LOW CARBON LIVING CRC

Distributed Renewable Energy Systems & Energy Efficiency

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LCL CRC Integrated Building Systems Program Leader

Program 1 Structure/ Impact Pathways

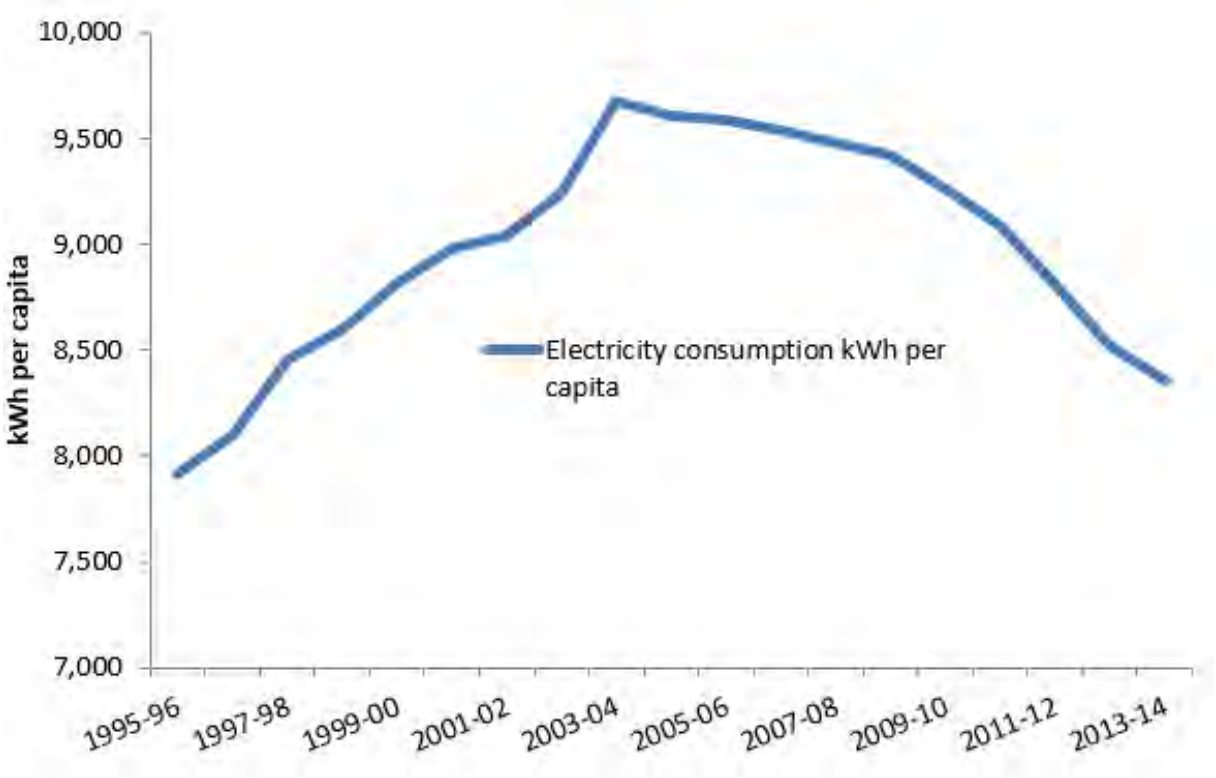
Program 1: Integrated Building Systems

- Harnessing the Australian sun
- Lowering the embodied carbon in buildings
- Mainstreaming low carbon buildings

Overview of presentation

- Electricity demand in Australia
- Distributed RE systems
- Energy efficient systems

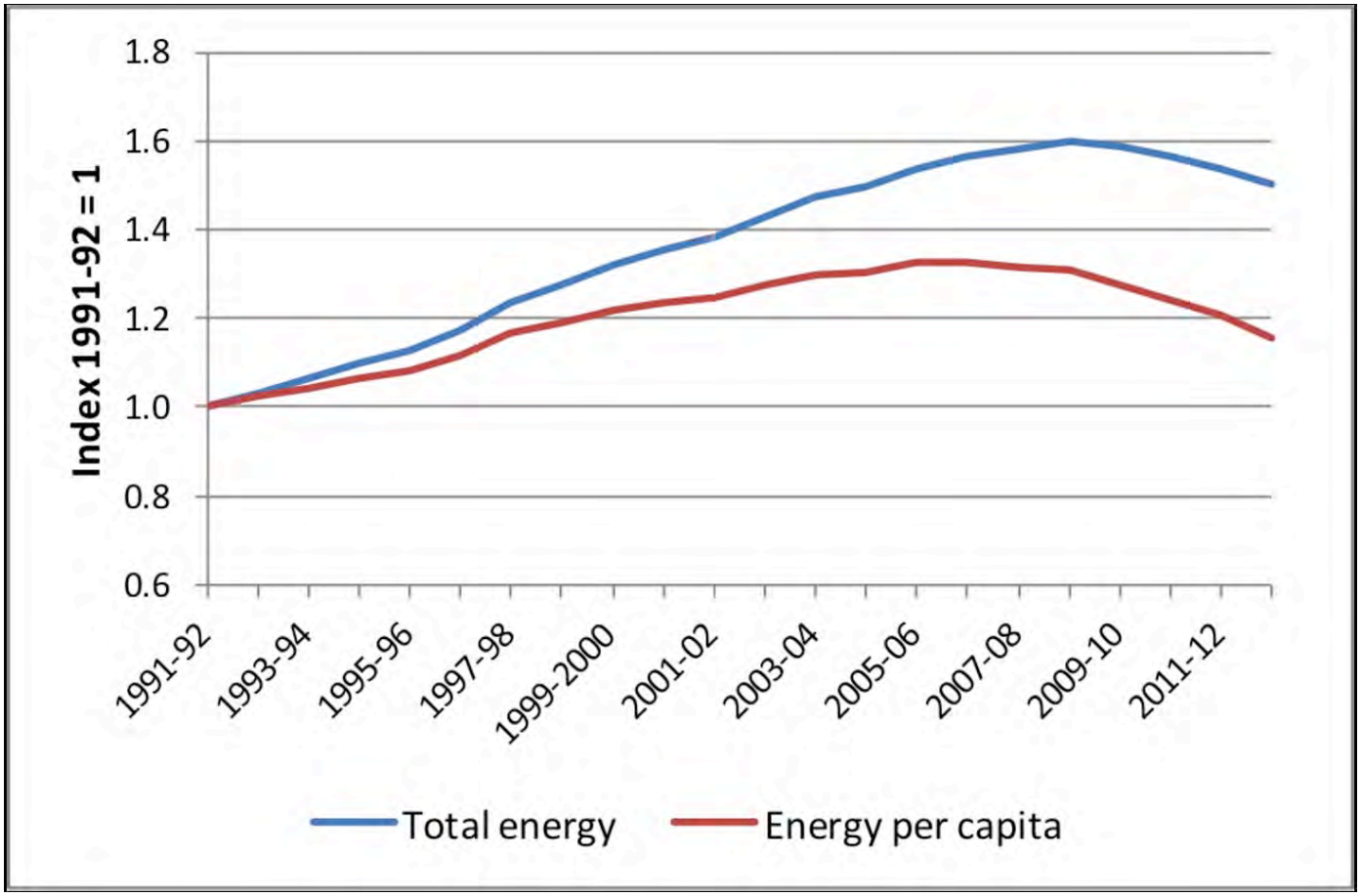
Electricity usage per capita and overall is declining



http://www.esaa.com.au/policy/data_and_statistics-_energy_in_australia

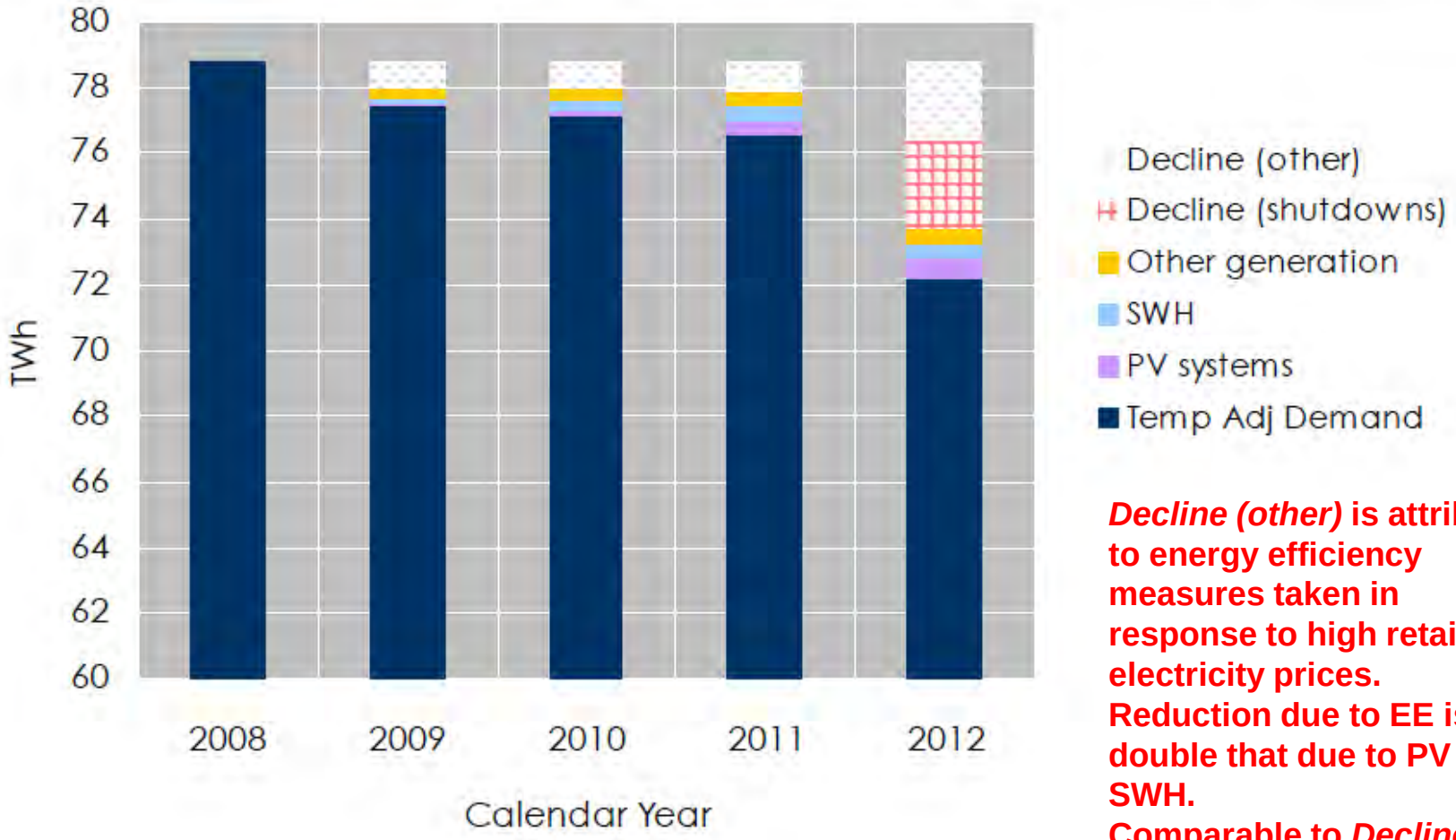
All of Australia's electricity demand could be supplied by an area of 40 km x 40 km of 14% efficient PV and 80% efficient batteries.

National Electricity Market 1991 - 2012



http://theconversation.com/why-is-electricity-consumption-decreasing-in-australia-20998

Figure 8 Components of the decline in NSW demand since 2008



Decline (other) **is attributed to energy efficiency measures taken in response to high retail electricity prices.**
Reduction due to EE is double that due to PV + SWH.
Comparable to *Decline (shutdowns)* – closure of Kurri Kurri Al smelter and Port Kembla blast furnace

http://reneweconomy.com.au/nem-watch

http://www.iesys.com/ies/Portals/2/Documents/Insider/IES%20Insider%2014%20FINAL.pdf

Energy usage lower while GDP increases

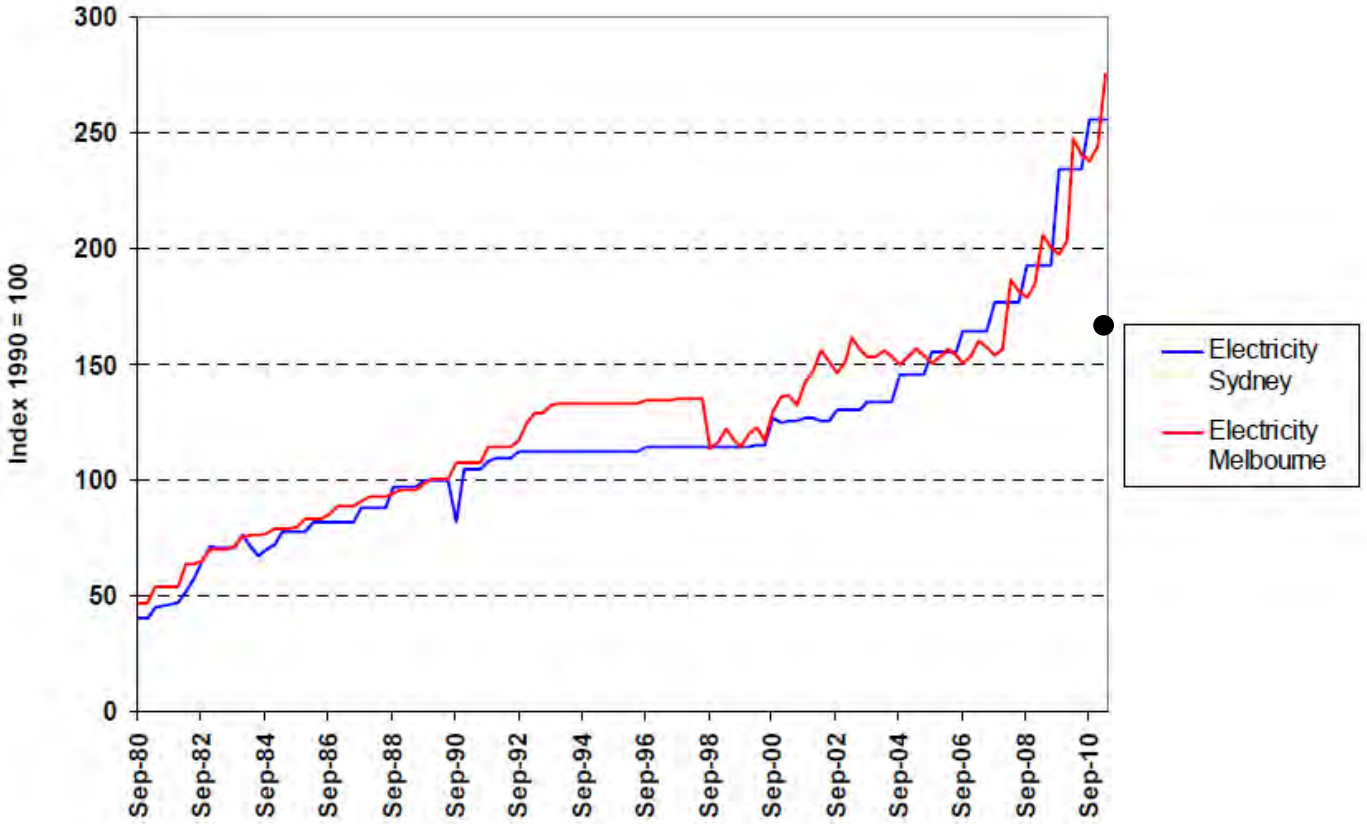
Since the last recession ended in 1992, **Australia's economy has grown by 108%** while our overall primary consumption grew by less than 47%. Coal consumption, including for power stations, has contributed a measly 5% of the additional energy needs of this economic growth. Oil, which since 2010 has overtaken coal as Australia's biggest single energy source, contributed 18% and natural gas, 17%. Even our burgeoning renewable energy sector contributed less than 3% of our growing energy needs.

By far the largest share of the new energy driving more than two decades of economic growth has come from our most neglected resource- improved energy productivity. In short, we have improved the energy productivity of the economy, squeezing out more economic value per unit of energy consumed. In an age when lifting productivity is critical to our future prosperity, energy productivity has delivered in spades, increasing by 42% since 1992. **At current energy prices, this is equivalent to cutting our national energy bill by almost $50 billion, *per year*.**

Chris Dunstan, UTS

http://reneweconomy.com.au/2016/shout-out-for-the-quiet-energy-revolution-72898

Residential electricity tariffs 1980 - 2010

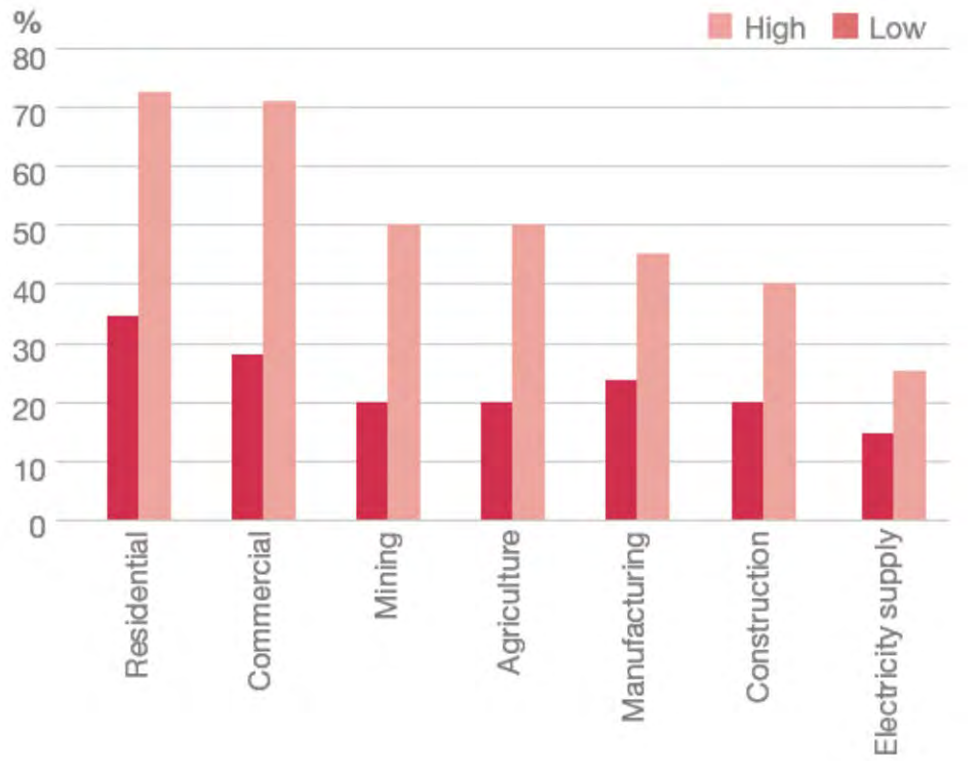


Most of the increase of electricity tariffs over the years has been in line with the CPI (average 4.4% p.a) **except** over the period 2007 – 2010, - electricity increases have been more like 14% p.a. (I have added a black dot to indicate the electricity price **IF** it had followed the CPI.

http://www.ausgrid.com.au/Common/About-us/Newsroom/Discussions/Syd-v-Mel-household-energy-bills.aspx

How low can we go?

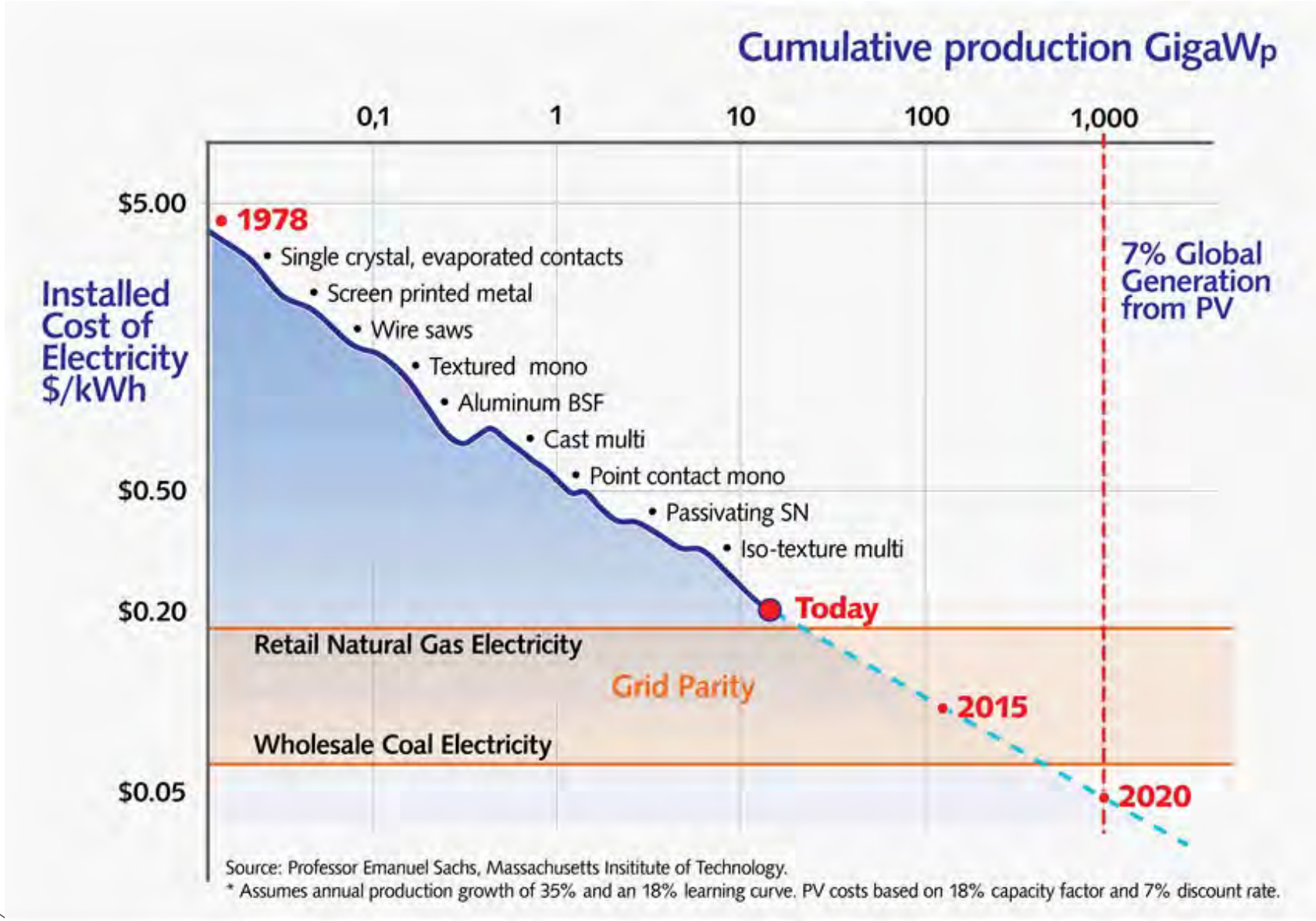
Figure 4: Percentage cost–effective energy consumption reduction potential across different sectors.



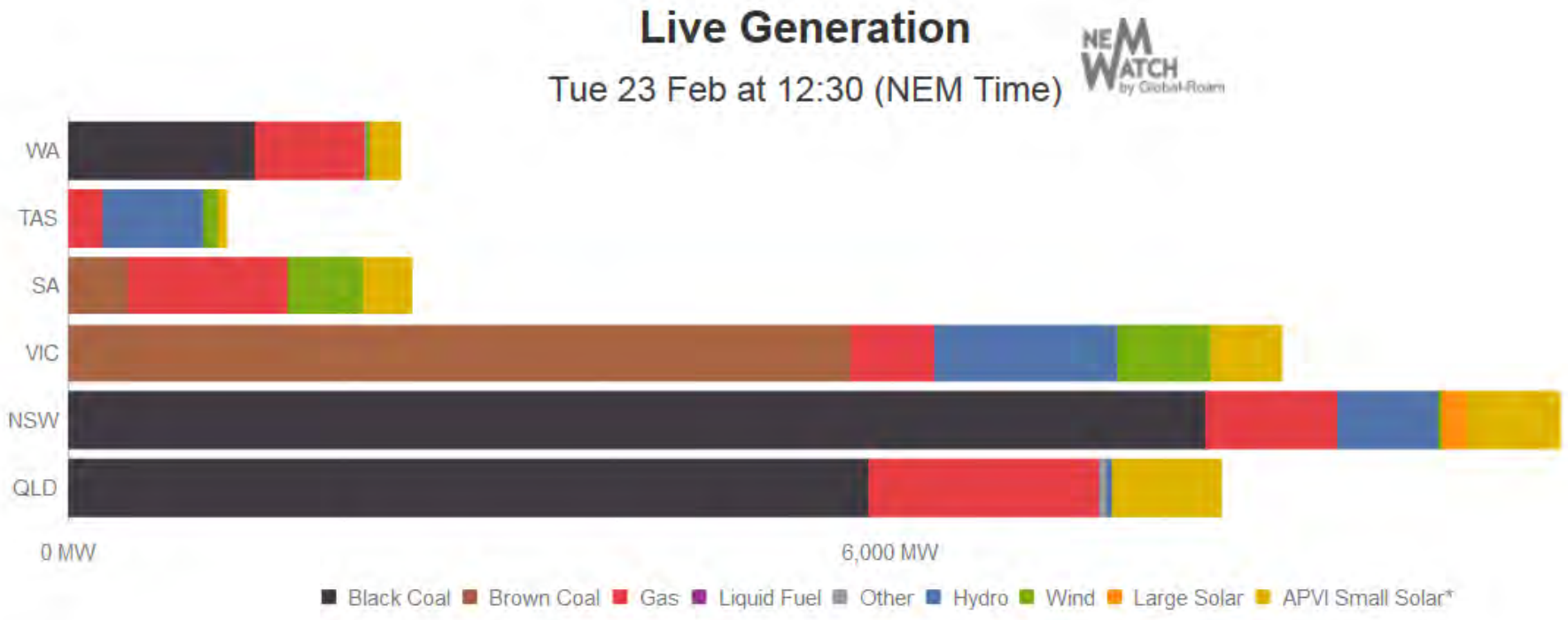
Conservatively Australia spends $100 billion each year on energy. Saving 30% through costs effective energy efficiency measures and deliver $30 billion dollars per year of savings to consumers (~ 4 year payback).

NFEE (2003) *Towards a National Framework on Energy Efficiency – Issues and challenges Discussion Paper*, National Framework on Energy Efficiency

PV is growing fast and getting cheaper

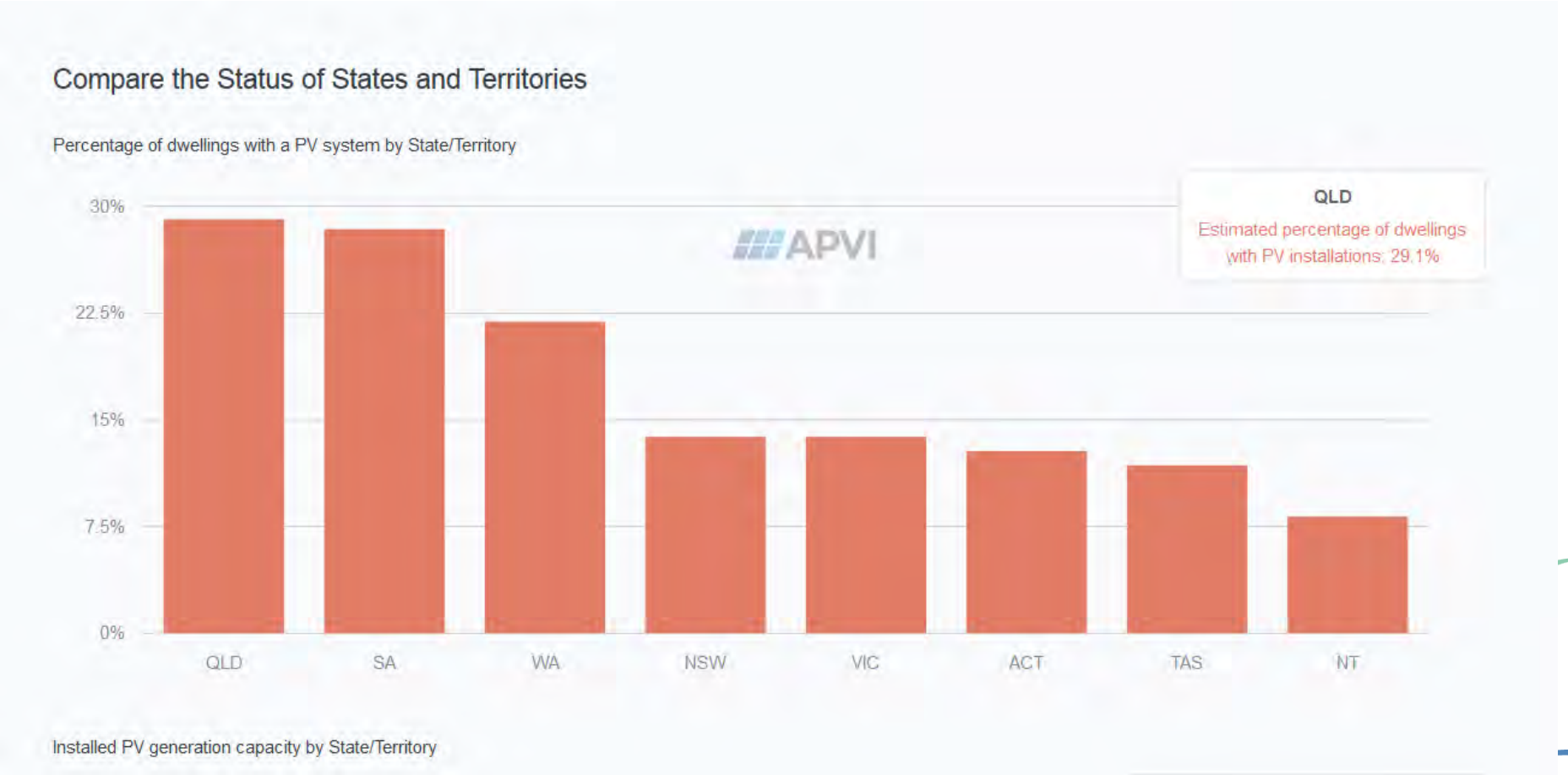


Rooftop solar: zero to 5 GW in five years



http://reneweconomy.com.au/nem-watch

Rooftop PV in Australia

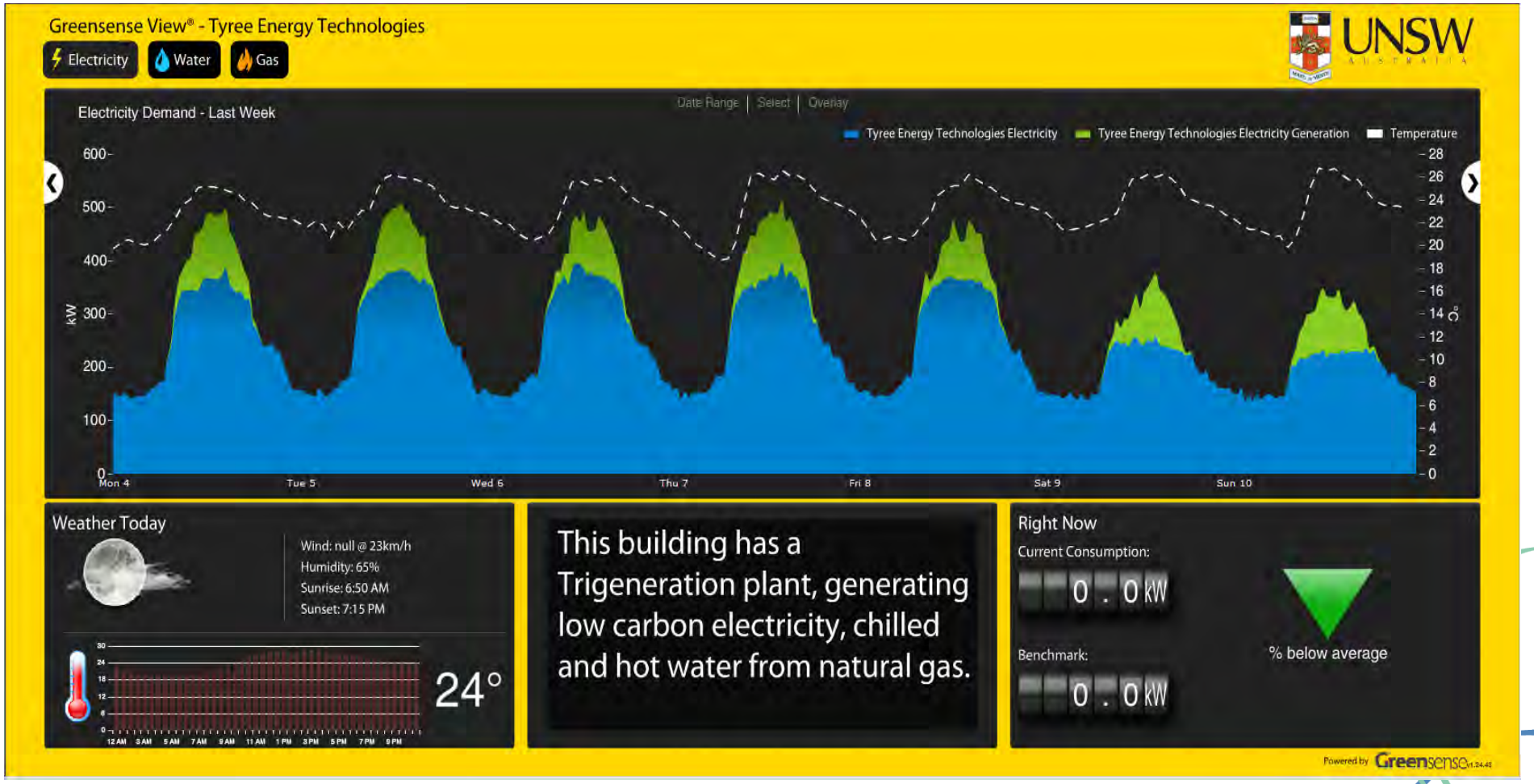


http://pv-map.apvi.org.au/historical#4/-26.67/134.12


UNSW TYREE ENERGY TECHNOLOGY
BUILDING - 150 kWp PV ARRAY

UNSW TETB Electricity

Mar 4 – 10, 2013



http://www.facilities.unsw.edu.au/campus-development/sustainability-campus/greensense-live-energy-project

UNSW Kensington Electricity

Jan 7 – 13, 2013

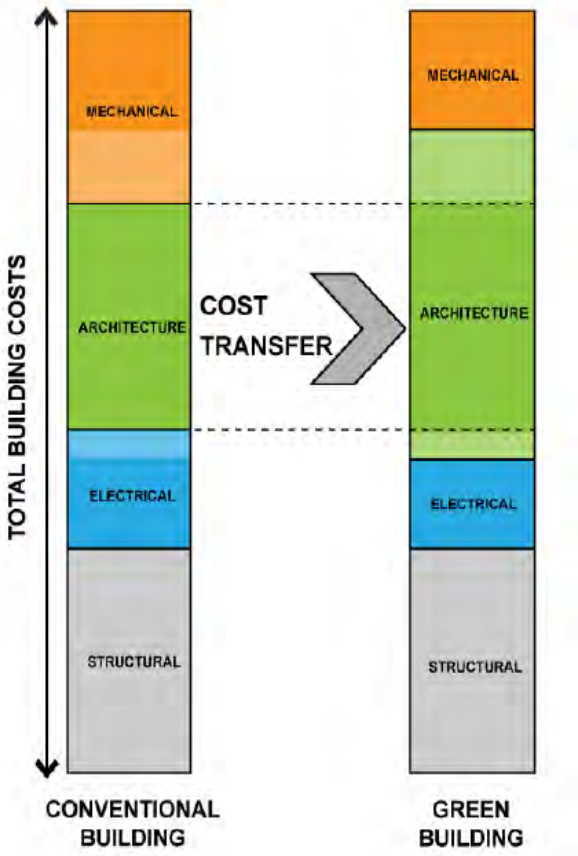
NREL's Zero Energy Building

http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/ns/webinar_rsf_03182010.pdf

Integrated Design for zero energy buildings

Cost Transfer

Transfer costs from mechanical and electrical systems to building architecture



http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/ns/webinar_rsf_03182010.pdf

Energy monitoring

http://www.nrel.gov/innovation/buildings.html

LED lighting

LEDs are now cost effective.

Soon LEDs will be more efficient than daylighting.

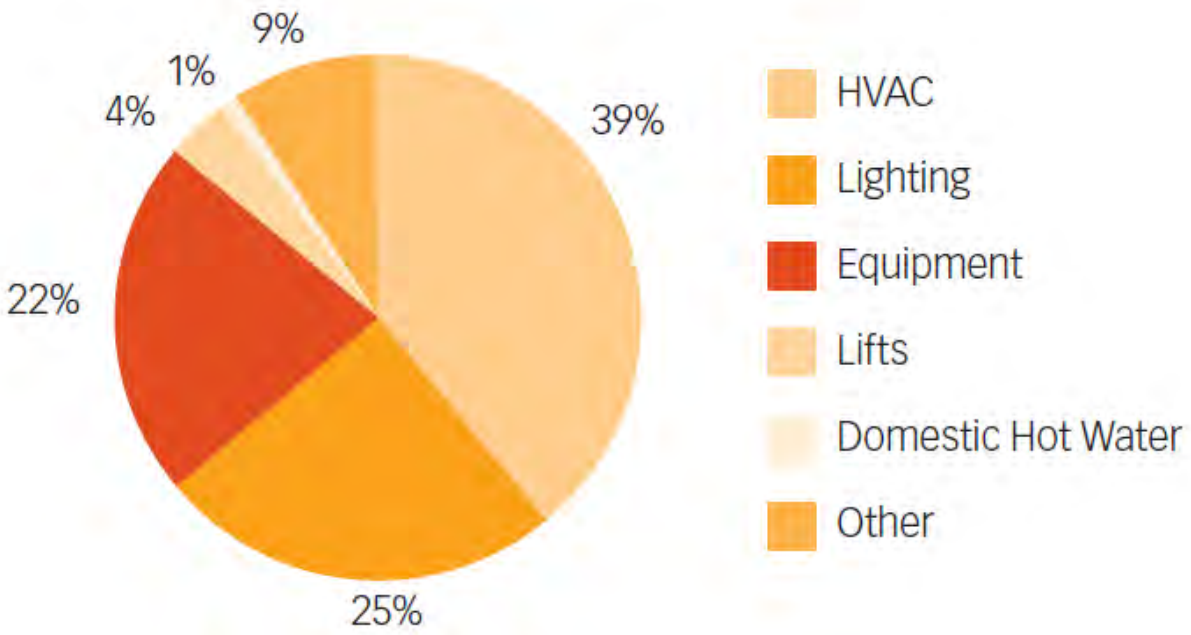
Daylighting delivers

150 lumens/watt

LEDs in the lab are at 300 lumens/watt

Typical energy usage in non-residential buildings

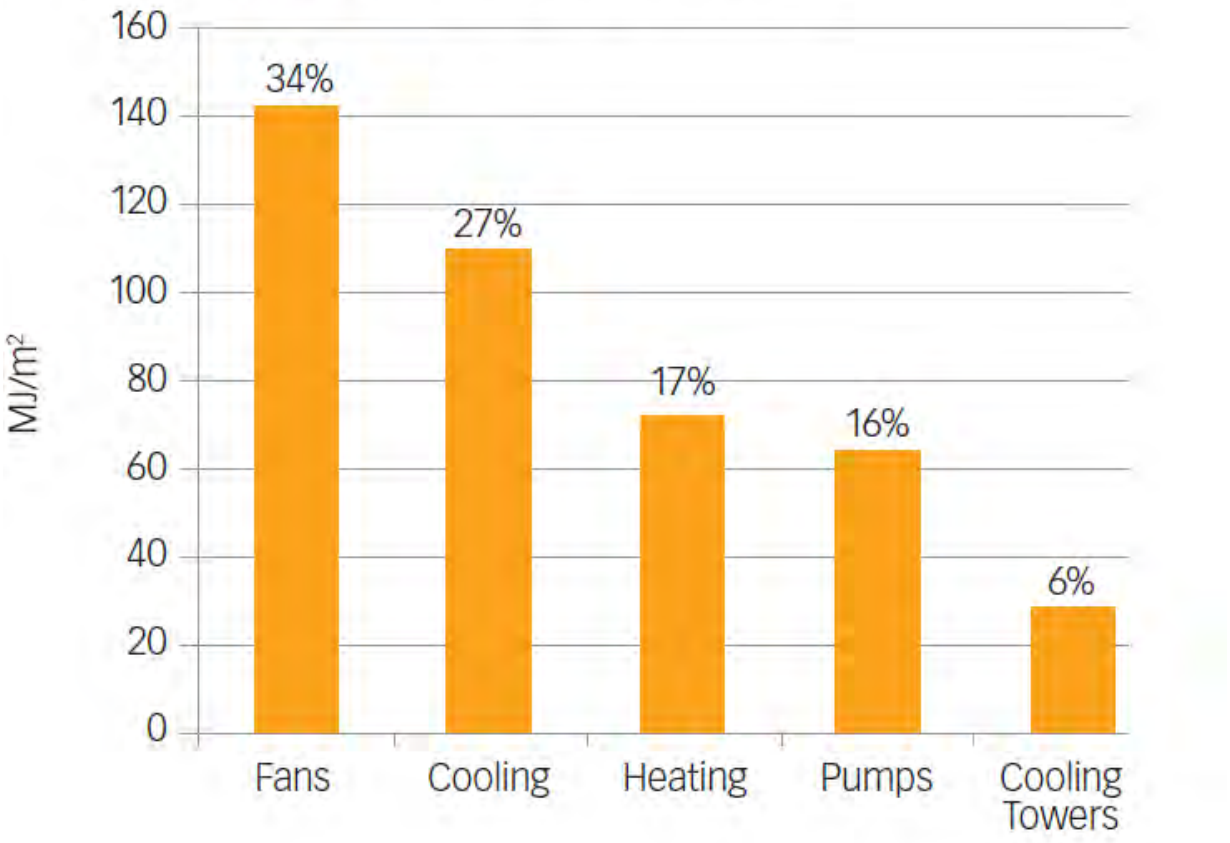
Figure 1: Typical energy consumption breakdown in an office building[1]



http://industry.gov.au/Energy/EnergyEfficiency/Non-residentialBuildings/HVAC/FactSheets/Documents/HVACFSEnergyBreakdown.pdf

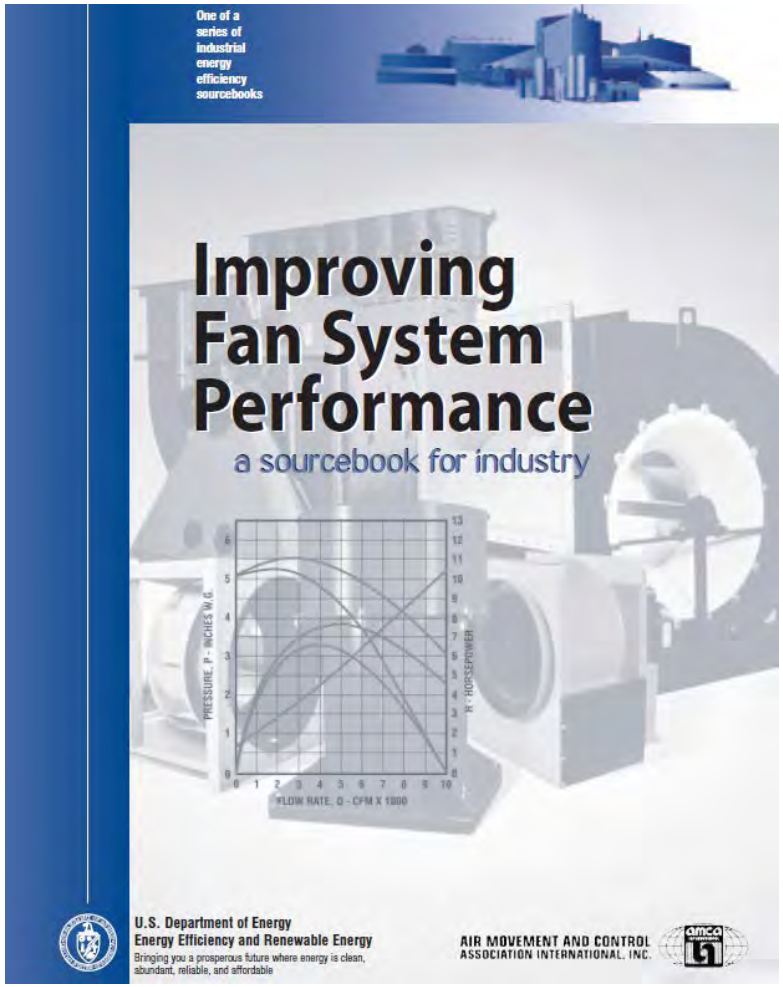
HVAC in non-residential buildings

Figure 2: Typical HVAC end use breakdown[1]



http://industry.gov.au/Energy/EnergyEfficiency/Non-residentialBuildings/HVAC/FactSheets/Documents/HVACFSEnergyBreakdown.pdf

Improving fan energy performance



Fan power required depends inversely on the duct diameter φ by:

$$Fan\ power\ \propto {}^{1}/_{\varphi^{5}}$$

So what? Increasing duct diameters form 250 mm to 300 mm reduces fan energy requirements by 60%

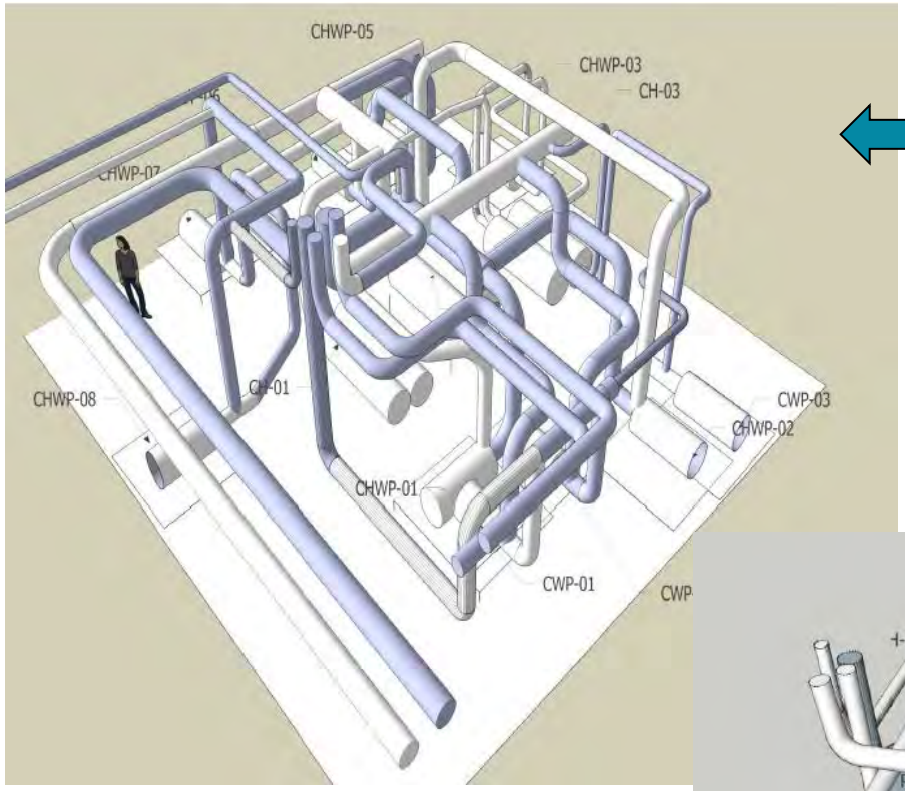
Redesigning a standard (supposedly optimized) industrial pumping loop…

…cut its power from 70.8 to 5.3 kW (–92%), cost *less* to build, and worked better in every way. No new technologies — just two changes in the design mentality. Many other examples are in *Natural Capitalism*, free at www.natcap.org

1. Big pipes, small pumps (not the opposite)

2. Lay out the pipes first, then the equipment (not the reverse).

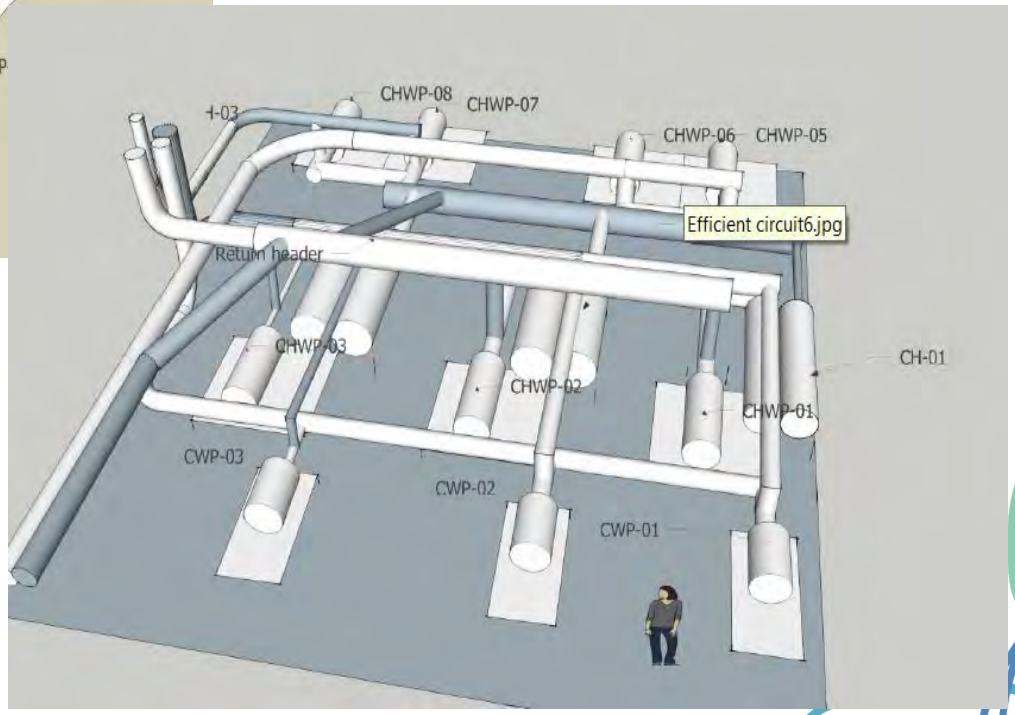
LOWER PRESSURE =
LESS ENERGY LOSS =
ENERGY EFFICIENCY!



An existing HVAC plant room – installed in 2006. Too many right angle bends –inefficient design.

Electric power required: 10.5 kW

Re-design for efficiency.
Straighter layout of pipes: reduces elec. power required by 46%.
+ Increase of pipe diameter by 25% this gives an overall reduction in electrical power of 82%.



Electric power required: 1.87 kW

Tunnel ventilation

Tunnel ventilation energy.

All energy is dependent on frictional losses in the duct.

Efficient fans are important.

Efficient duct design is the most important consideration.

http://www.mitsuimiike.co.jp/english/product/hydraulics/t_vertilation/

Rooftop solar rail stations, carparks, warehouses….

http://www.solarserver.com/solar-magazine/solar-report/solar-report/building-integrated-photovoltaics-an-emerging-market.html

Distributed PV?

Sydney Metro Northwest to support new renewable energy project

10th February 2016

Over the past 18 months, the Division of Resources and Energy has been working with Transport for NSW (TfNSW) to help develop the most cost-effective model to offset the operational emissions of the Sydney Metro Northwest (SMNW).

TfNSW has recently released a tender for the procurement of 137 GWh of electricity from a new renewable energy project in NSW. This is enough energy demand to support a large scale renewable energy project, driving new investment and jobs in a regional part of the State.

This represents a major step for the Government in delivering on our commitment to increase renewable energy under the Renewable Energy Action Plan, and can also be used as a model to offset future infrastructure projects.

On 3 February 2016, the Division hosted an industry briefing about the tender. More than 170 stakeholders attended, highlighting the strong interest in the tender and its significance to the NSW renewable energy industry.

SMNW is a priority infrastructure project for the Government. Australia's first fully automated, driverless train, the line will include the country's longest railway tunnel, and a sky bridge.

Rooftop PV: carparks and electric vehicles.

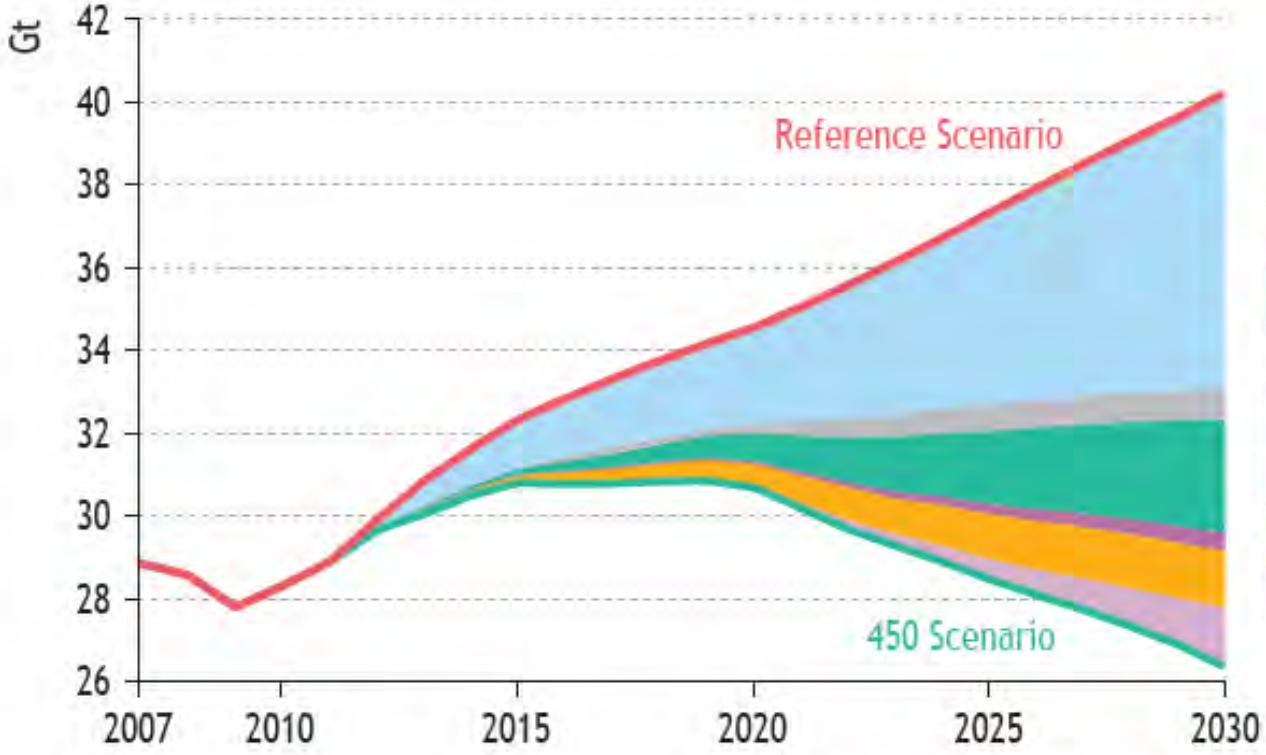
http://www.solarserver.com/solar-magazine/solar-report/solar-report/building-integrated-photovoltaics-an-emerging-market.html

Rooftop PV: airports

http://inhabitat.com/foster-partners-unveil-plans-for-solar-powered-leed-gold-kuwait-international-airport/

IEA : WORLD ENERGY OUTLOOK

Figure 5.8 • World energy-related CO_2 emission savings by policy measure in the 450 Scenario



	Abatement ($Mt CO_2$) 2020	2030
Efficiency	2 517	7 880
End-use	2 284	7 145
Power plants	233	735
Renewables	680	2 741
Biofuels	57	429
Nuclear	493	1 380
CCS	102	1 410

http://www.worldenergyoutlook.org/

Conclusions

Grid electricity form fossil fuels – prices continue to rise

Rooftop solar is now cheaper than grid electricity in Australia for many buildings and customers.

Photovoltaic prices continue to fall

Energy efficiency is improving and cost effectiveness just gets better and better.