WHY IS RESIDENTIAL ELECTRICITY CONSUMPTION DECREASING AND WILL IT CONTINUE TO DO SO?

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Seminar at University of NSW

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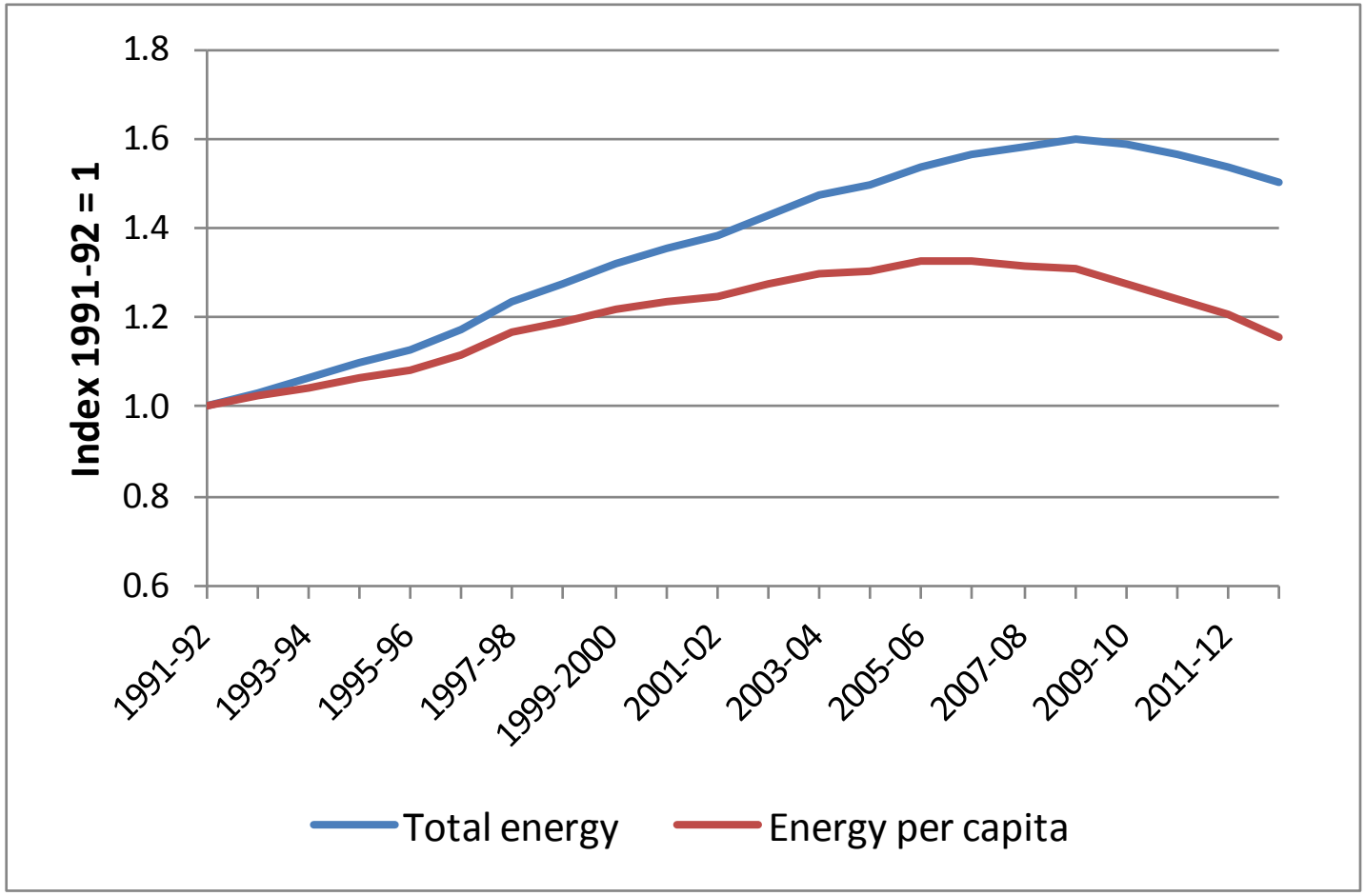
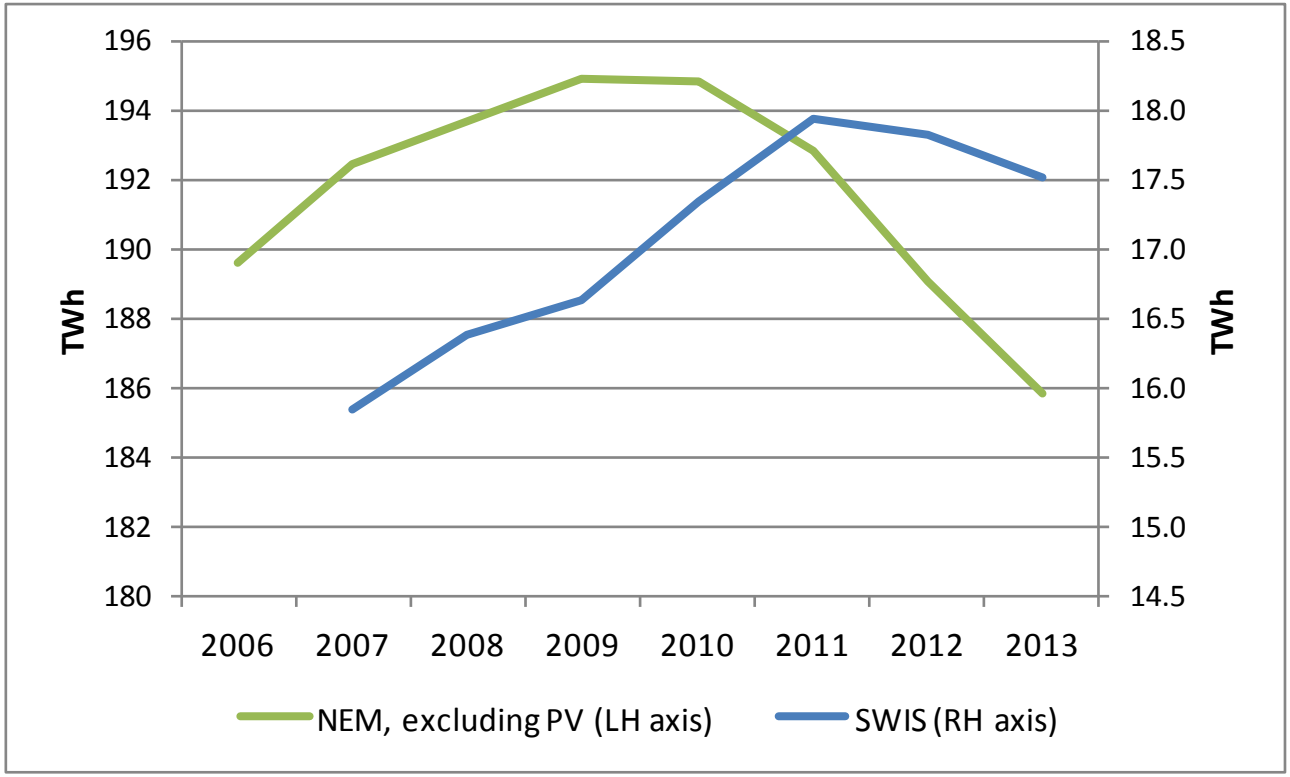
Trends in total and per capita annual electrical energy consumption in the NEM

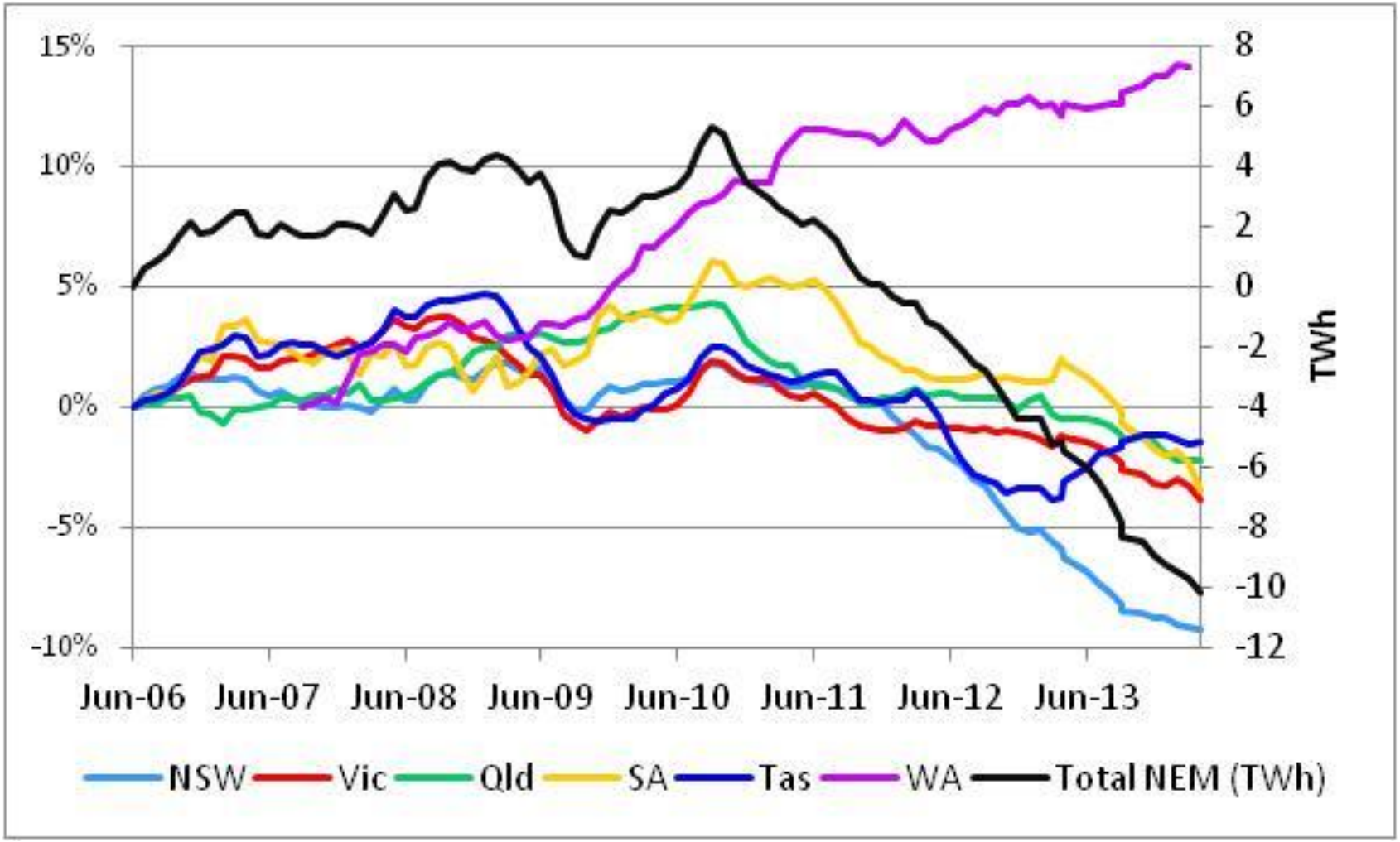


Annual electricity sent out in the NEM and the SWIS

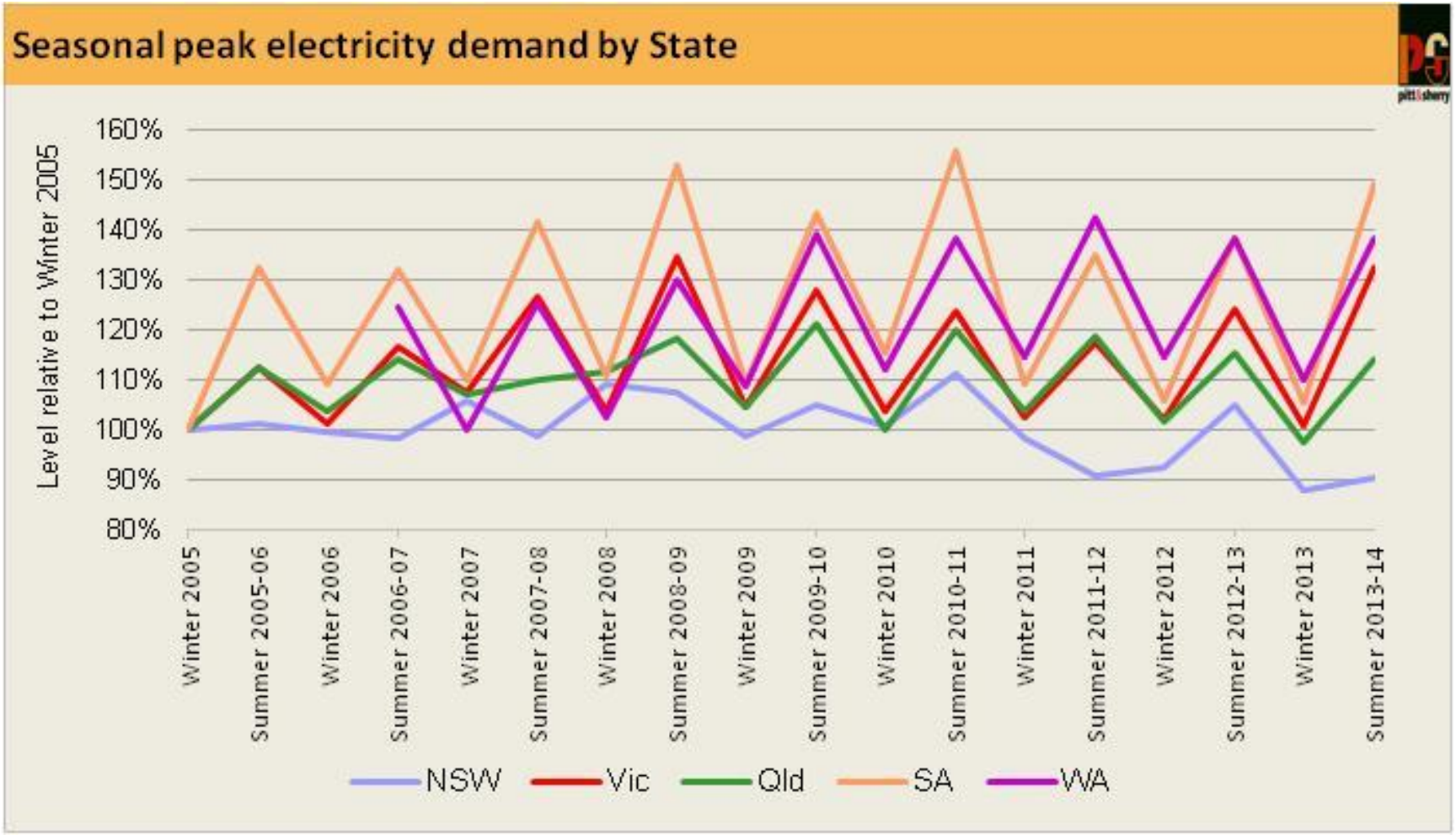
(This means electricity supplied by "major" generators, connected to the transmission network. It excludes output from small distributed generators embedded in distribution networks.)



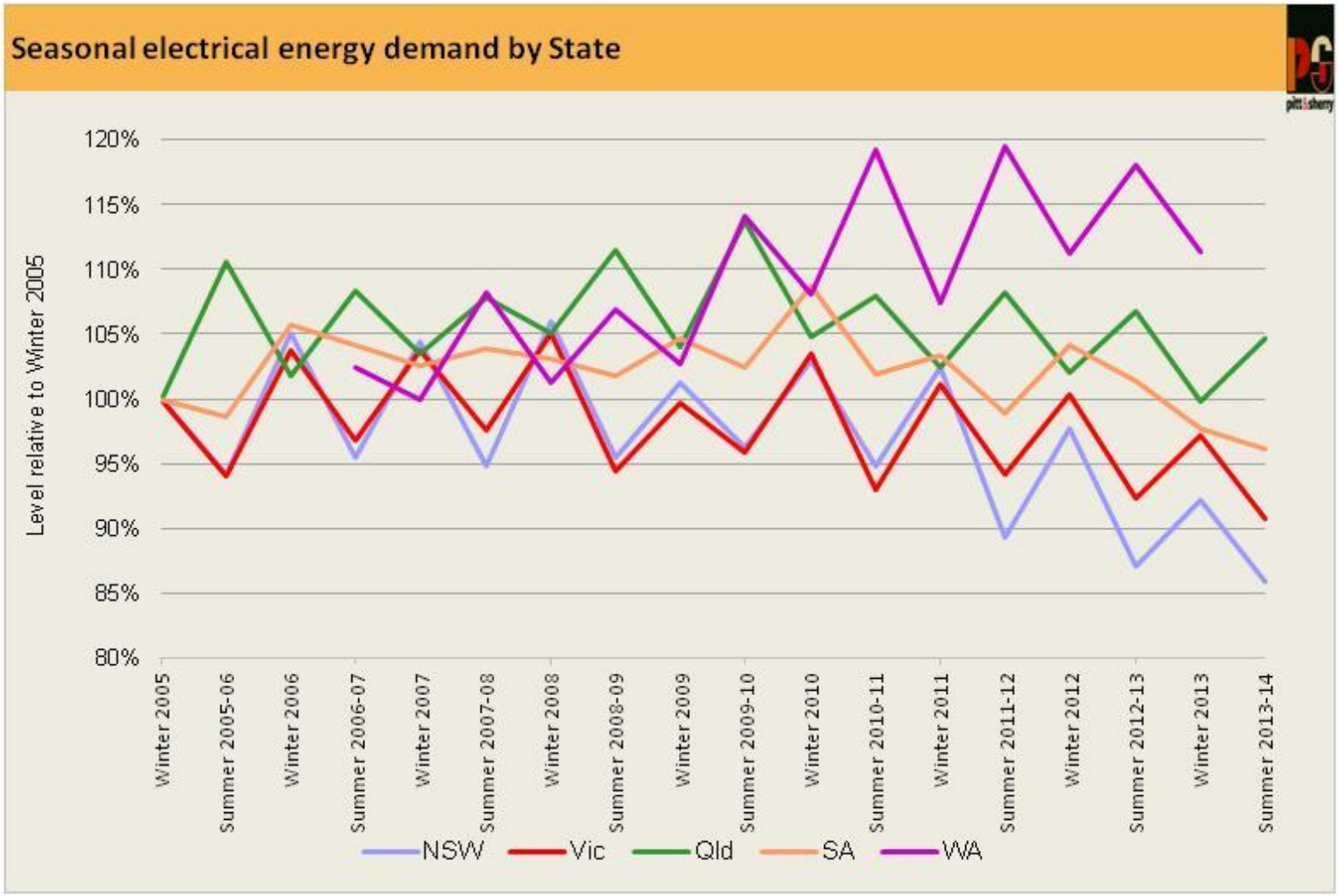
Relative changes in annual sent out electricity in each state



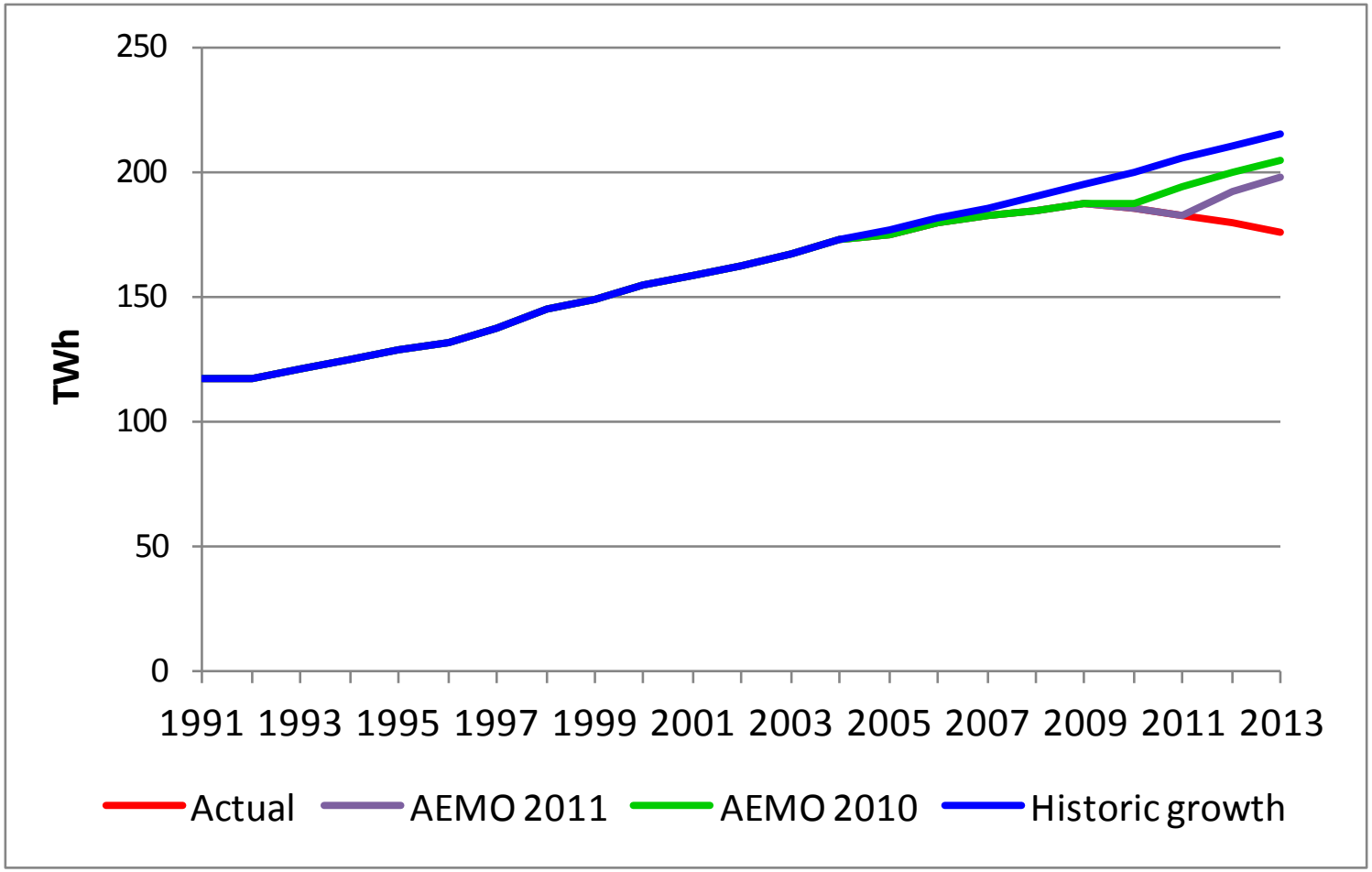
Trends in seasonal peak electricity demand in each state



Trends in seasonal electrical energy demand in each state



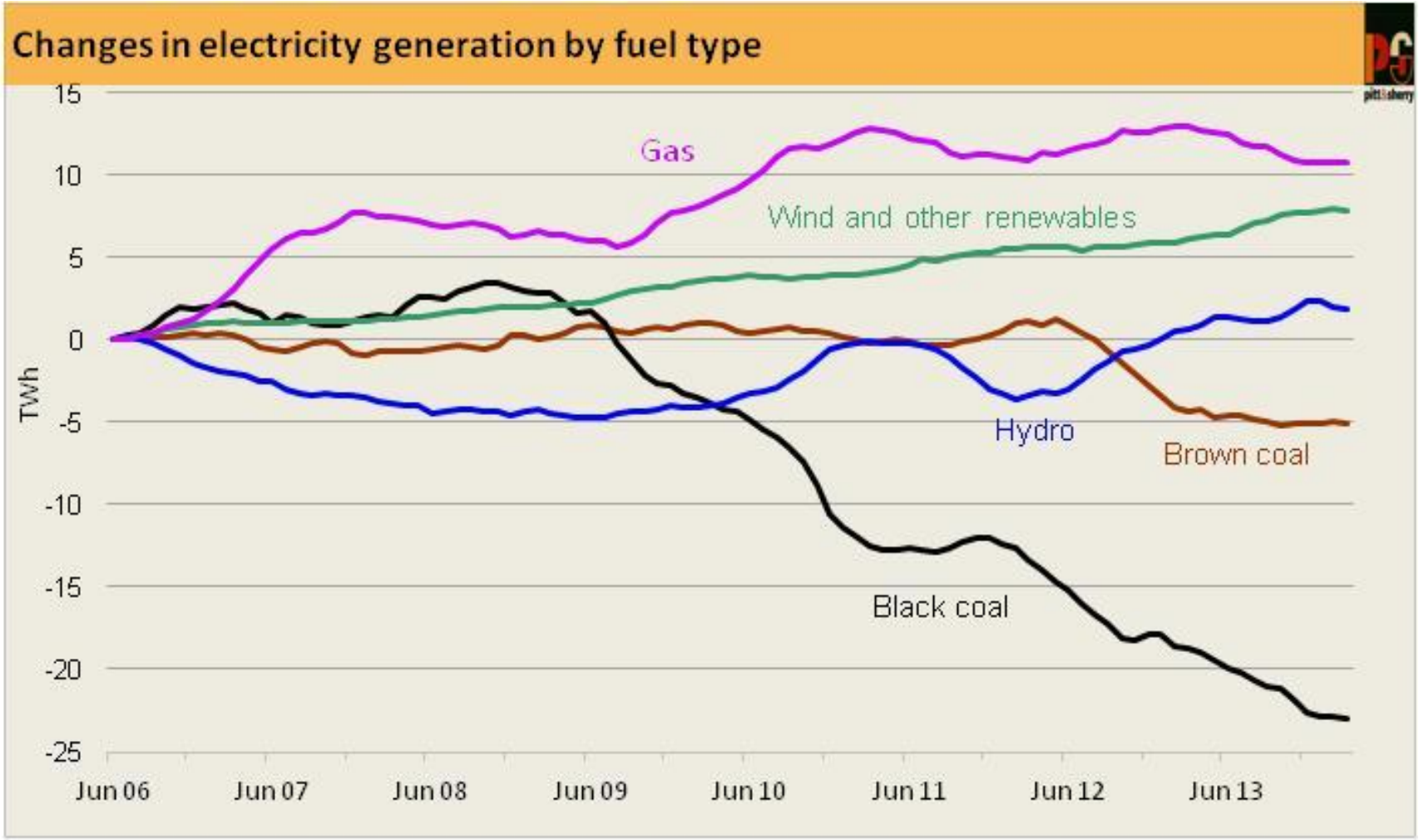
Until less than two years ago, official expectations were for rapid demand growth to resume in the NEM



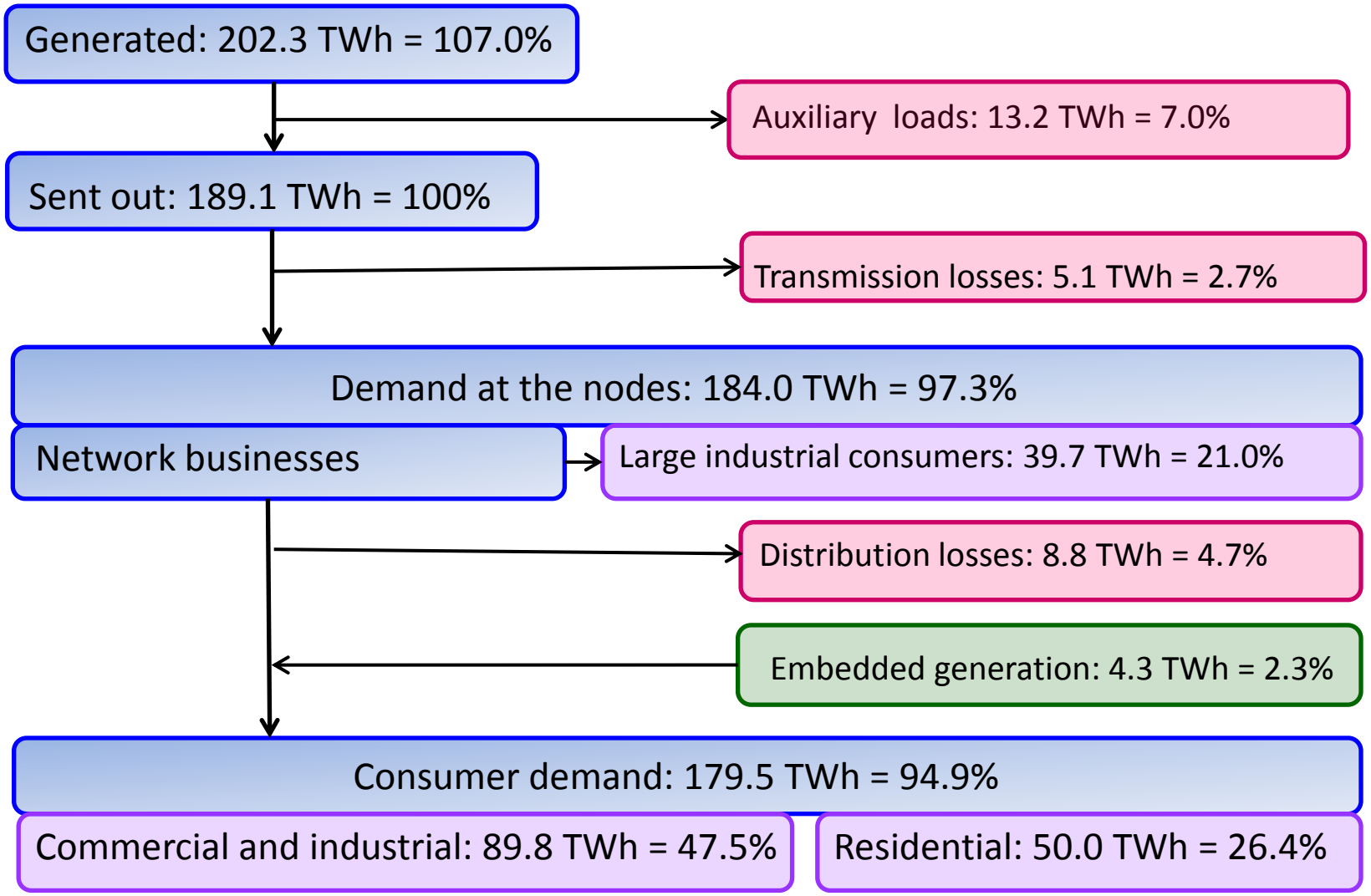
Why is this important?

- If demand growth in the NEM from 2005 had continued at the same rate as from 1992 to 2005, it would have been 37 TWh (21%) higher than it actually was in 2013
- Output from coal fired generators is falling rapidly and most are barely profitable, if at all.
- Less coal fired generation means that emissions have been falling rapidly: 9.2 Mt CO_2-e in calendar 2012 and a further 8.4 Mt in 2013, making a total of 10.0% (about 3% of Australia's total annual emissions).
- The finances of network (transmission and distribution) businesses are being undermined by the need to meet largely fixed costs mostly from variable $/kWh prices, as kWhs fall.
- Residential consumers have contributed well over half of this fall in demand, although accounting for less than 30% of total demand for electricity in the NEM.

Changes in electricity generation in the NEM by fuel type



Flows of electrical energy in the NEM, 2011-12



What explanations have been advanced to explain the decline?

1) Increased output from rooftop PV
2) An unusually mild summer in 2011-12
3) Weak manufacturing activity (or even “collapse”)

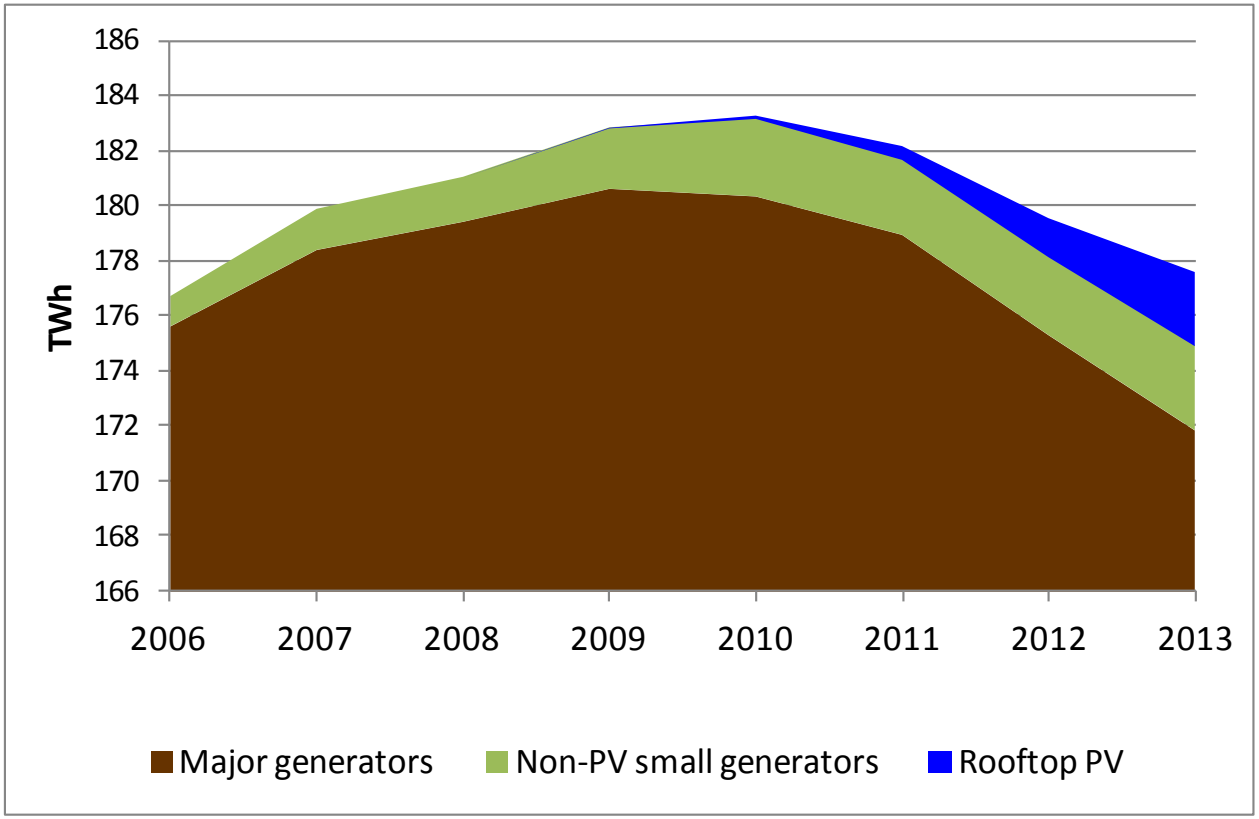
These are discussed briefly, before turning to:

4) Energy efficiency measures
5) Consumer response to higher prices

for which residential demand is particularly important

Rooftop PV and other distributed generation

- Rooftop PV 2.7 TWh = 1.6% of electricity supplied to customers by large generators (i.e. net of t&d losses)
- Total other distributed generation 3.1 TWh; increase since 2006 = 2.0 TWh = 1.2%

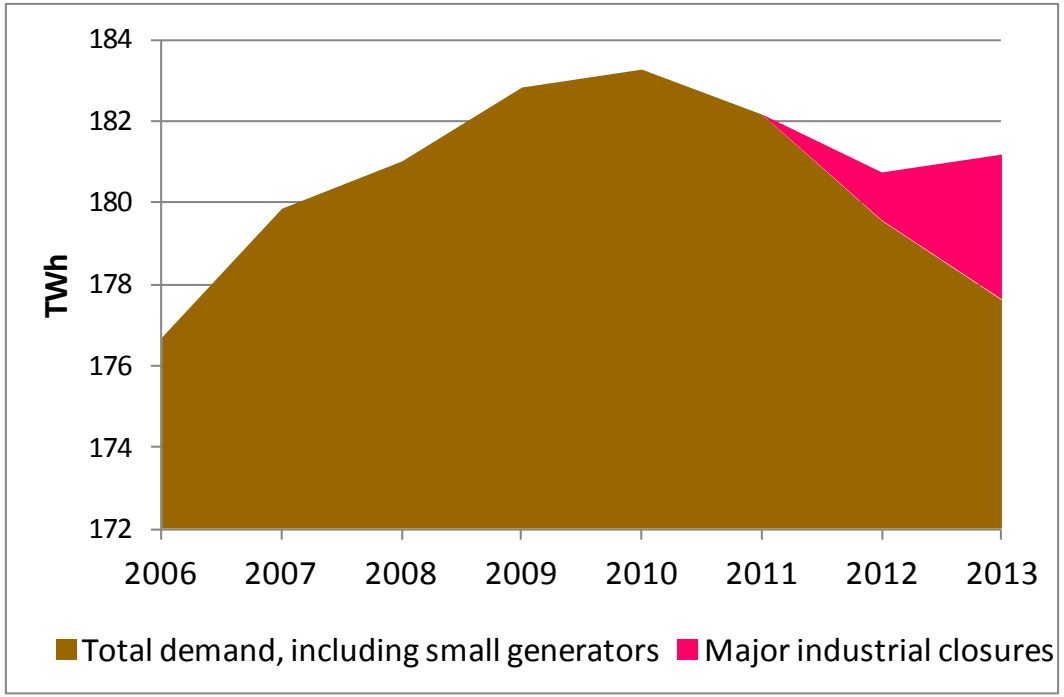


Milder seasonal weather (measured by heating and cooling degree days)

- For each state capital city, total heating degree days were calculated for the four highest consumption winter months (May to August) and cooling degree days were calculated for the four highest consumption summer months (December to March) over the past nine years.
- No strong relationship between heating/cooling degree days and total seasonal electricity consumption was found, either for winter or summer.
- The relationship was drive by the steady overall decline in electricity demand.
- Specifically, during particularly cold winters and hot summers in some states during the last few years, demand was significantly lower than equivalent winters and summers six to eight years ago.
- Residential demand is the main driver of seasonal changes in electrical energy consumption and also of the seasonal demand peaks.

Demand from manufacturing industry

- Three major closures, all in NSW, have removed about 3.6 TWh (2.1% of 2013 actual demand):
  - Kurri Kurri aluminium smelter
  - One blast furnace and related downstream facilities at Port Kembla steelworks
  - Clyde oil refinery



Changes in electricity use by large business are broadly in line with economic growth, with some evidence of increasing energy efficiency

- Analysis of three year trend (2010 to 2012) of electricity emissions reported by the 100 largest Scope 2 emitters (excluding electricity industry businesses) shows that total electricity consumption increased by 5% over 2 years.
- 46 manufacturing sector businesses increased by 4%
- 22 service sector businesses decreased by 2%
- These businesses include the major banks, large commercial property owners and major retailers, e.g. Myer, Harvey Norman, Woolworths

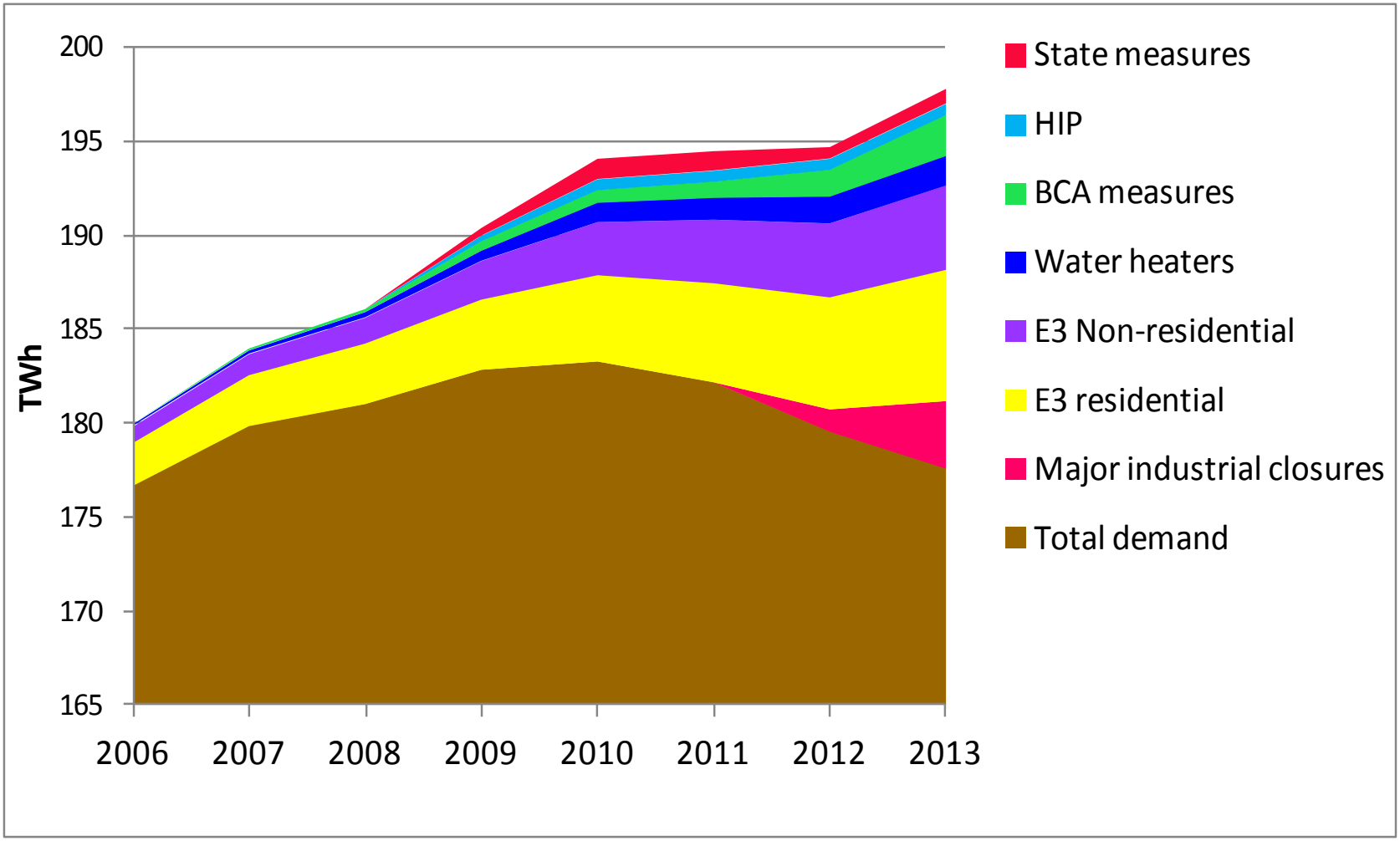
Energy efficiency programs

- Energy Efficiency Equipment (E3) program (Minimum Energy Performance Standards for appliances and equipment)
  - Largest residential sector contributions are from refrigerators and freezers, electric water heaters, lighting, air conditioners, televisions
  - Largest non-residential sector contributions are from lighting, air conditioners, electric motors, fluorescent lamps and ballasts

  Based on a 2009 meta-analysis by George Wilkenfeld and Associates
- Energy efficiency standards for new and refurbished buildings in the Building Code of Australia (saves more gas than electricity)

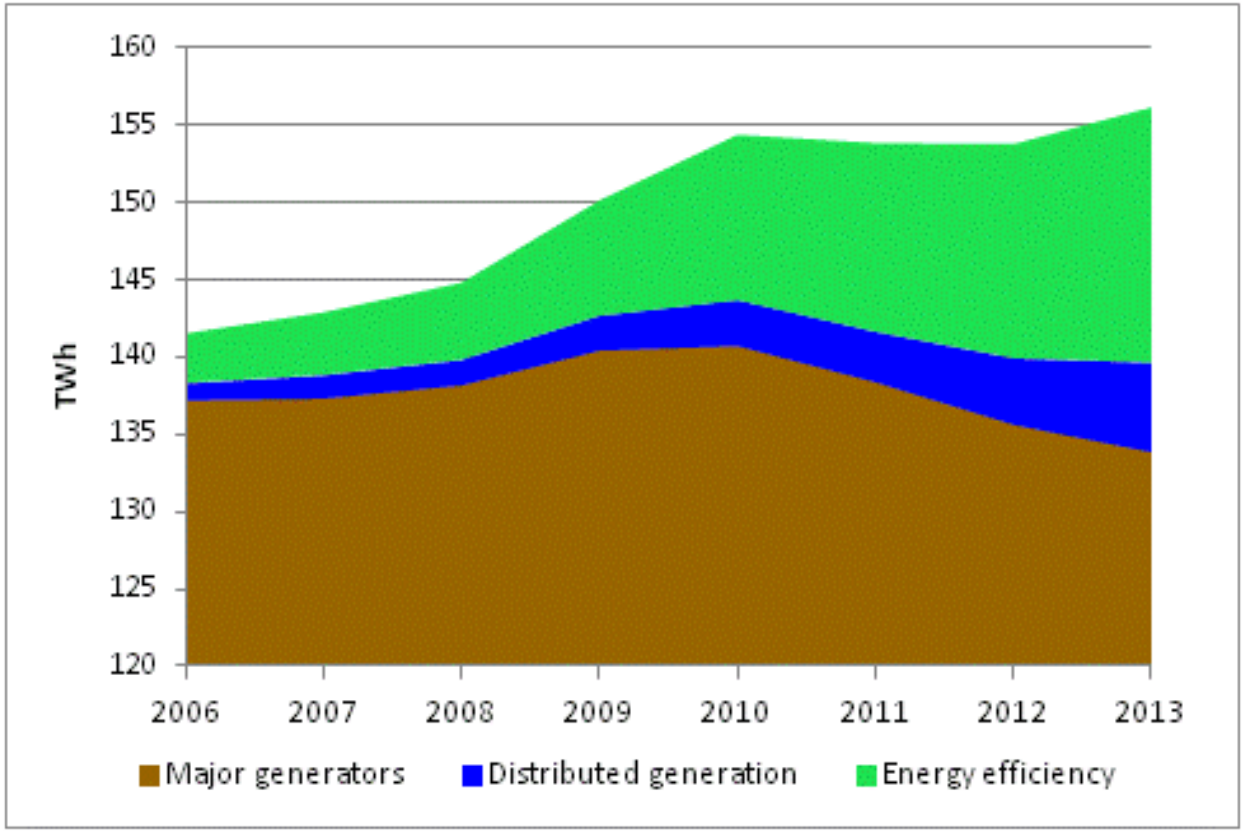
  Based on a 2012 meta-analysis by pitt&sherry
- Home Insulation Program (saves more gas than electricity)
- Adoption of solar and heat pump water heaters supported by the Small Renewable Energy Scheme (formerly MRET)
- Energy retailer customer energy efficiency mandate programs (VEET, NSW ESS, REES)

The effect of major energy efficiency policies and programs on electricity demand



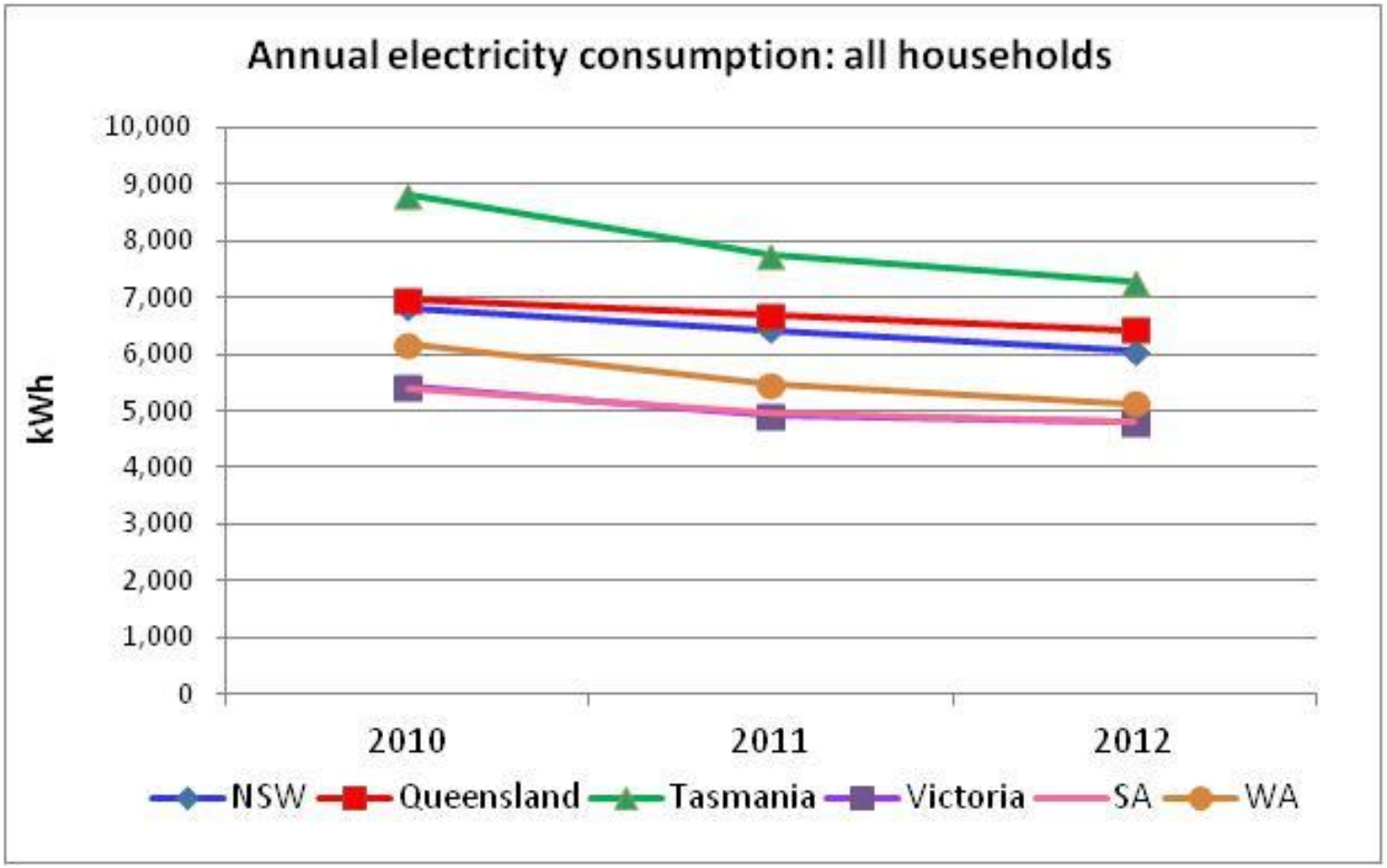
NEM Residential and Commercial demand, plus embedded generation and savings from enhanced energy efficiency

This is a measure of the total supply of "electricity services"

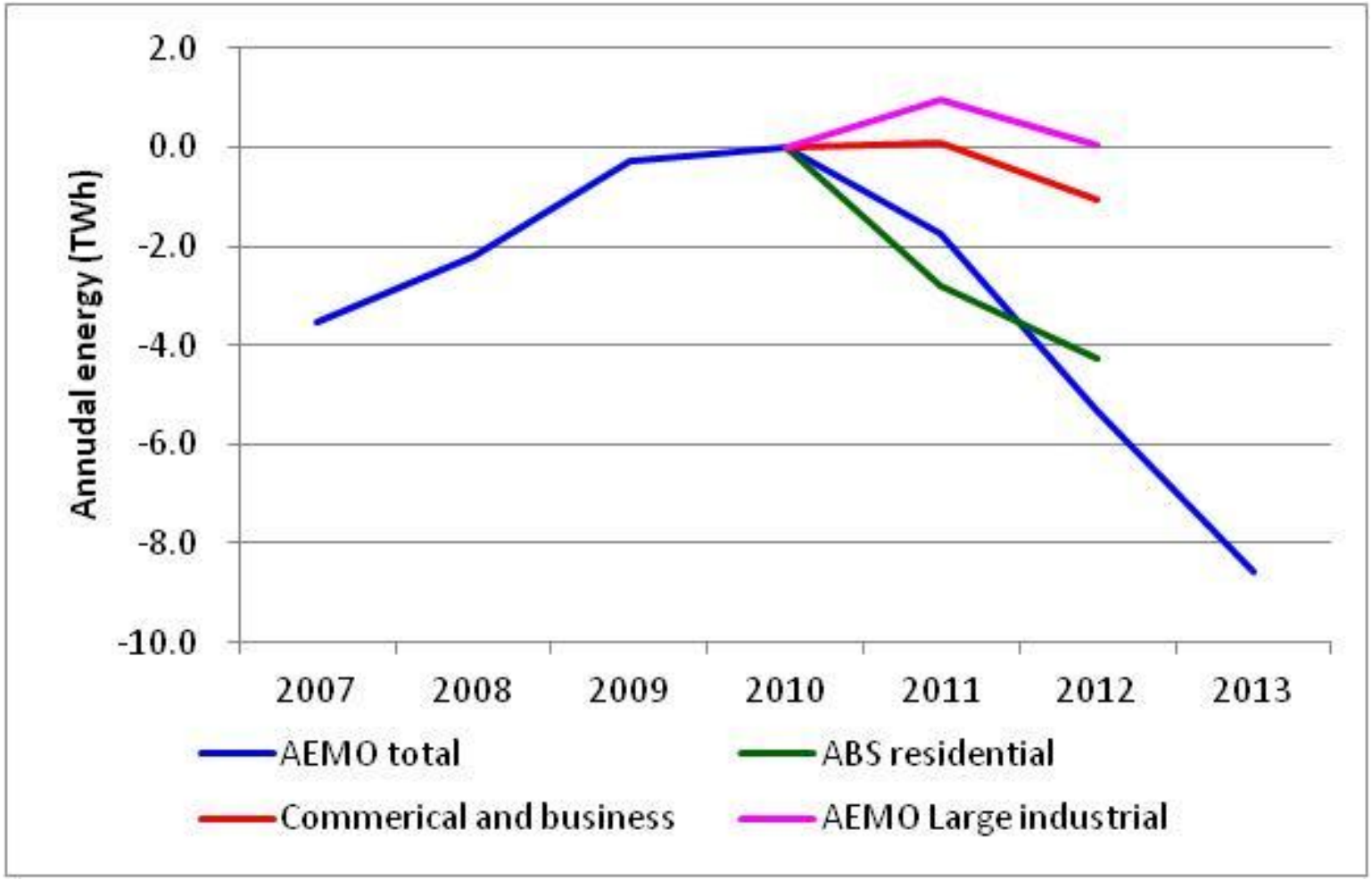


Something happened in 2010

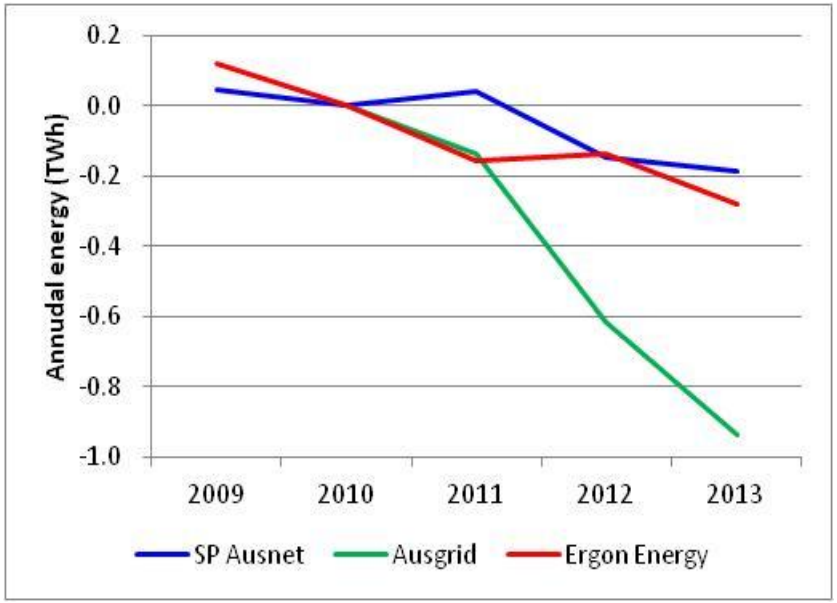
Average annual per customer sales of electricity to residential customers
Source: ABS Cat. No. 4670.0, 2014

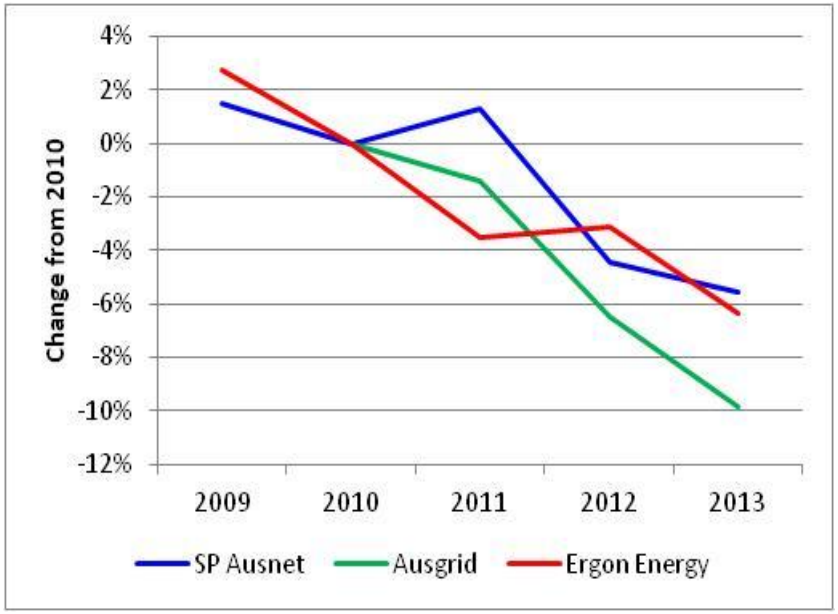


Electricity consumption 2010 to 2012 by major customer group

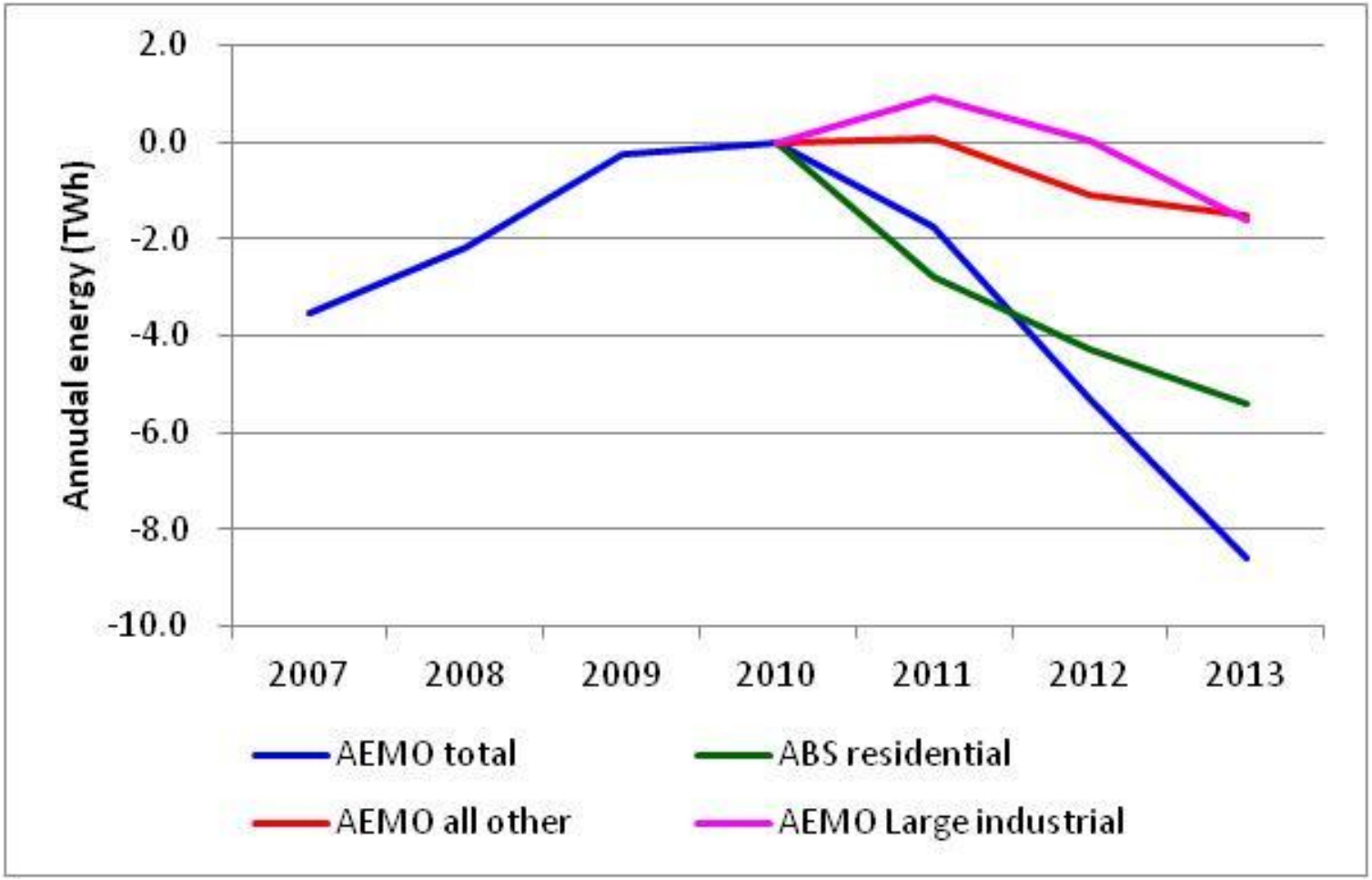


Electricity supplied to residential customers, as reported by three network businesses, 2009 to 2013

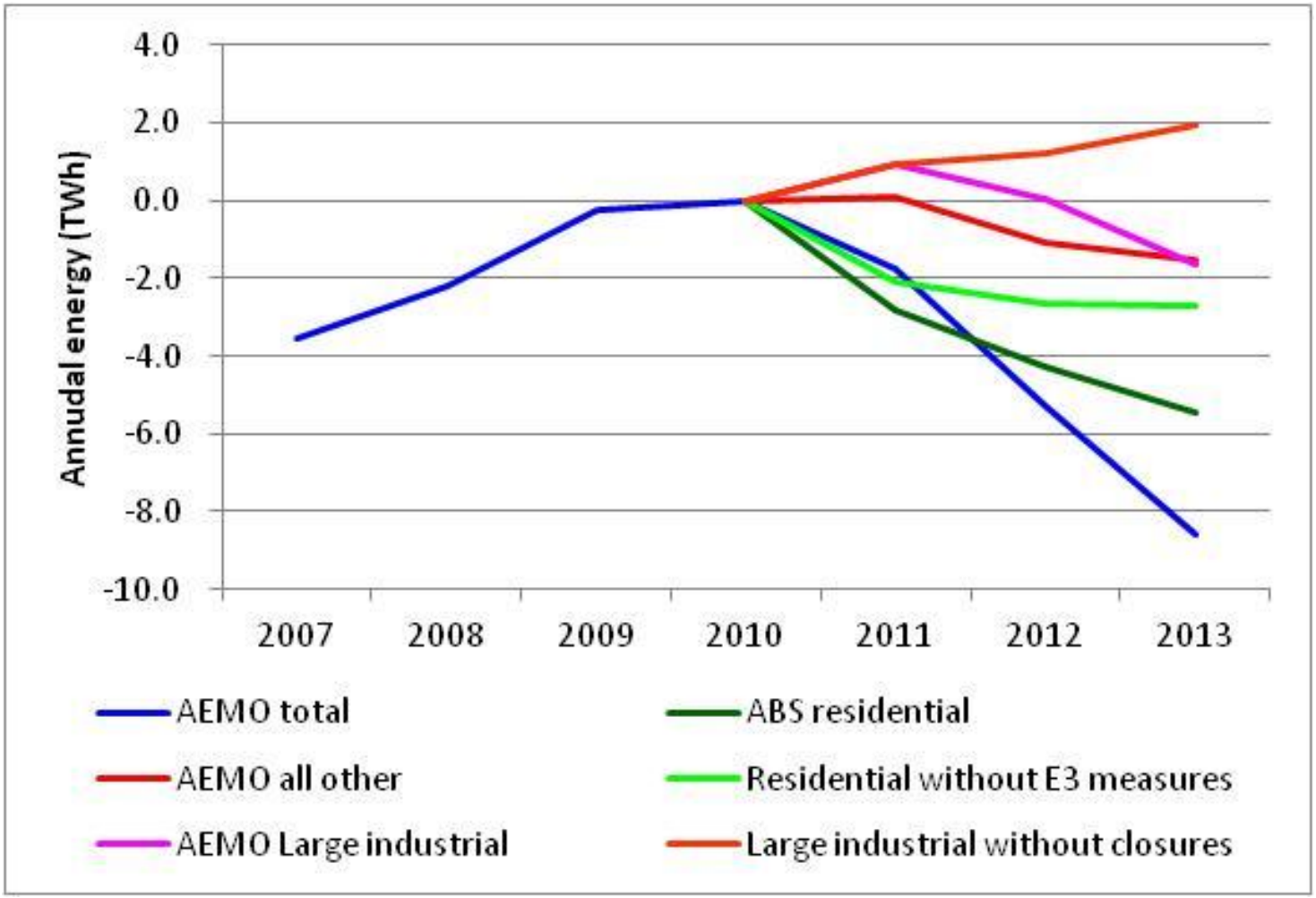




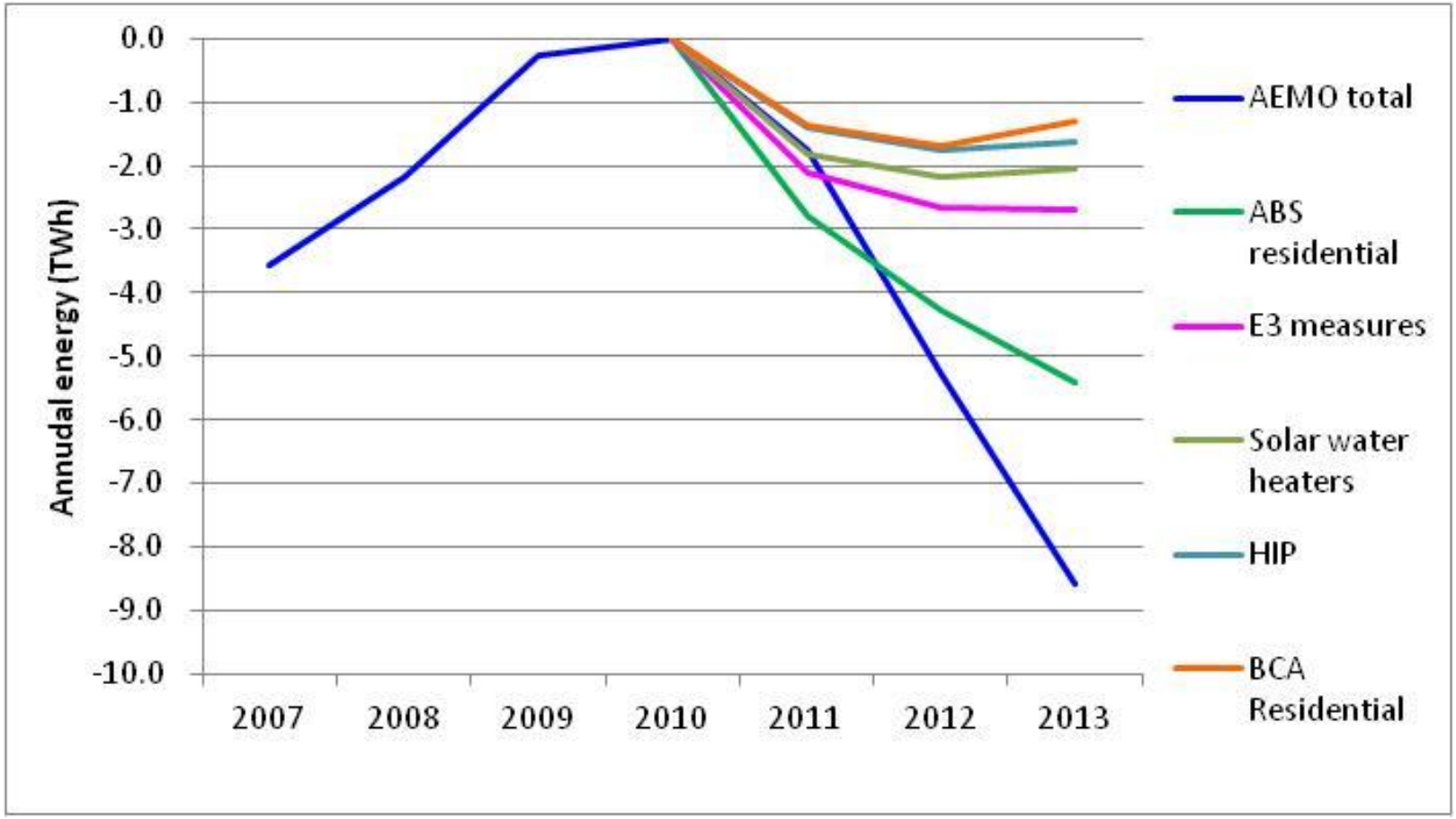
The effect of applying the average sales reduction of three network businesses to total residential sale in the NEM



The contribution of key factors to reduced demand for electricity since 2010



Contribution of major residential sector energy efficiency measures to reduced residential demand

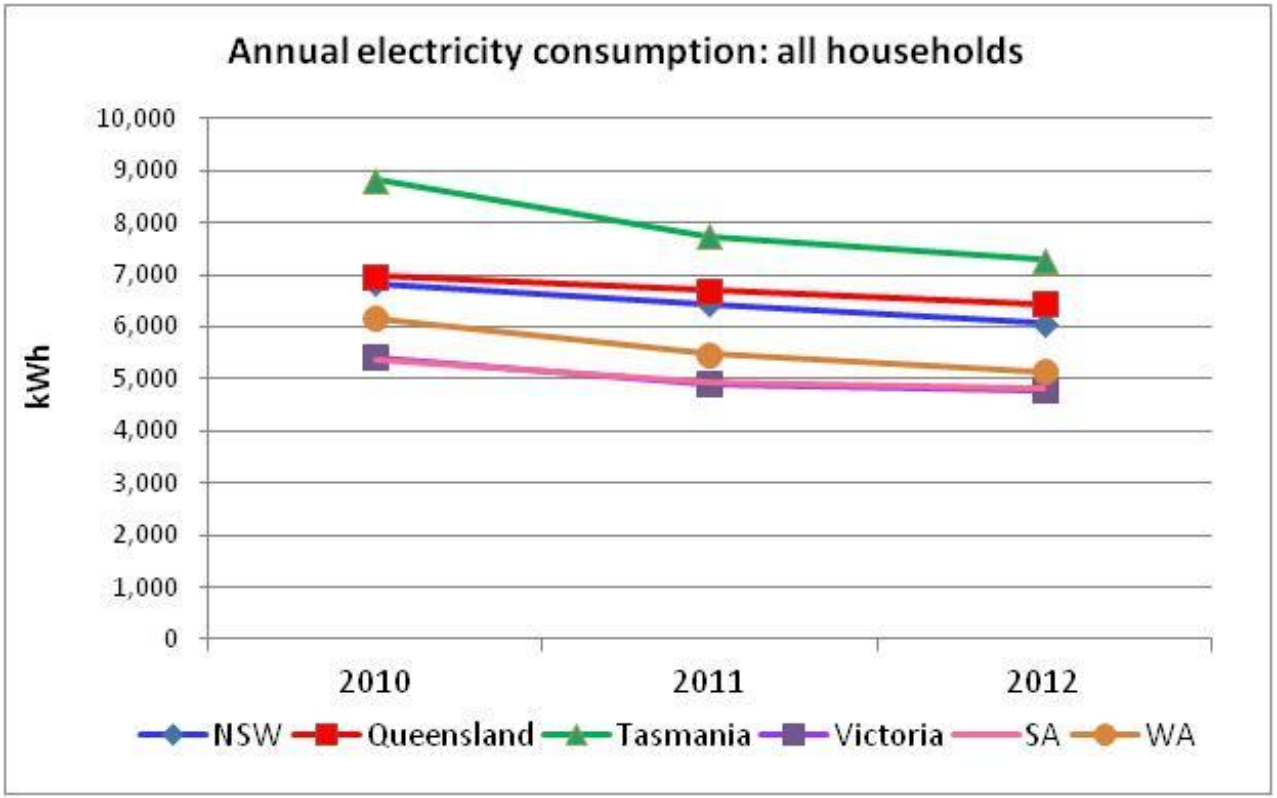


Electricity prices, electricity consumption and expenditure on buying electricity

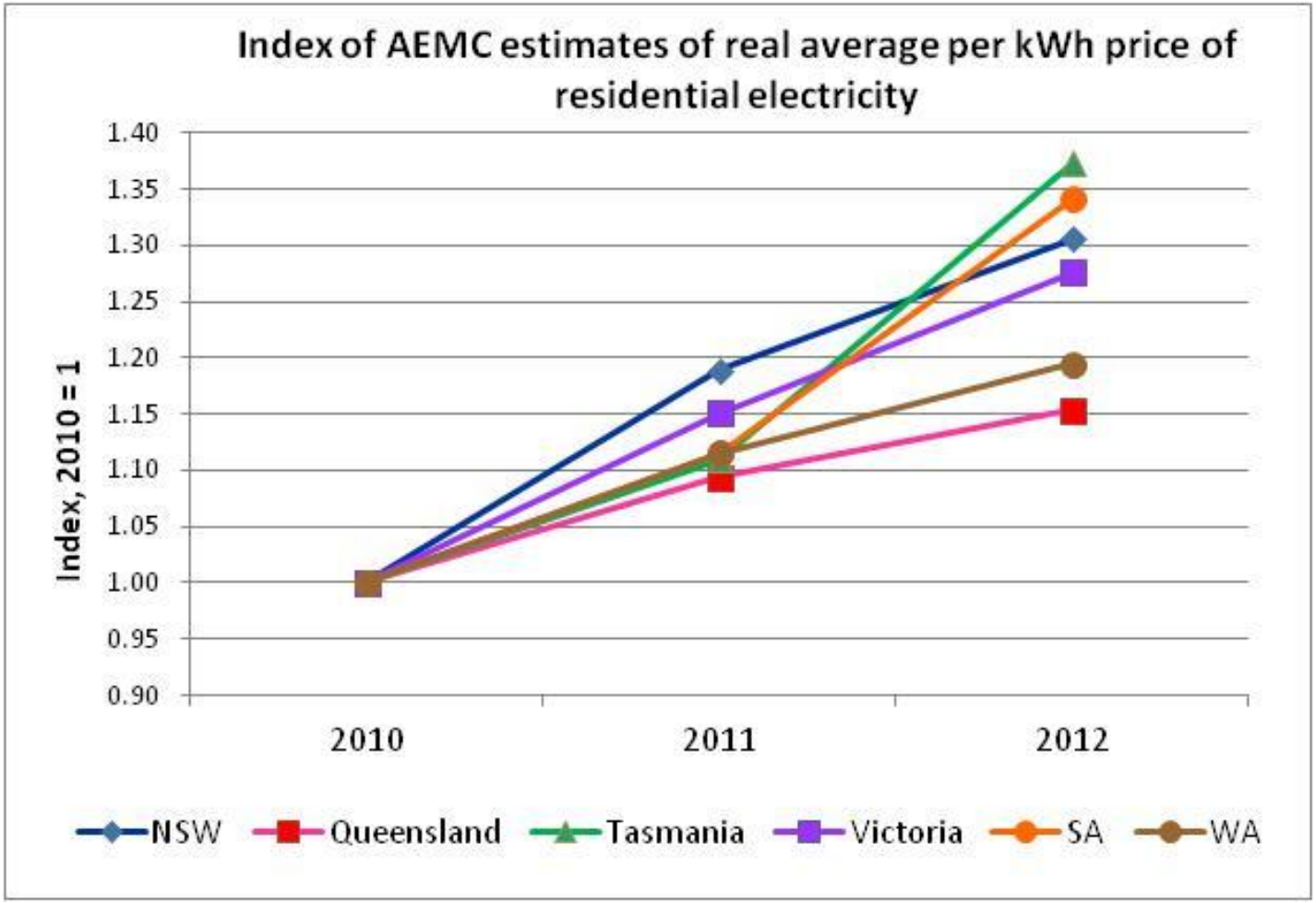
ABS Cat. No. 4670.0 - Household Energy Consumption Survey, Australia (published 2013, 2014)

Business Survey of Residential Electricity Distribution, Experimental Estimates

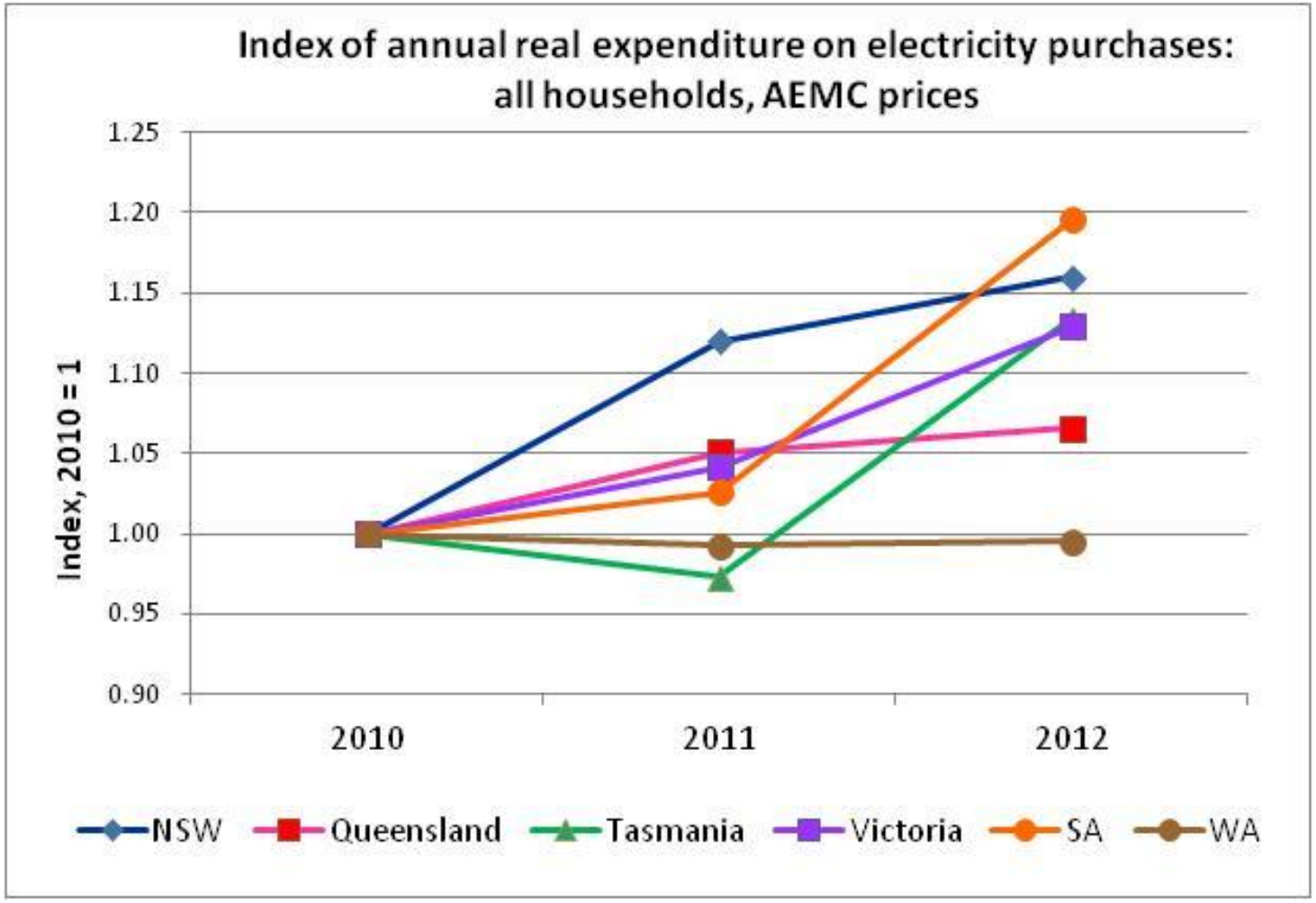
The data are, in effect, a "census" of residential meter readings, collected fro the network businesses



Residential electricity prices increased strongly over this period (as we have been told *ad nauseam* by our political leaders)



When demand and price are combined to calculate annual cost

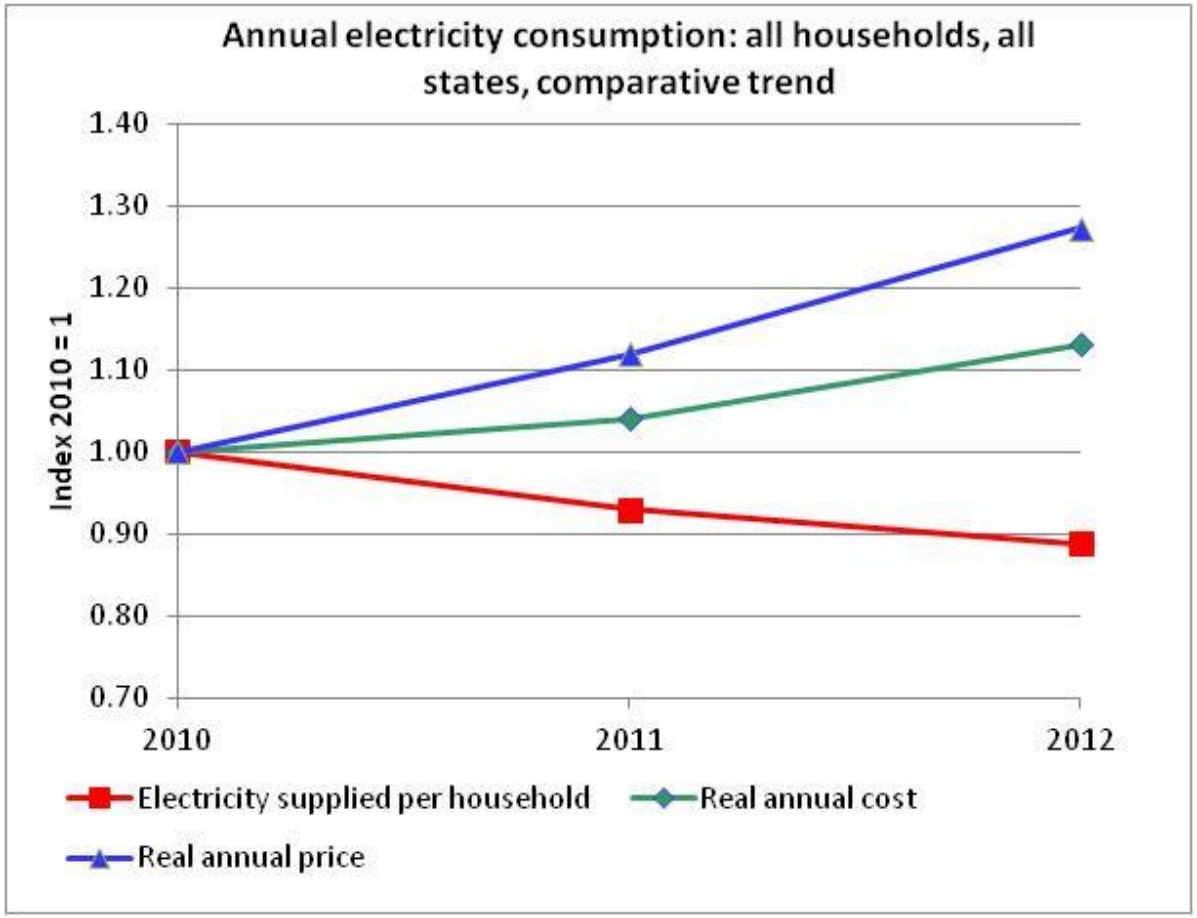


•The weighted average national numbers look like this

The real price increase was 27%

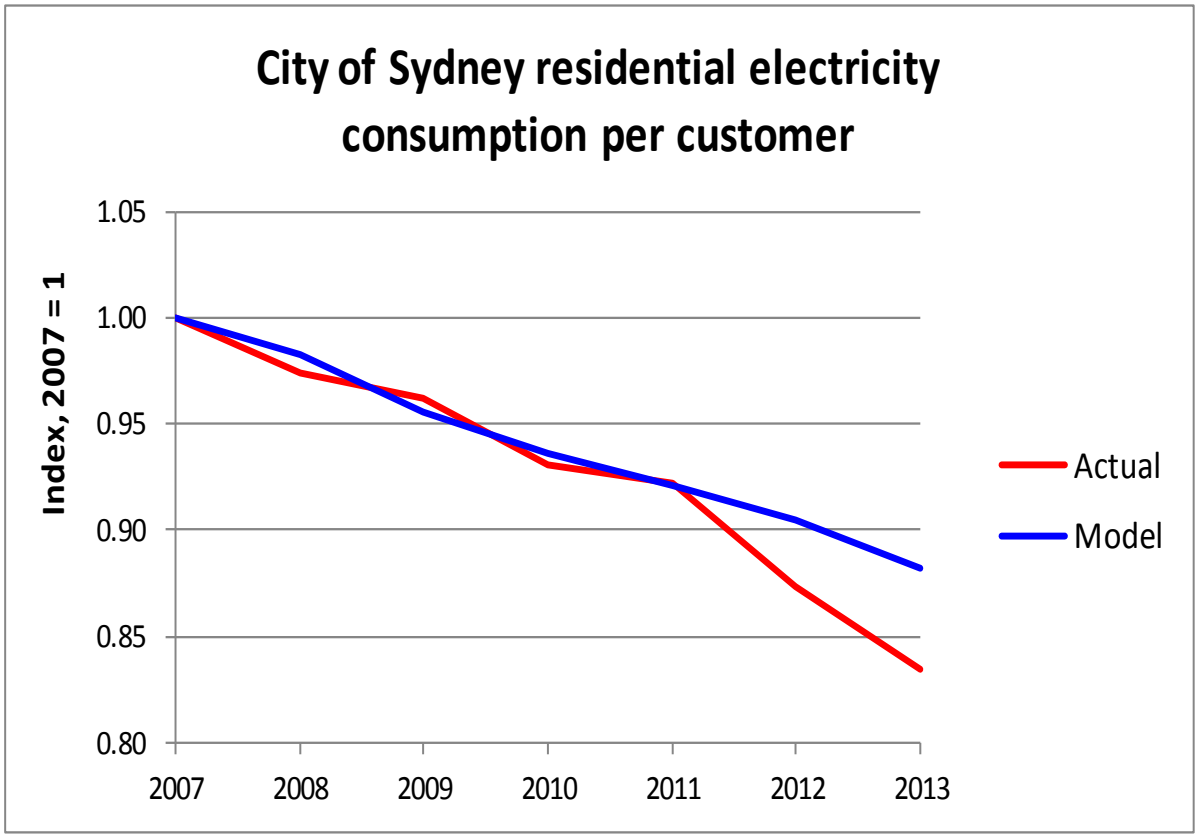
The demand decrease was 11%

The annual cost increase from 2010 to 2012 was $161 or 13% ($1,230 to $1,391)



Detailed *ex post* bottom-up modelling of electricity consumption in one local government area leads to the same conclusion

Model has no price response



5) The effect of higher electricity prices on demand

General approach

- Use AEMO annual data from 2005-06 to 2012-13 inclusive, divided between:
  - Large industrial consumers
  - Residential and Commercial (includes smaller manufacturing and mining) consumers
- Model Residential and Commercial at the state level, using state price and income changes
- Allow price and income elasticities to change over time, but be the same in every state
- All modelling is done on a per capita basis
- Three stages of modelling:
  1. Total NEM demand for electricity with Large industrial and Residential and Commercial modelled separately
  2. AEMO Residential and Commercial demand for electricity, net of distribution losses
  3. Notional (modelled) Residential and Commercial demand for electricity services

Stage 1: Total NEM demand

Both Residential and Commercial, and Large industry are modelled

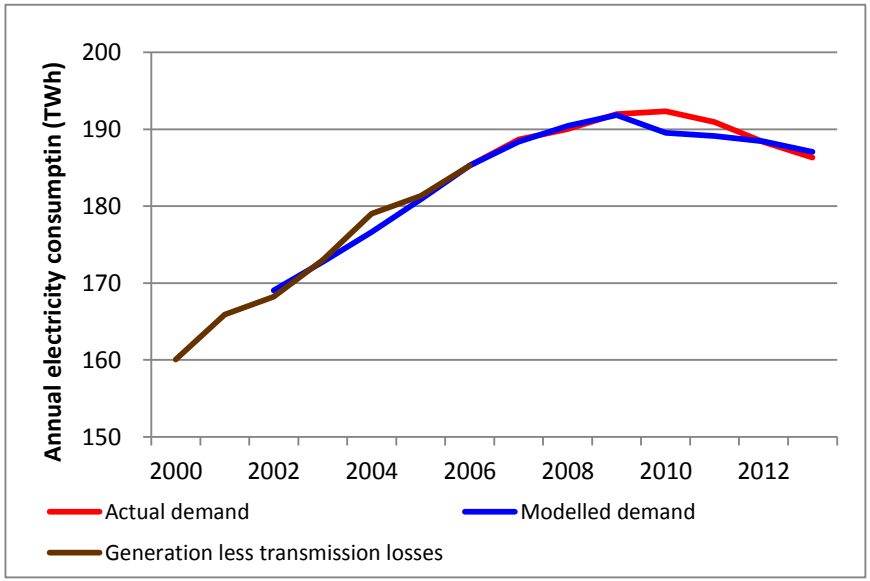
For Residential and Commercial:

price elasticity = -0.25

income elasticity = 0.4 up to 2006, 0.1 thereafter

For Large Industry:

price elasticity = -0.1; income elasticity = 0



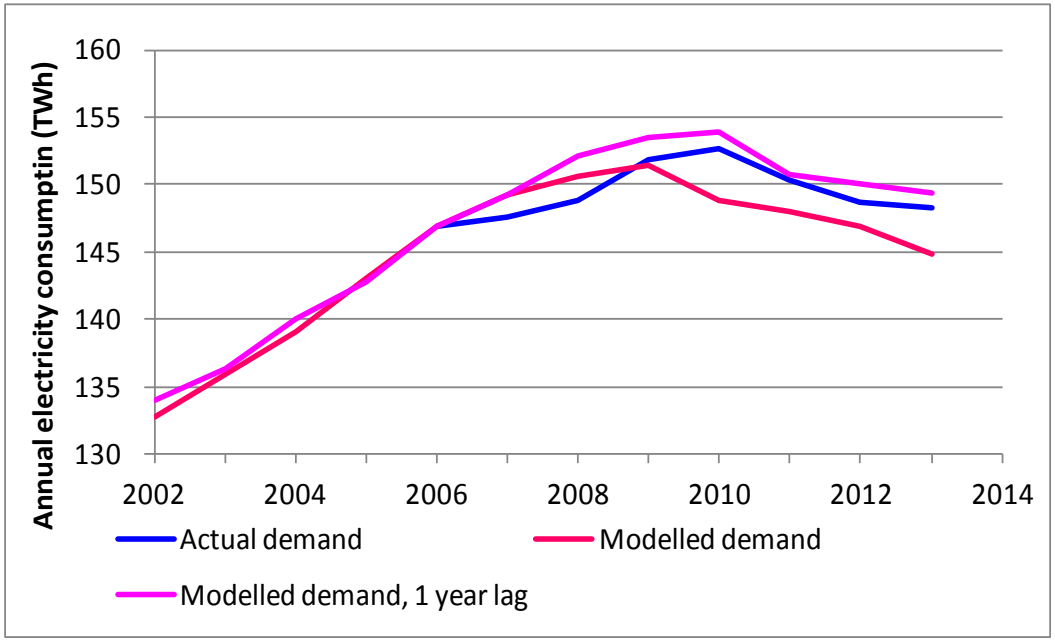
It is impossible to reproduce the observed demand trends if the same income elasticity value is retained, even with absurdly high values for price elasticity. The apparent good fit in 2012 and 2013 is an artefact of the large industrial closures.

Stage 2: Residential and commercial demand only

Only Residential and Commercial is modelled

price elasticity = -0.25 up to 2006, = -0.30 thereafter

income elasticity = 0.4 up to 2006, 0.1 thereafter



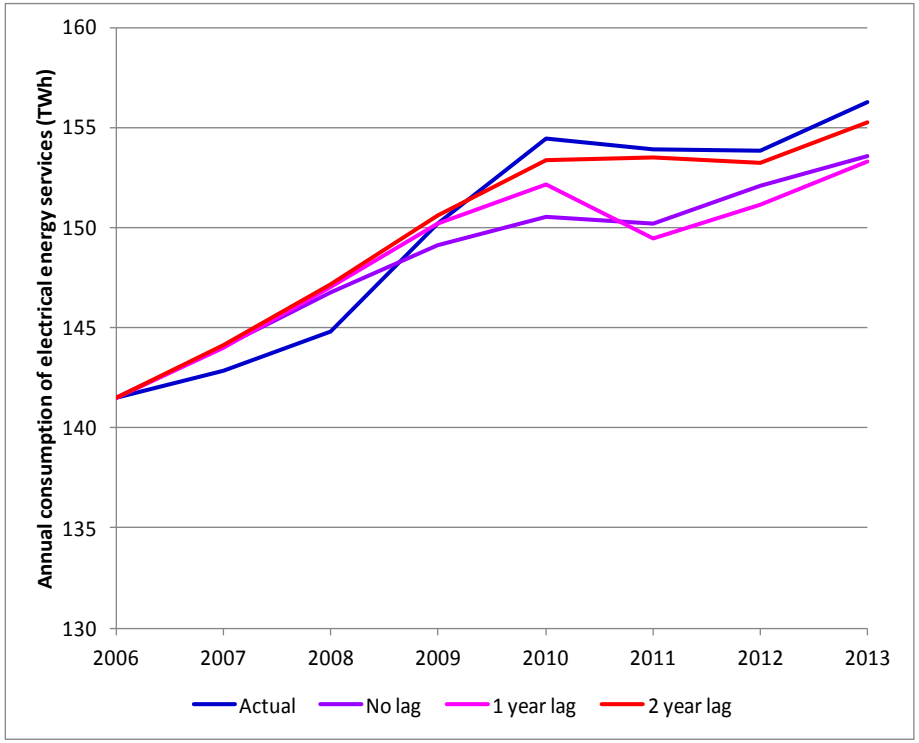
The observed recent trends in electricity demand cannot be well explained as a simple response to changing prices. It requires the assumption of a dramatic change in income elasticity around 2007

Stage 3: Demand for electricity services

Analysis is undertaken at the whole of NEM level because of limited availability of state data on various elements of electricity services.

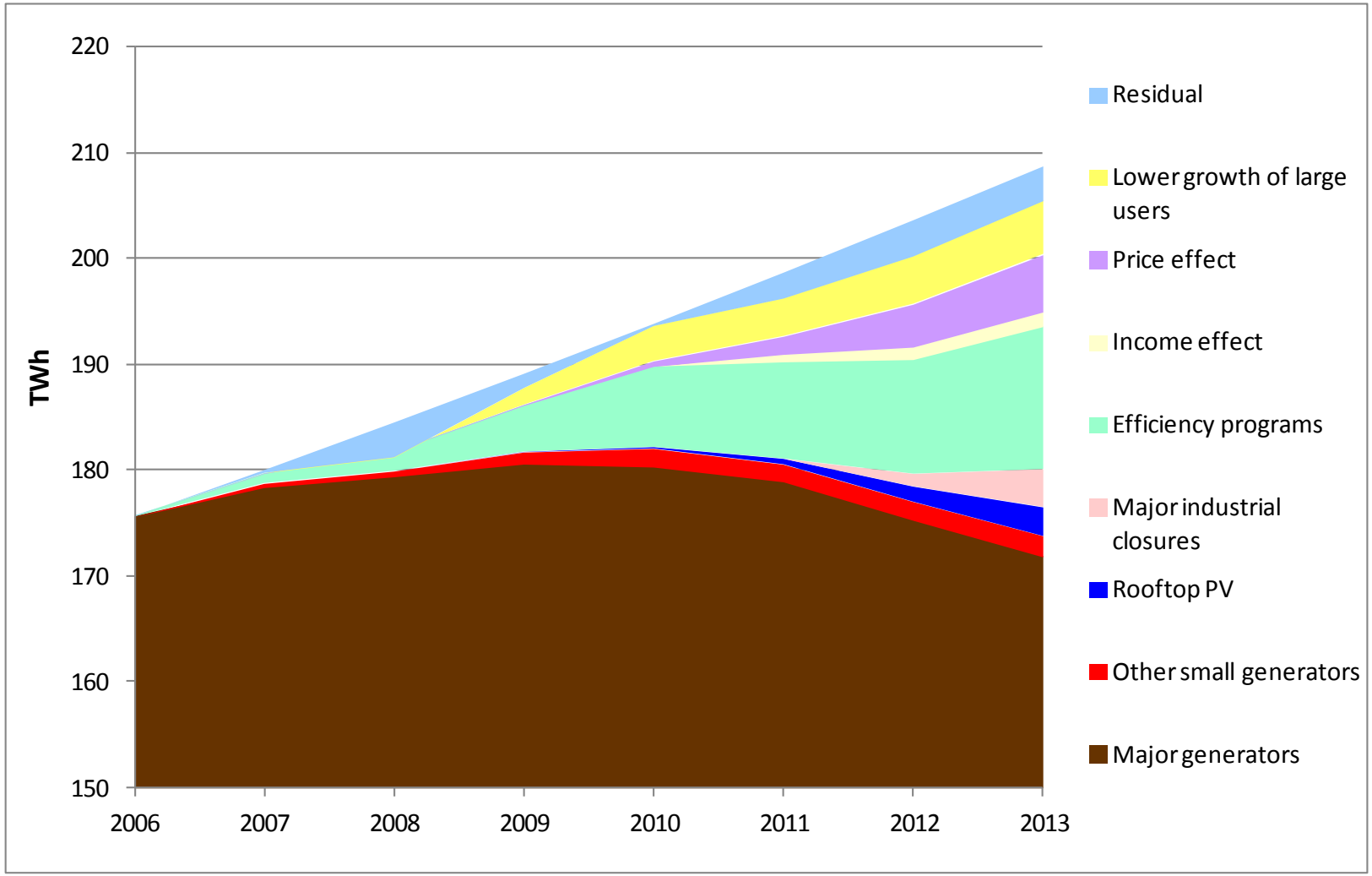
price elasticity = -0.05 up to 2010, = -0.2 in 2011, = -0.10 in 2012, = -0.05 in 2013

income elasticity = 0.2 throughout



6) Putting it together

Contribution of the various factors to reduced demand for electricity since 2006



Factors contributing in 2013 to observed reduction in growth of electricity demand since 2006

	TWh	Share of "reduction"
Electricity supplied to consumers by major generators (equals "NEM demand" minus auxiliary loads minus transmission and distribution losses)	171.8	
Electricity supplied if growth had continued from 2004 at 2.5% per annum	208.7	
"Reduction"	36.9	100%
Made up of:		
Rooftop PV	2.7	7%
Increase in other embedded generation	2.0	5%
Major industrial closures	3.6	10%
Energy efficiency programs	13.5	37%
Income effect (if real GDP per capita had continued to grow after 2008 at 1.5% per annum)	1.4	4%
Recent price effect	5.2	14%
Reduced growth of large users	5.0	14%
Residual	3.6	10%

Conclusions: the past

- Regulatory energy efficiency programs are very important.
- Households have been reducing electricity consumption much faster than businesses because of:
  - the incidence of these programs, and
  - behavioural responses to higher electricity prices.
- Quality time series data on residential electricity consumption would allow analysis to better understand these processes.
- Reductions in demand from large industry are also important and there are more coming shortly: Kurnell, Point Henry, Bulwer Island ….

Conclusions: the future

- There are few prospects for significant growth in consumption by large industrial users in the immediate future (AEMO says CSG production is the only source of growth.
- More broadly, the continuing shift away from electricity intensive manufacturing in the structure of the economy will lead to a gradual reduction in the electricity intensity of economic activity.
- Energy efficiency regulations already in place have been modelled to achieve further large reductions from 2013 to 2020, measured against a 2000 benchmark:
  - E3 residential 6.6 TWh
  - E3 other 3.4 TWh
  - Residential buildings 7 TWh
  - Commercial buildings 14 TWh
- *Prima facie*, there remains significant potential for more efficient use of electricity across the generality of commercial and industrial consumers.

Full paper on total demand available at
www.tai.org.au/content/power-down

Monthly data updates and commentary available at
www.pittsh.com.au/cedex

Paper on residential demand to come