *eg. a challenging Week in Winter 2010*

(Elliston, 2012)

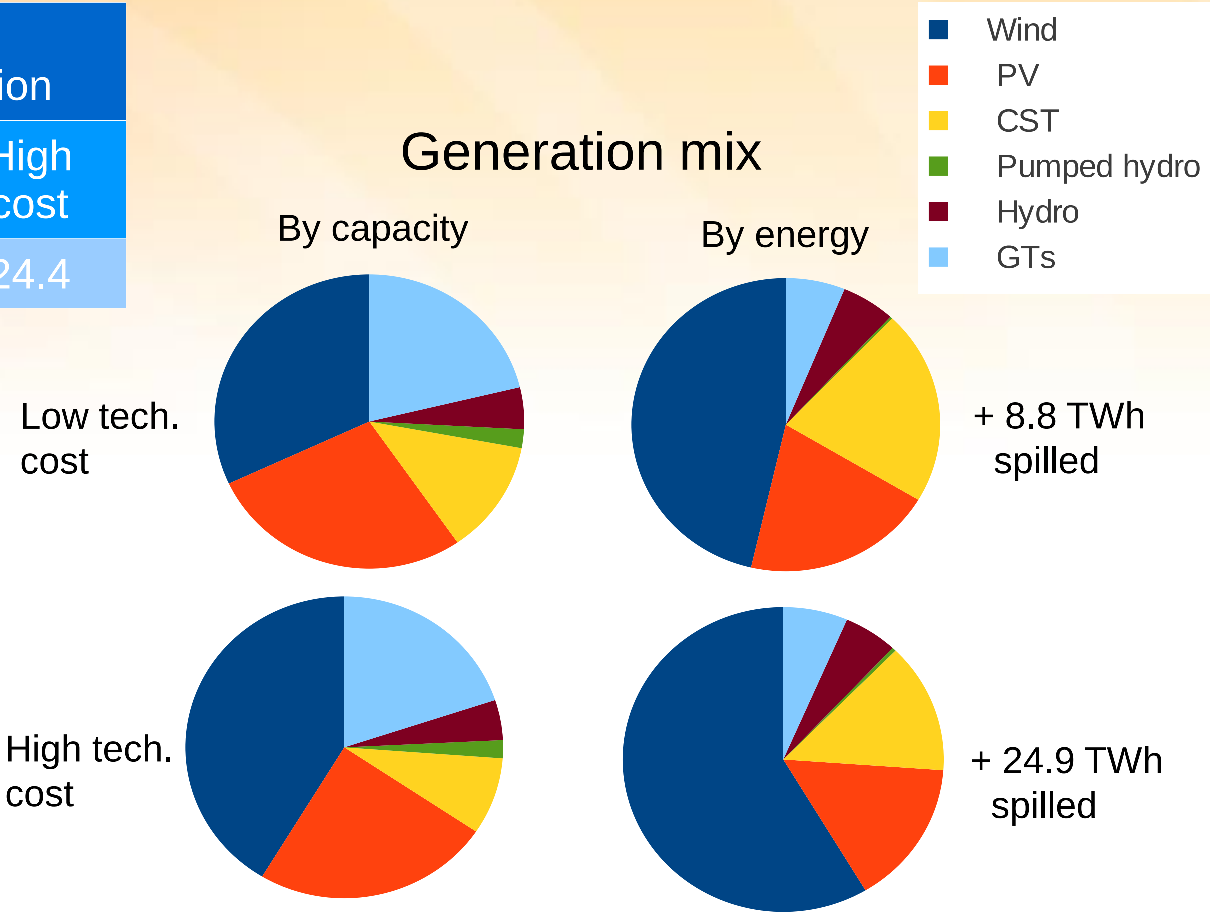


Economic feasibility - 100% RE findings

A$b/yr for AETA *high* and *low* technology cost scenarios (Elliston, 2013)

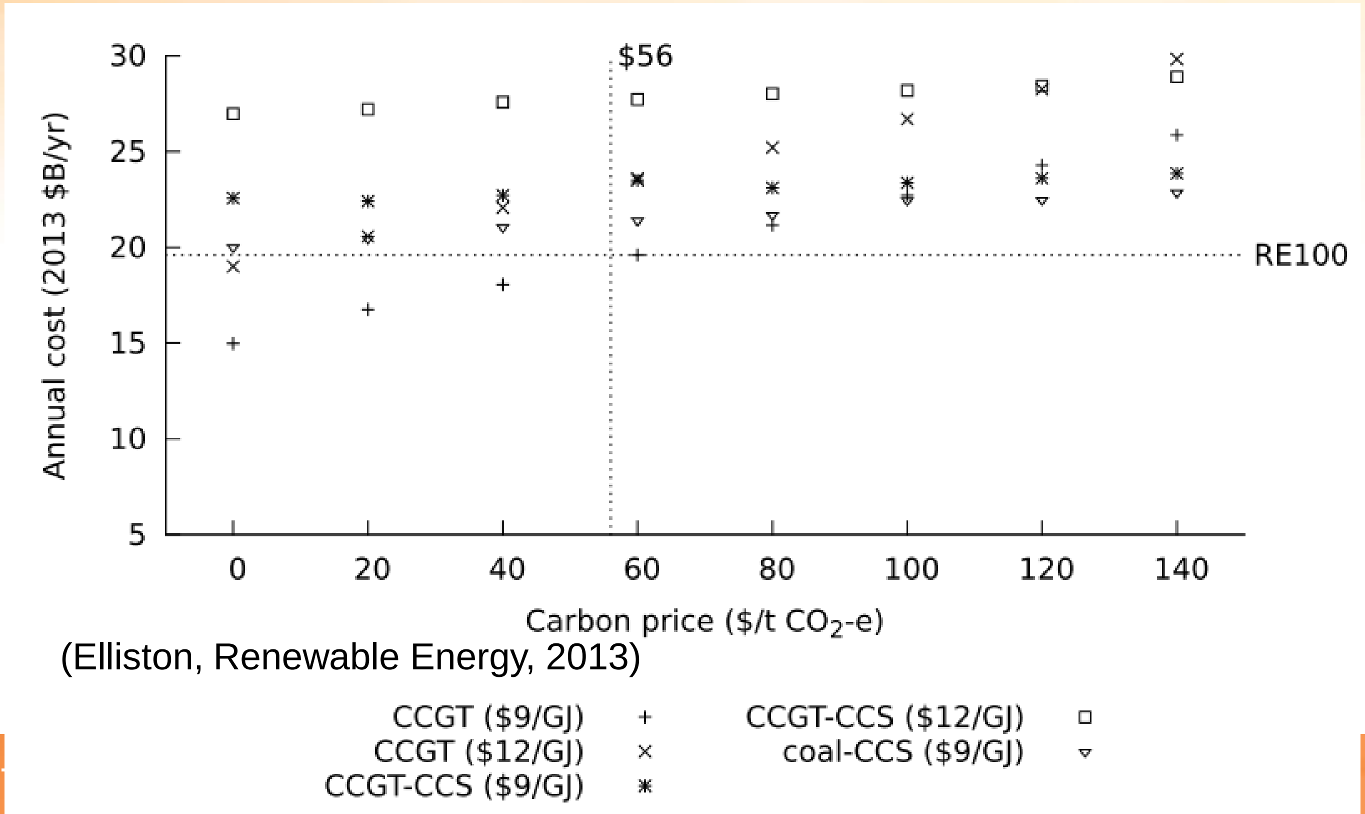
Without transmission		With transmission	
Low cost	High cost	Low cost	High cost
19.6	22.1	21.2	24.4

Current NEM costs approx. $10b/year. At carbon prices of $50-100/tCO2 100% renewables costs can be lower cost than 'replacement' scenario



Additional scenarios for comparison

- CCGT: conventional CCGTs plant, existing NEM, OCGT
- CCGT + CCS: as above with CCS on CCGTs
- Coal + CCS: supercritical pulverised black coal with post-combustion CCS, existing hydro, OCGT



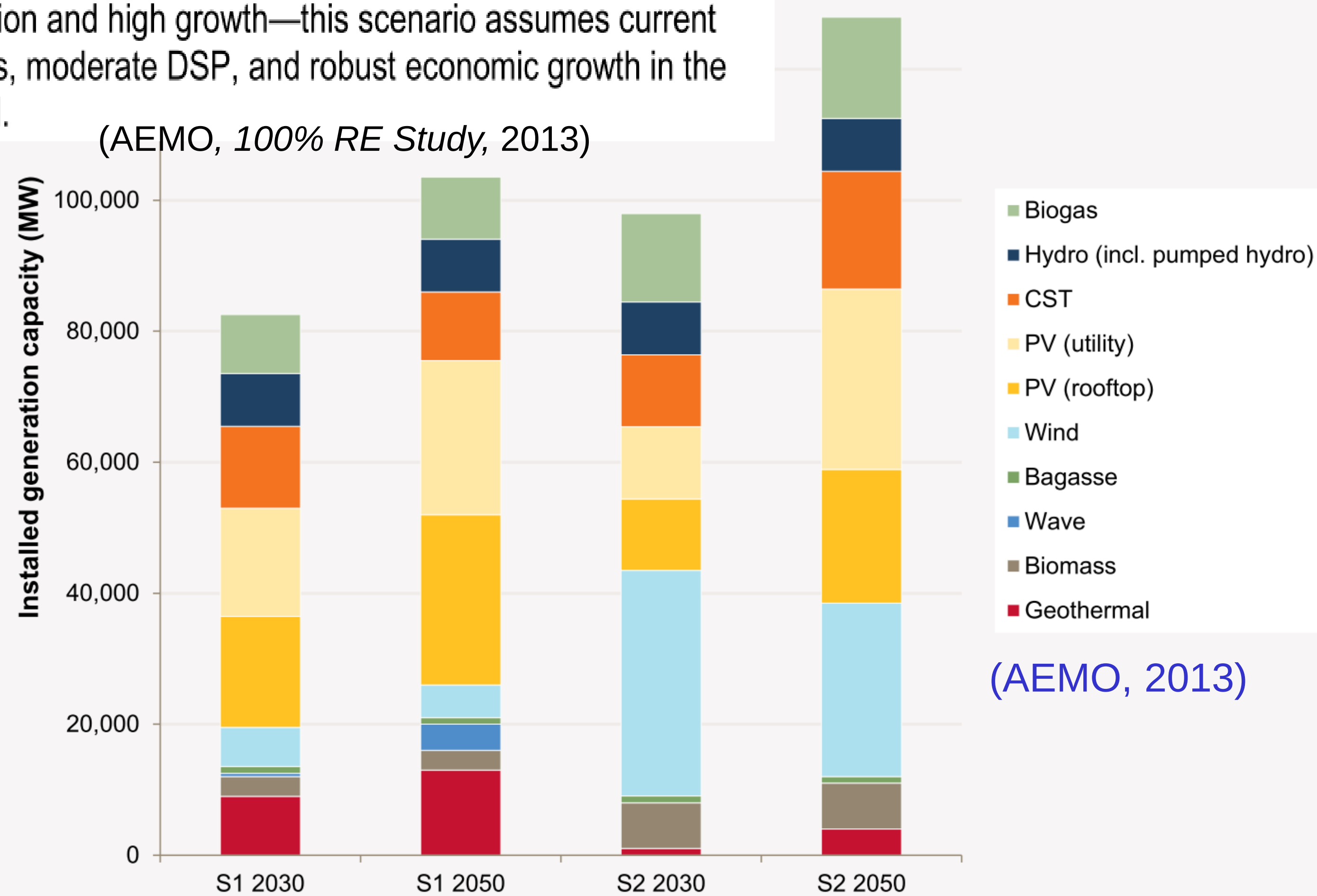
(Elliston, Renewable Energy, 2013)

AEMO 100% RE – least cost capacity mix

Scenario 1: Rapid transformation and moderate growth—this scenario assumes strong progress on lowering technology costs, improving demand side participation (DSP), and a conservative average demand growth outlook in the lead up to the year being modelled.

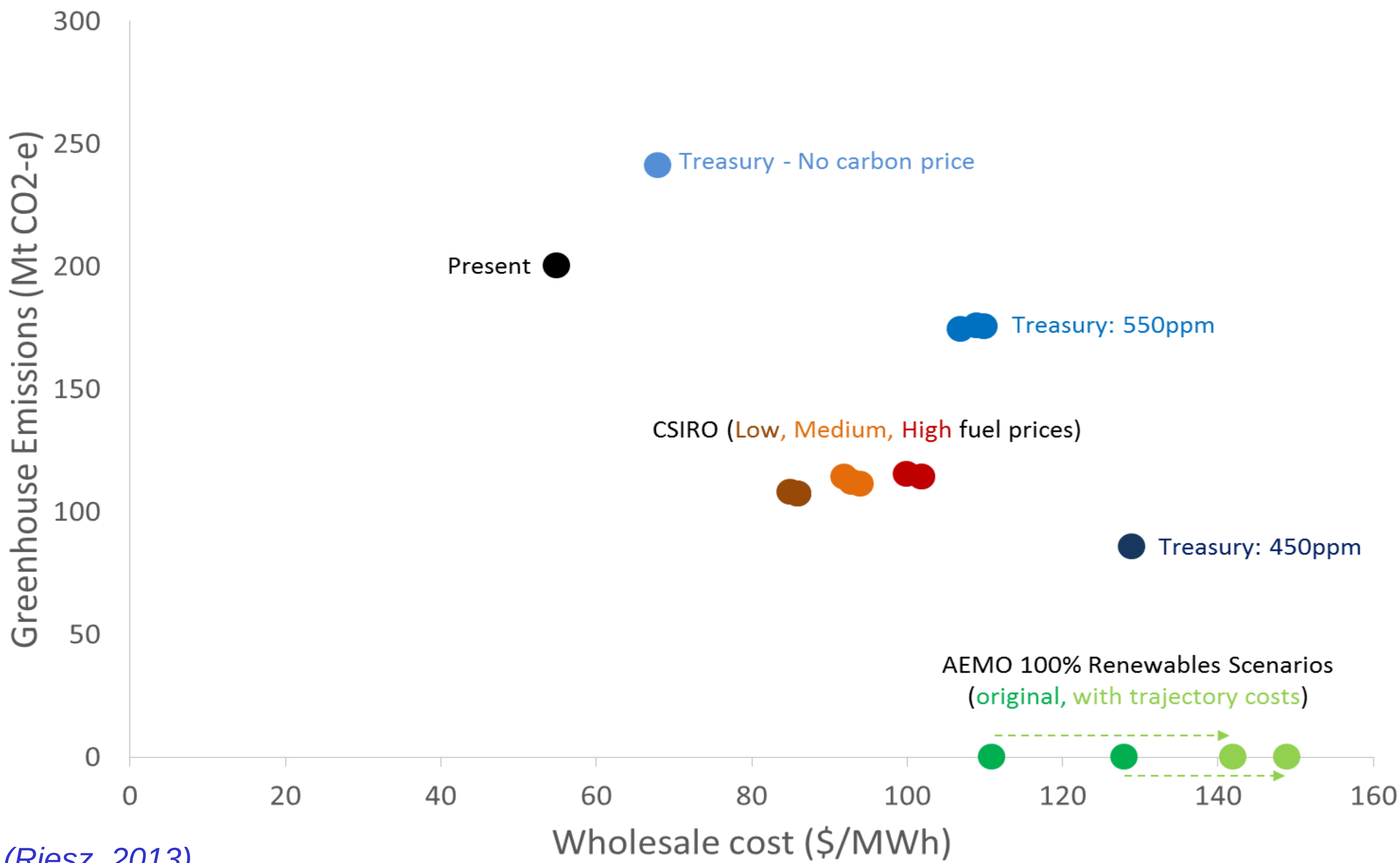
Scenario 2: Moderate transformation and high growth—this scenario assumes current trends in lowering technology costs, moderate DSP, and robust economic growth in the lead up to the year being modelled.

(AEMO, *100% RE Study*, 2013)



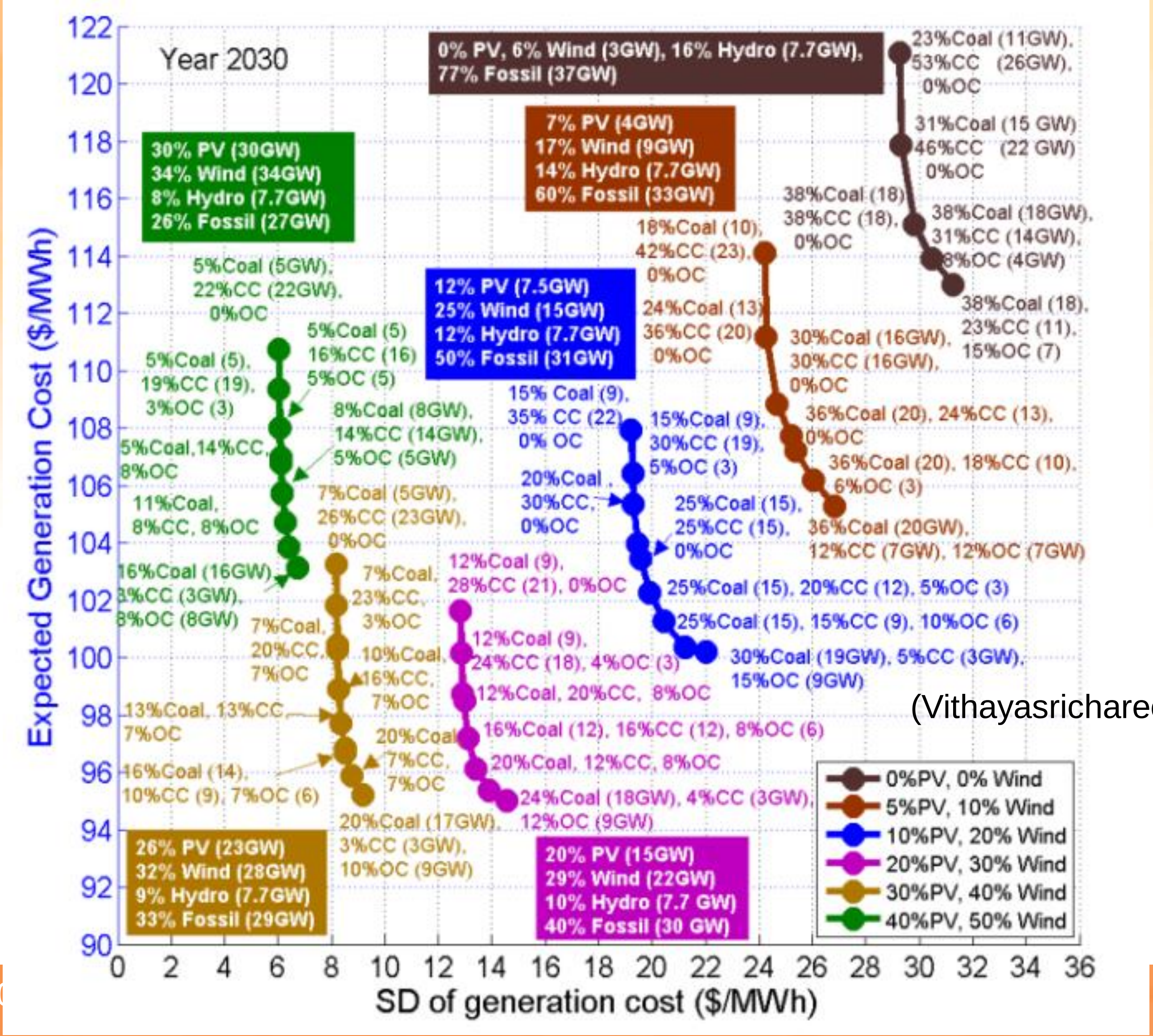
(AEMO, 2013)

Comparing 100% RE versus other options



(Riesz, 2013)

Does high RE add or reduce risk?



(Vithayasrichareon, 2013)

How to get there? Better understand how markets are responding to renewables already present

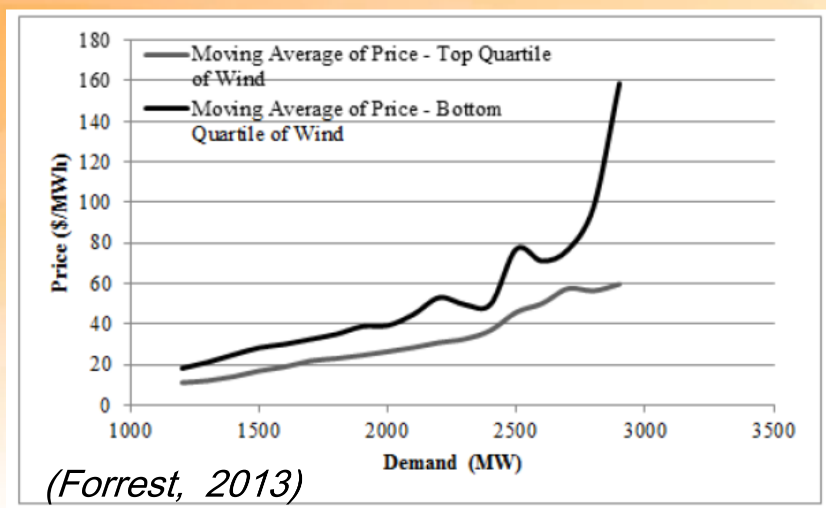


Figure 4 Indicative RET costs for residential and small business consumers for different assumptions on pass-through of merit order effects

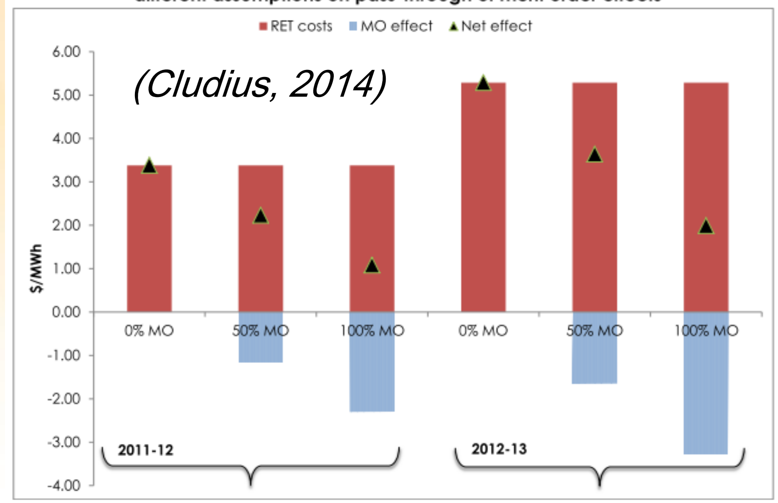
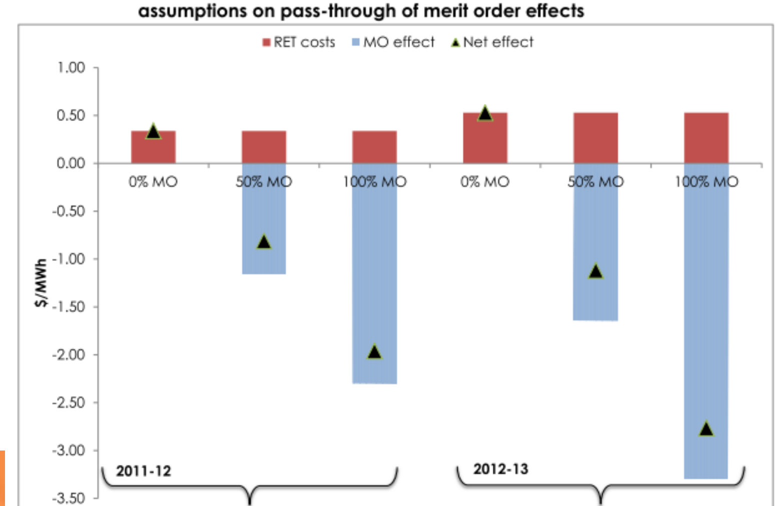


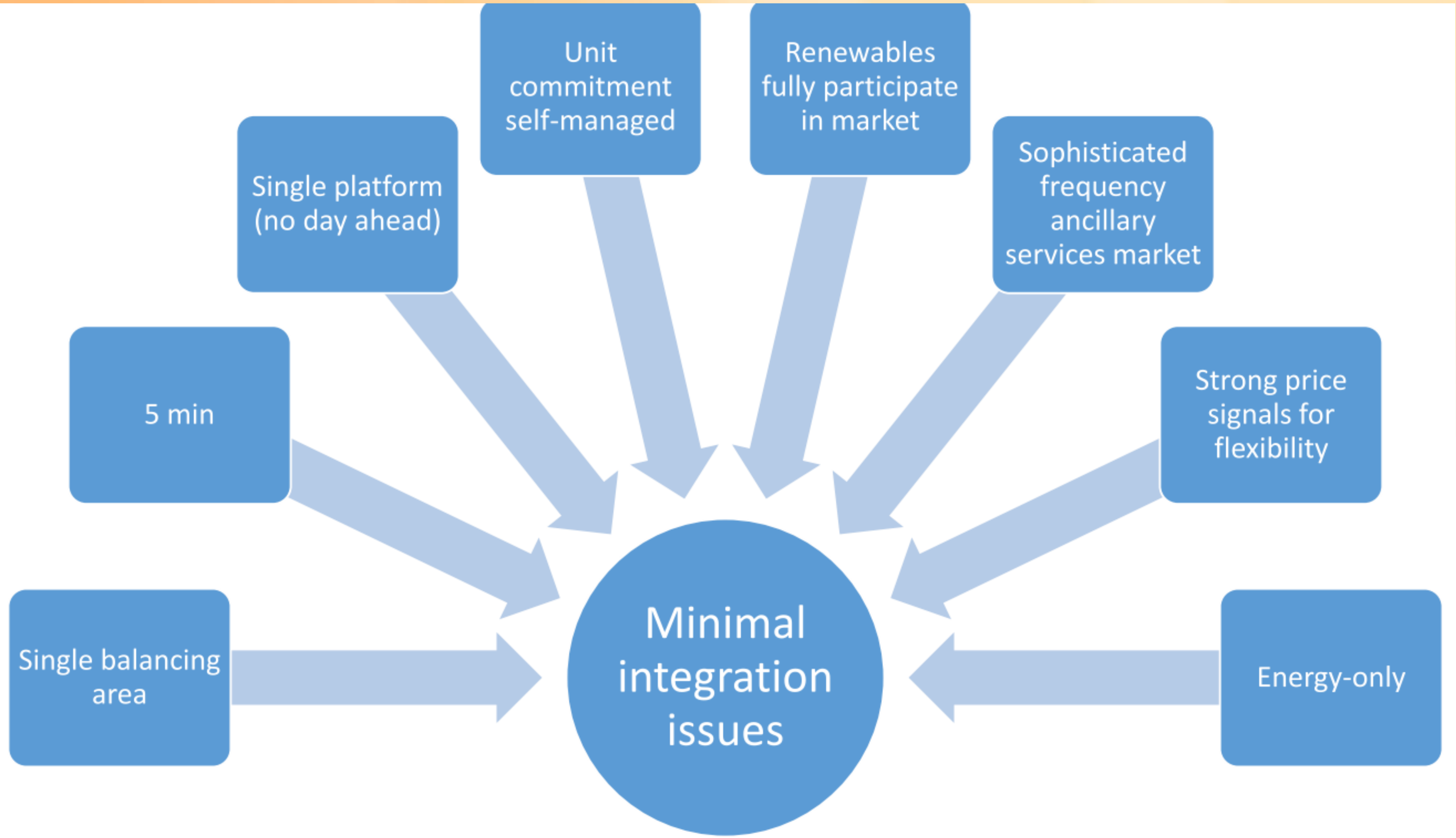
Figure 5 Indicative RET costs for industry with 90% RET exemptions for different assumptions on pass-through of merit order effects



Energy source	South Australia registered generation capacity		Electricity generated in 2012–13 by energy source	
	Megawatts (MW)	Percentage of total	Gigawatt hours (GWh)	Percentage of total
Gas	2,672	50%	6,786	52%
Wind	1,203	23%	3,483	27%
Coal	770	14%	2,238	17%
Rooftop PV[a]	400	7%	497	4%
Diesel	270	5%	12	<1%
Landfill methane/ landfill gas	16	<1%	55	<1%
Hydro	3	<1%	6	<1%
Total	**5,334**	**100%**	**13,077**	**100%**

(AEMO, 2013)

Questions of future market design for high RE

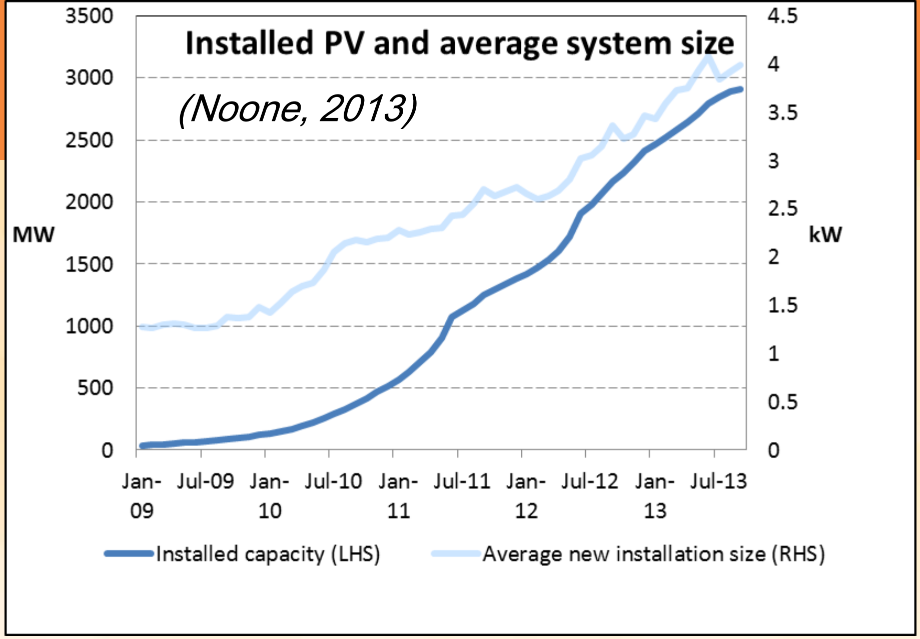


(Riesz, 2013)

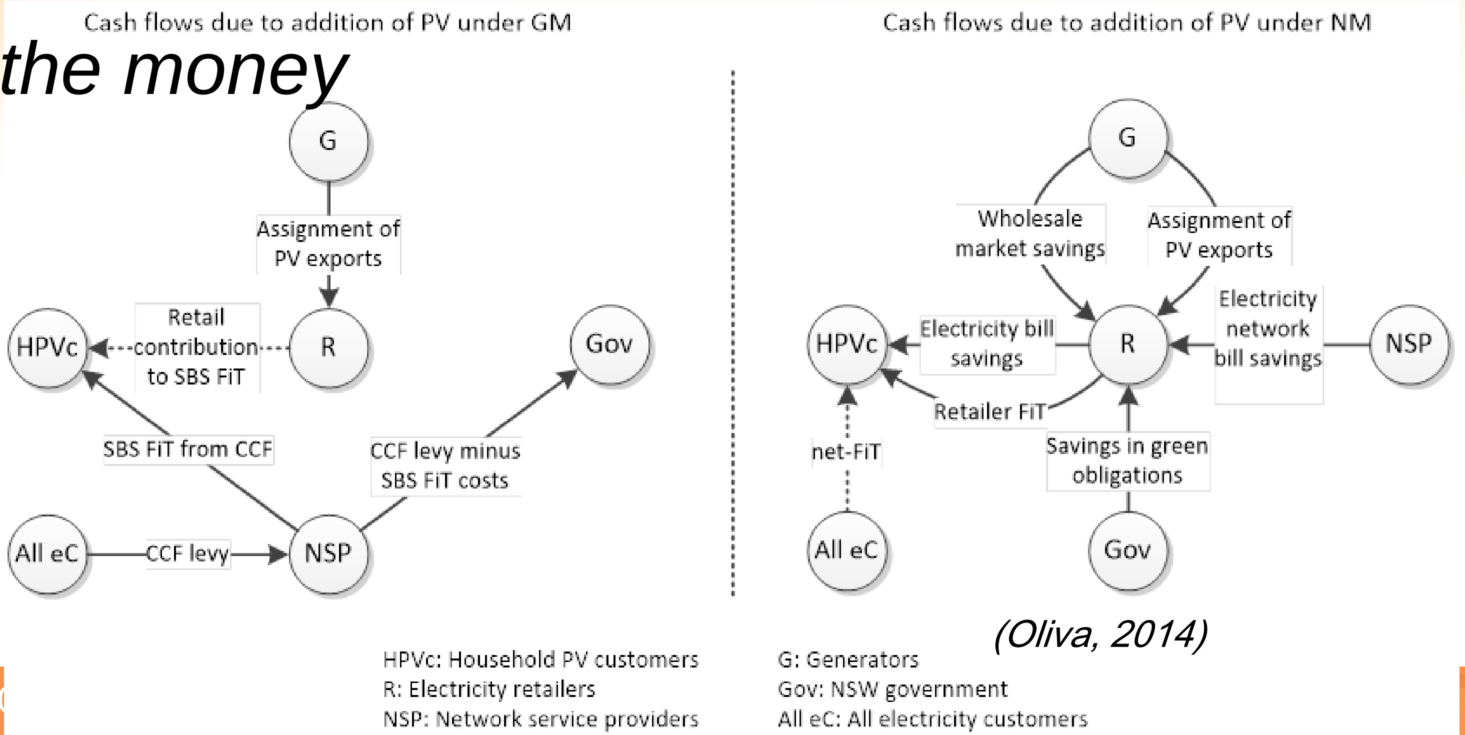
Some real retail competition with PV

State	#systems	Capacity (MW)	Proportion of dwellings with Solar Power
ACT	14,000	38	10%
NSW	252,000	633	10%
NT	3,000	11	4%
QLD	360,000	986	22%
SA	160,000	450	25%
TAS	18,000	55	9%
VIC	201,000	532	10%
WA	149,000	334	18%
National	1,157,000	3,039	14%

(from www.renew-economy.com.au)



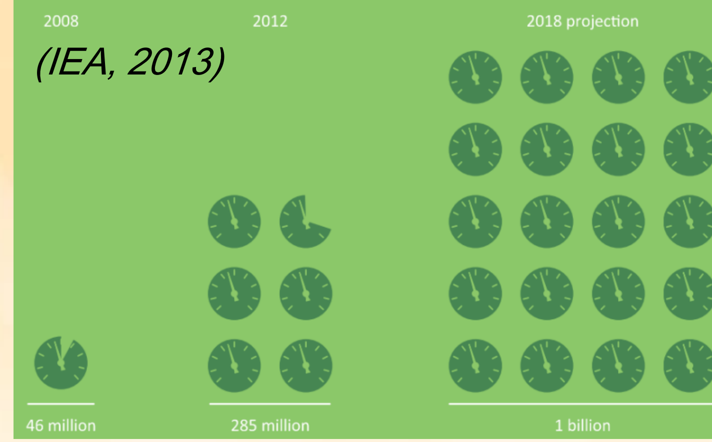
Follow the money



(Oliva, 2014)

Smart grids and Demand-Side Participation can improve our options for high RE

4.2 Global cumulative smart meter installations



4.5 Smart grid technologies

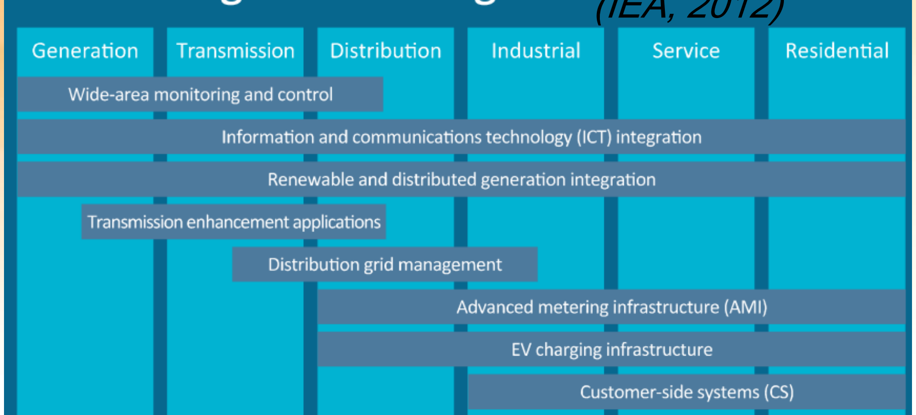
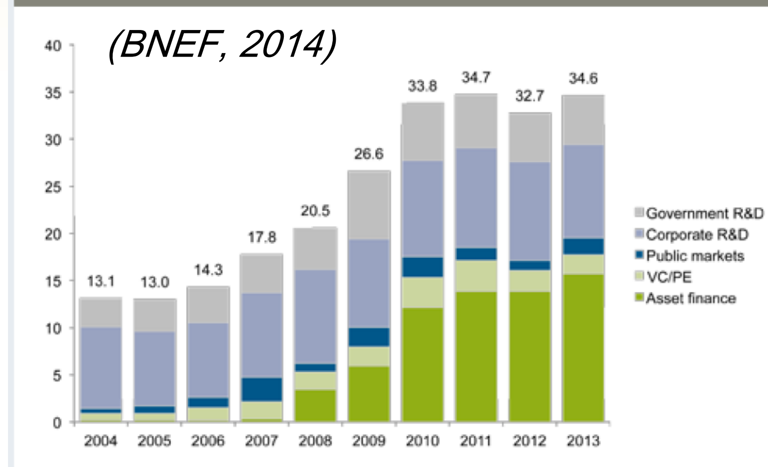


FIGURE 27. NEW INVESTMENT IN ENERGY-SMART TECHNOLOGIES, 2004-2013, $BN



Asset finance includes smart grid and power storage only, excludes roll-out of efficiency and advanced transportation products

Source: Bloomberg New Energy Finance

Table 15.1 Emissions reductions and investment needs in the 2DS, by technology

Sector *(IEA, 2012)*	CO_2 savings (Gt) 2050	Cumulative CO_2 savings (Gt) 2010 to 2050	Investment needs (USD trillion) 2010 to 2050
Power generation			
Bioenergy for heat and power	1.7	20.4	0.5
CCS in power generation	3.3	57.0	2.6
Concentrating solar power	1.7	22.5	2.6
Geothermal for heat and power	0.5	7.1	1.3
High efficiency, low emissions coal	n.a.	n.a.	1.9
Hydropower	0.9	19.4	3.0
Nuclear	3.2	59.6	4.0
Smart grids	1.7	36.4	5.0 to 6.0
Solar photovoltaic (PV)	1.7	27.7	3.9
Wind	3.0	61.0	5.9

Potential policy implications

- Renewables will likely play the key role in any effective global and Australian electricity *supply* sector response to climate change
- … and offer other potential benefits
- As such, require major, appropriately targeted and robust deployment oriented policy support
- … as do other potential options
- continuing, and expanding now
- … and as renewable penetrations grow we need governance arrangements to ensure appropriate energy market design, regulation and policy frameworks that can manage the challenges that will emerge

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Thank you… and *questions*

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