



Centre for Energy and
Environmental Markets

UNSW
THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA



Prospects for wind energy in Australia

Hugh Outhred

University of New South Wales, Sydney, Australia

ANZSES NSW Branch, Sydney, 24/7/08

www.ceem.unsw.edu.au



Centre for Energy and
Environmental Markets

UNSW
THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA

Outline

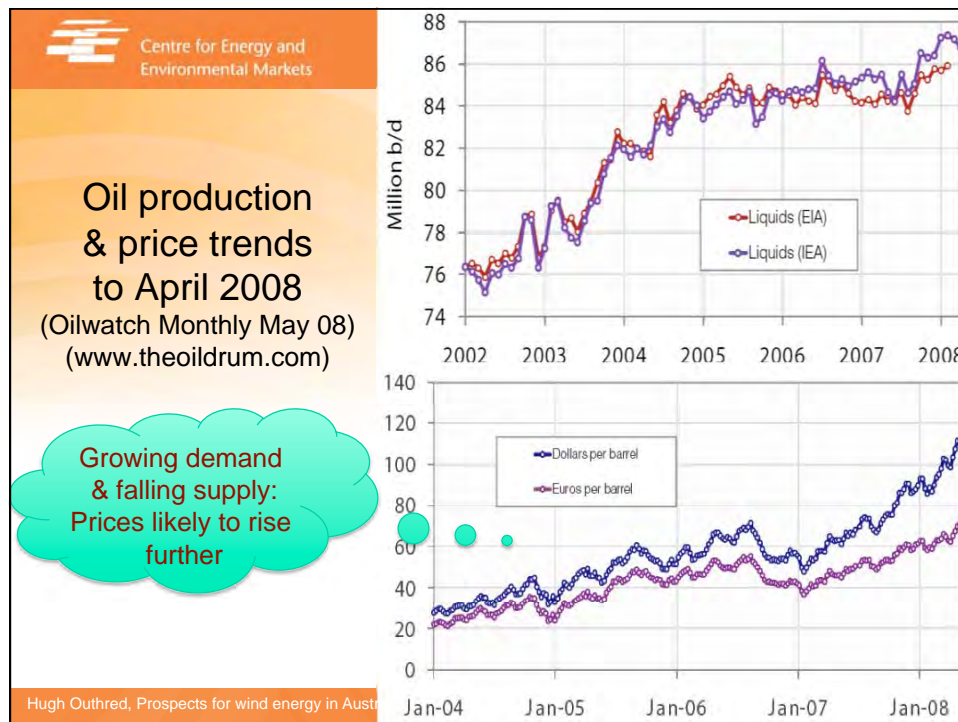
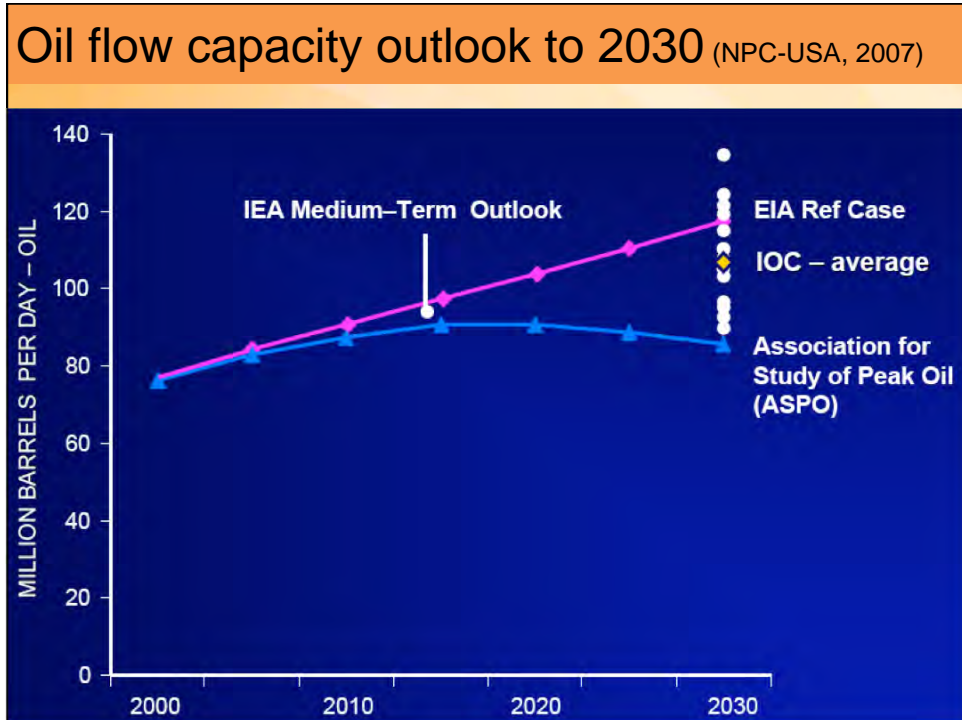
- Global energy-related crises:
 - Energy security, fossil fuel prices, climate change
- Implications for the stationary energy sector
- Wind energy resource & technology issues
- Issues in integrating large amounts of wind energy into the Australian electricity industry
- Conclusions

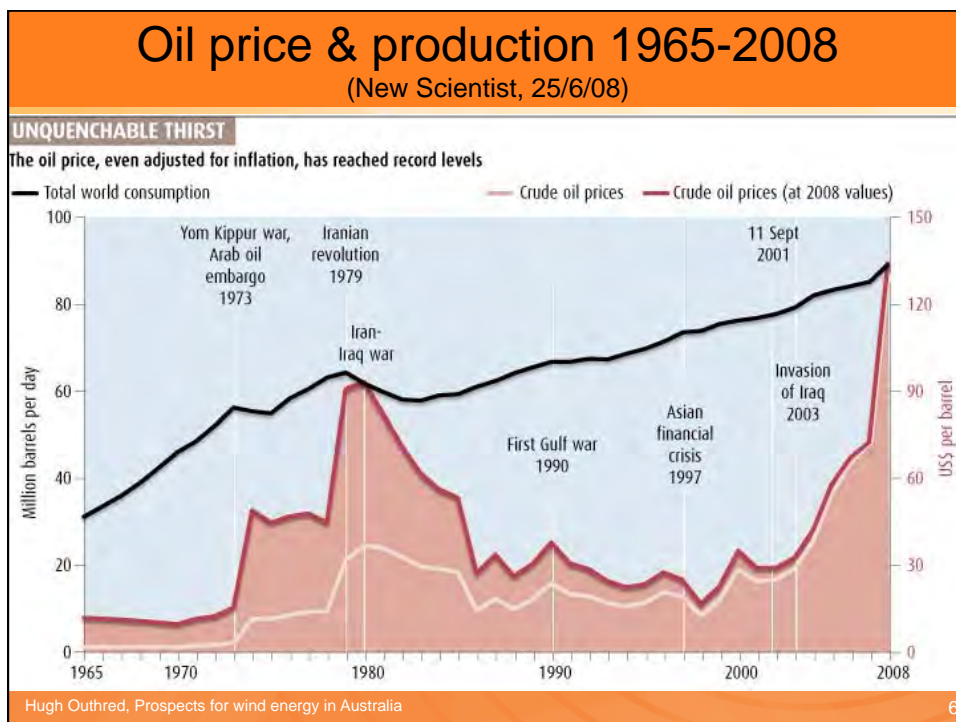
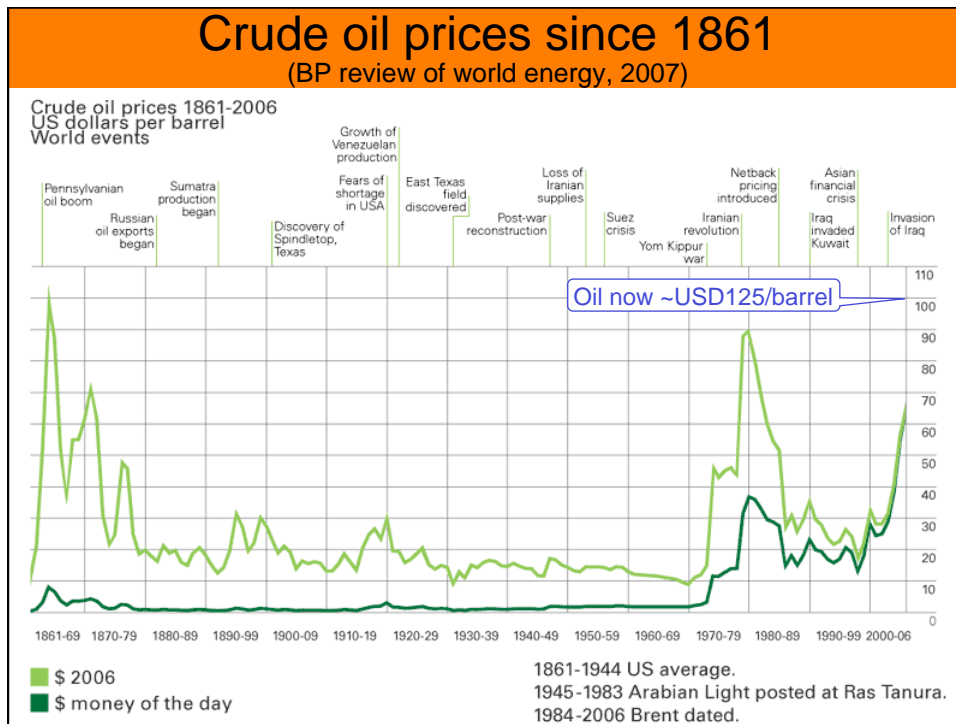
Hugh Outhred, Prospects for wind energy in Australia

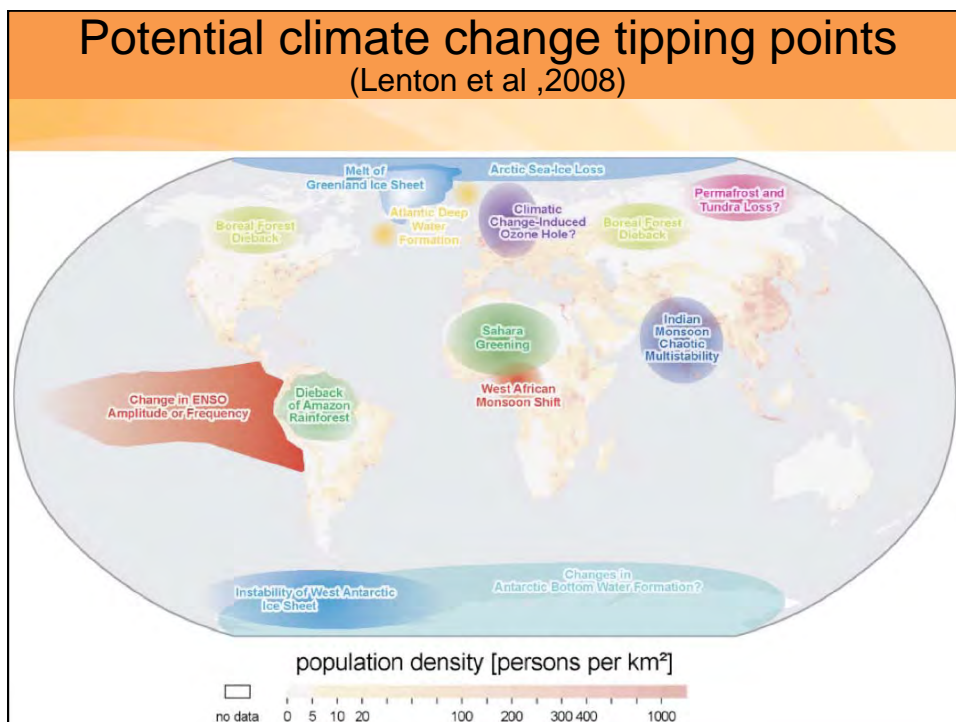
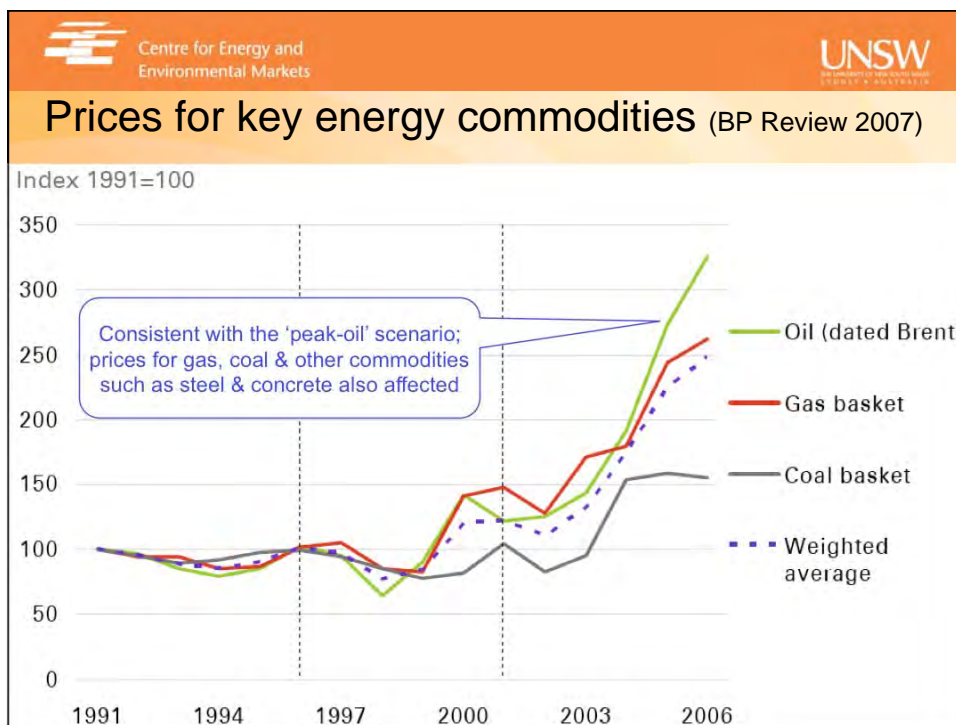
2

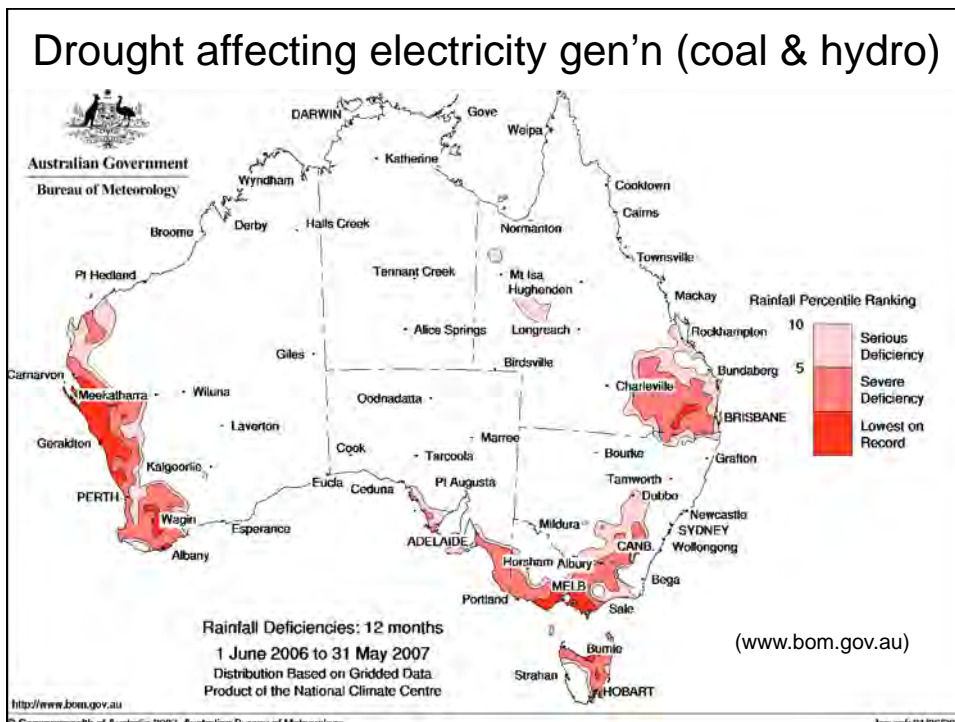
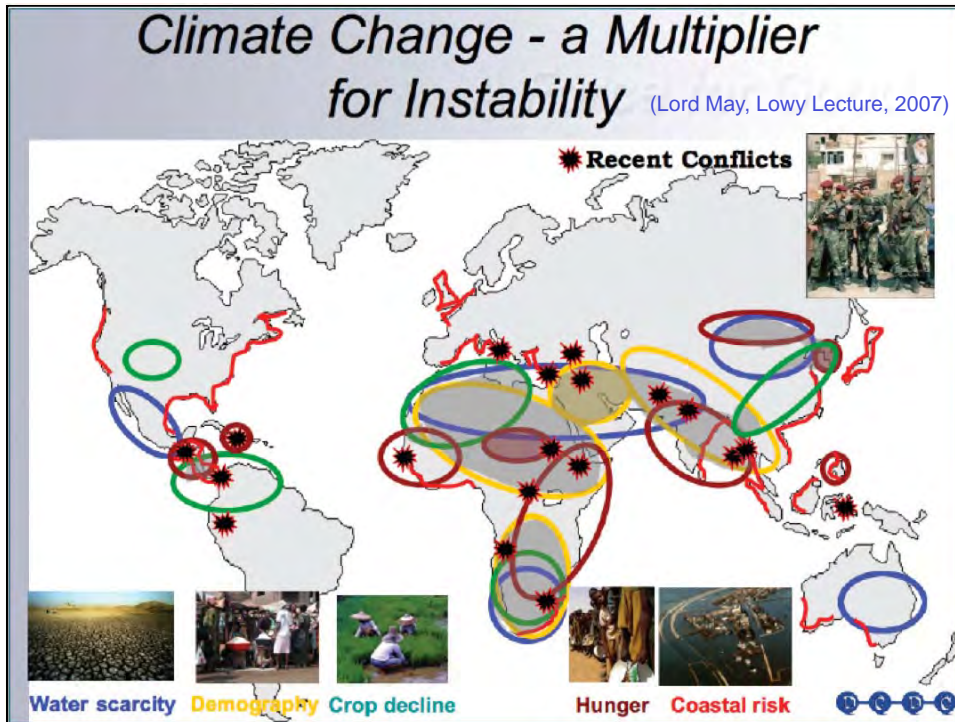


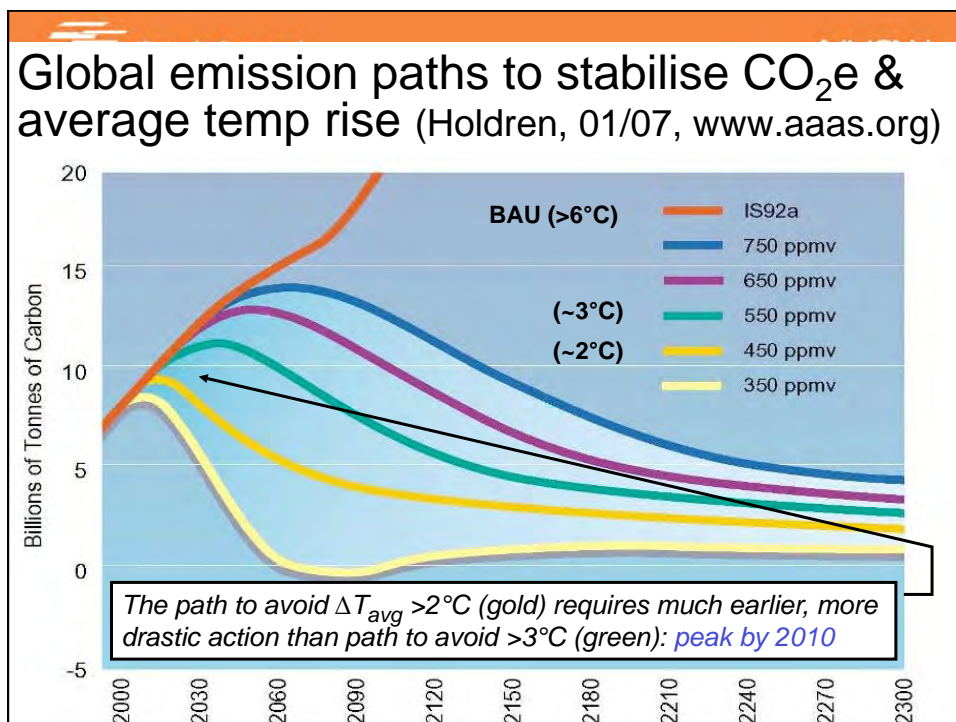
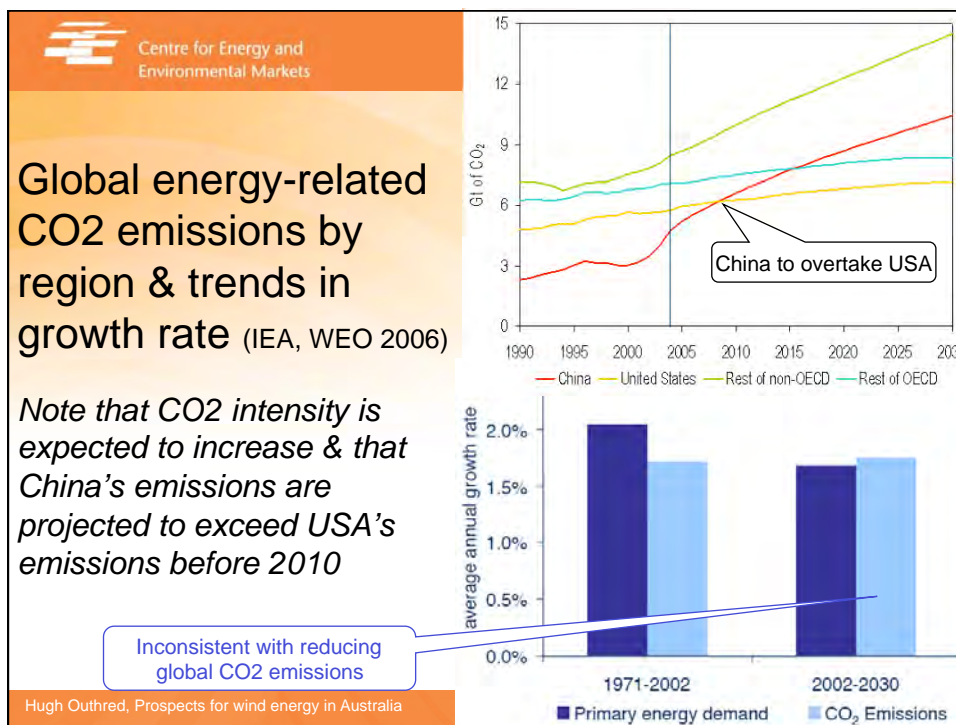
Centre for Energy and
Environmental Markets

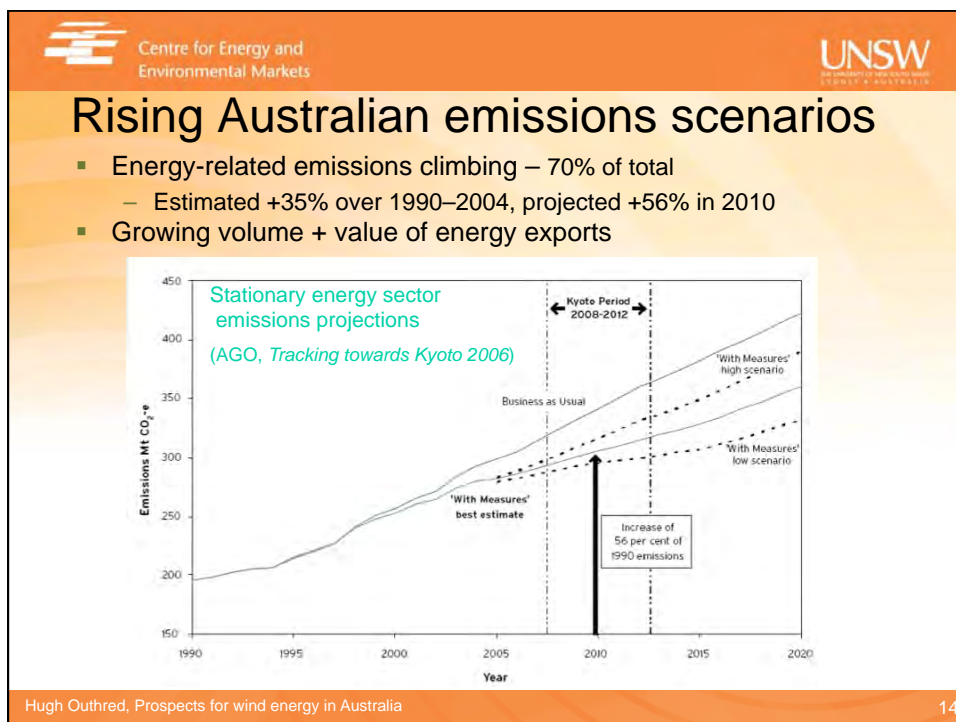
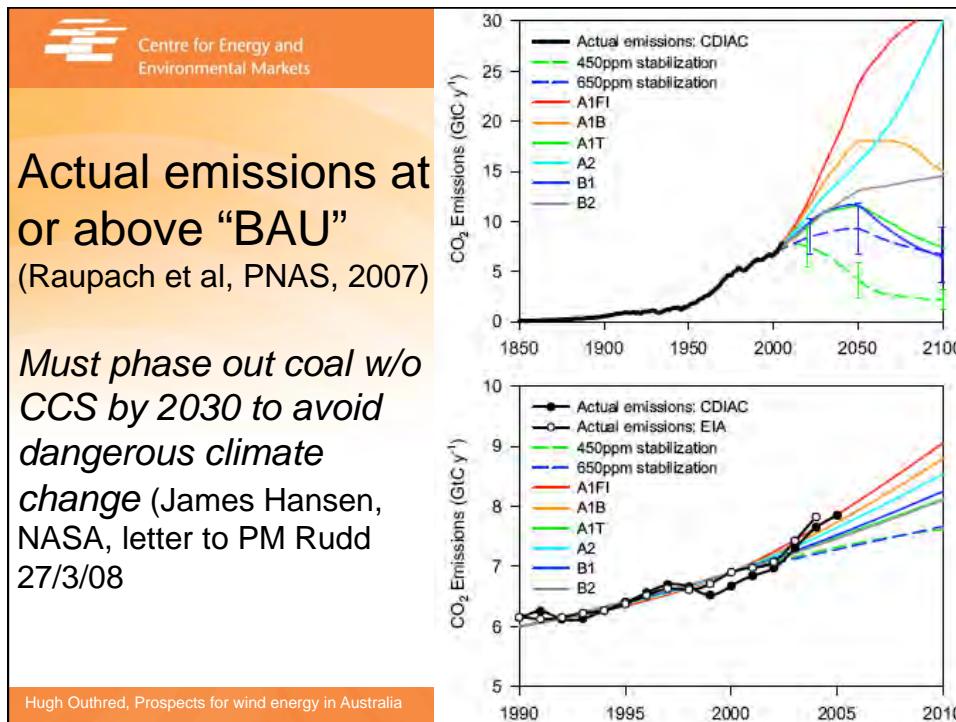


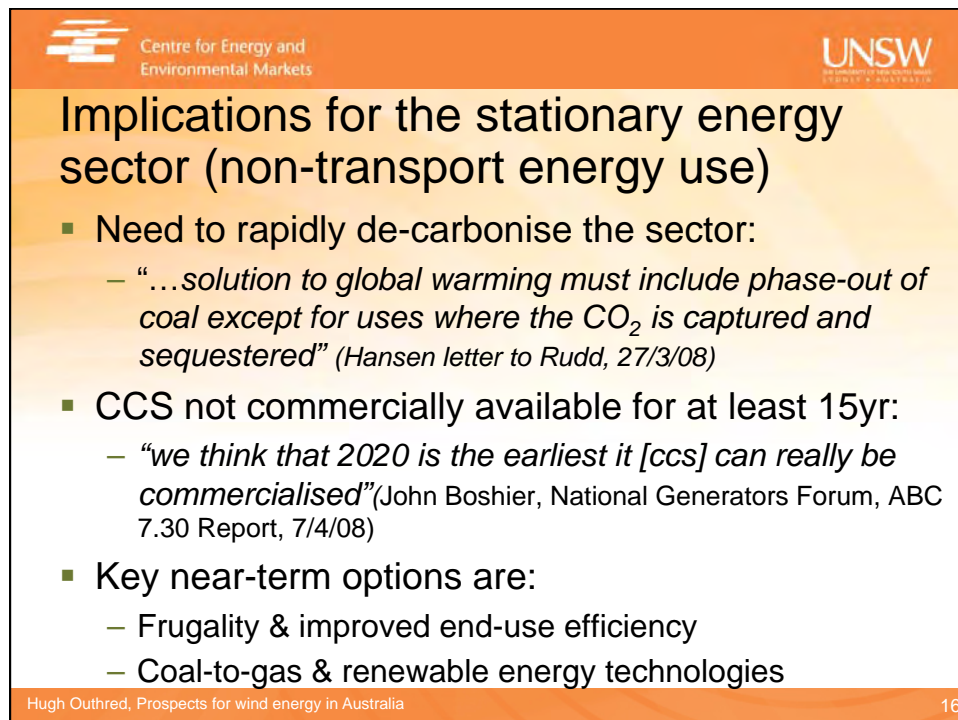
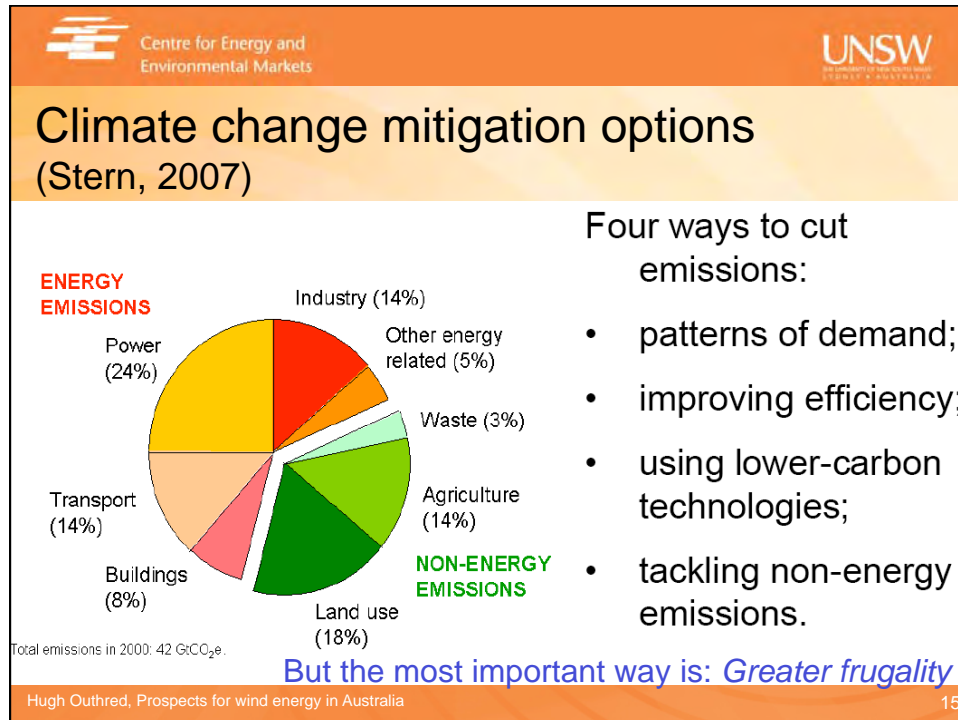












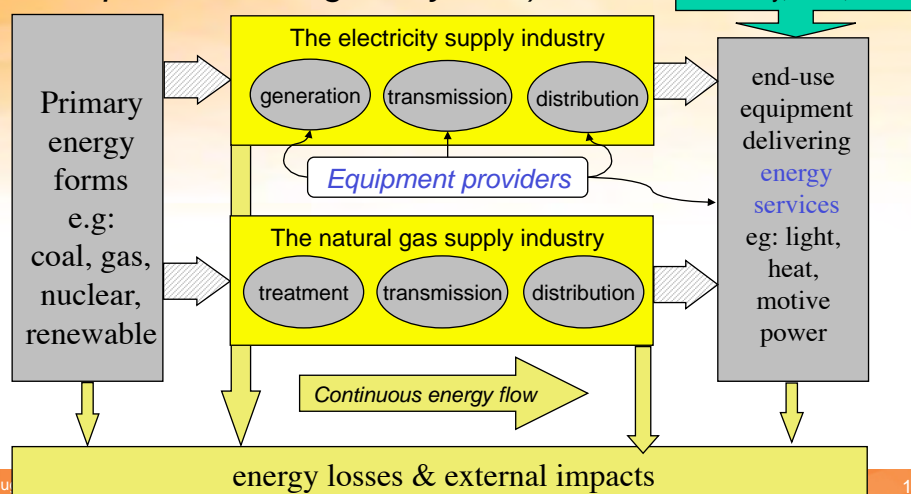


Summary of the presentation so far...

- Human species faces energy-related challenges:
 - Fossil fuel flow physical constraints:
 - “Peak-oil” now & in future “peak-gas”, “peak-coal”, “peak-uranium”
 - Energy security concerns:
 - Unequal distribution of energy resources among nation states
 - Growing risk of dangerous climate change:
 - Excessive release by human activity of CO₂ & other climate change gases
- These challenges are primarily matters of equity:
 - Intra-generational: rich versus poor
 - Inter-generational: old versus young & future generations
 - *Our best hope is frugality but we prefer to party*



Energy service delivery in the stationary energy sector (a complex technological system)





Centre for Energy and Environmental Markets

The Art of Knowing and Doing

The study of **technology** concerns *what* things are made and *how* things are made. Technology, from the Greek *science of (practical) arts*, has both a *material* and an *immaterial* aspect.

What is technology?

(www.iiasa.ac.at)

Technology = Hardware + Software + "Orgware"

Software & orgware are critical issues in complex technological systems such as an electricity industry

Hardware: Manufactured objects (artifacts)
Software: Knowledge required to design, manufacture, and use technology hardware
"Orgware": Institutional settings and rules for the generation of technological knowledge and for the use of technologies

Technology's most important characteristic: **Continuous change >>**

Hugh Outhred, Prospects for wind energy

Centre for Energy and Environmental Markets

UNSW
THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA

Issues for enhancing EI sustainability

- Energy flow constraints, energy security & rapid climate change present massive challenges
- Response tasks must largely be delegated to industry participants (companies & communities):
 - Through “socially-organised decision-making”
- Policies must:
 - Develop capabilities in companies & communities
 - Reward socially-beneficial technological innovation
 - Correctly assign incentives & penalties to induce decisions that are in the long-term public interest

Hugh Outhred, Prospects for wind energy in Australia

20



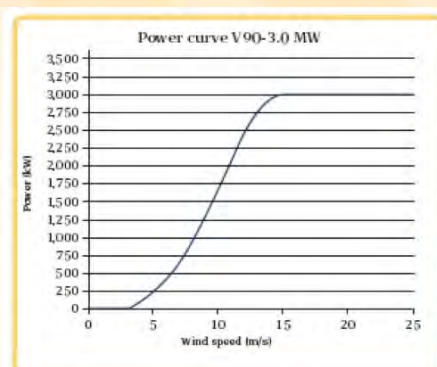
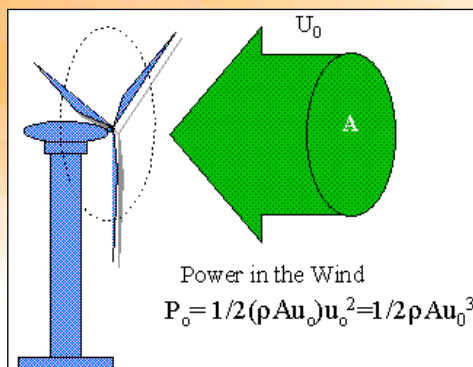


Socially-organised decision-making

- Most human decision-making occurs within a social (group) context supported by public policy:
 - “Effective policies are those that support socially valued outcomes not only by harnessing selfish motives but also by evoking, cultivating and empowering public spirited motives” (Gintis, Bowles & Fehr (eds), *Moral Sentiments and Material Interests*, MIT press, 2007)
- Electricity industry: *a complex technological system*:
 - Policies should address hardware, software & orgware
 - Enhanced end-user engagement will be essential



Wind power density & wind turbine conversion curve



- Doubling wind speed increases wind power density 8 times
- A wind turbine is designed with a varying conversion efficiency of up to ~50% between 5 and 10 m/s



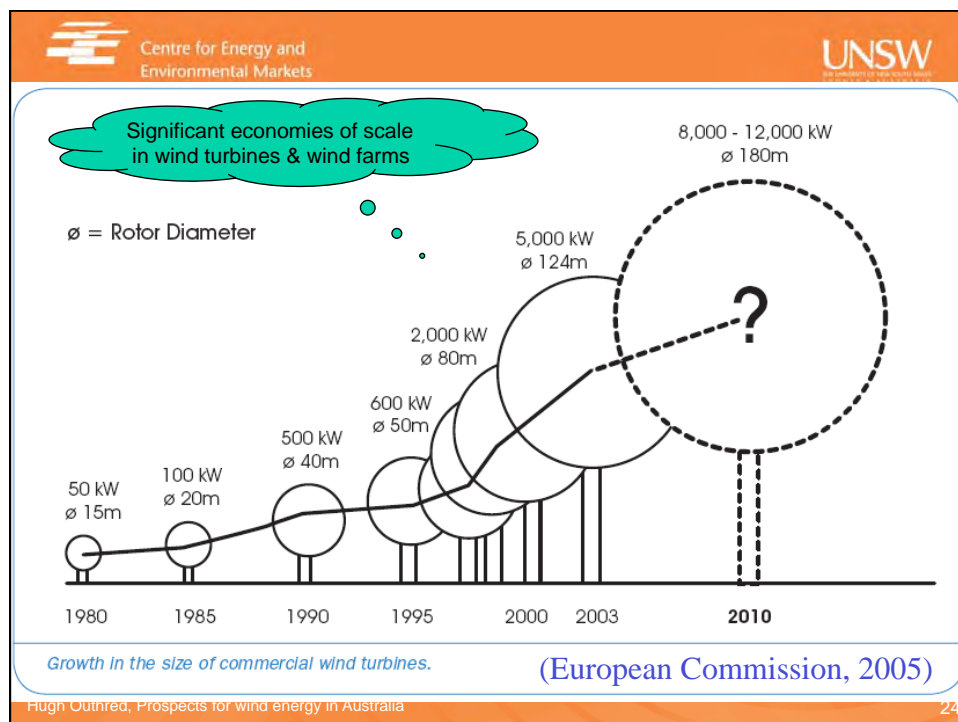


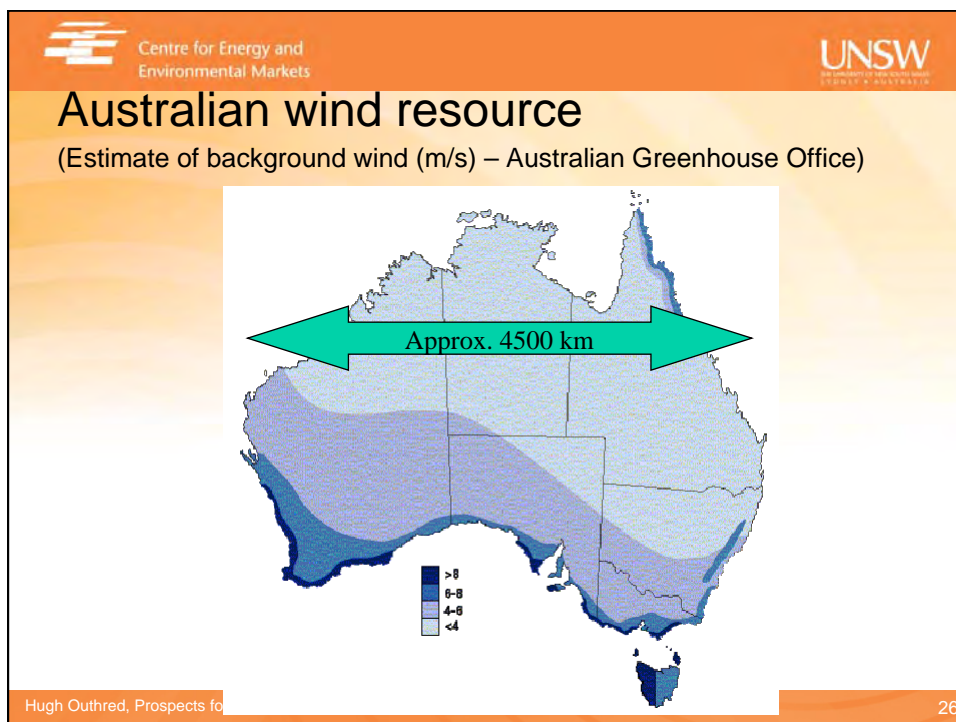
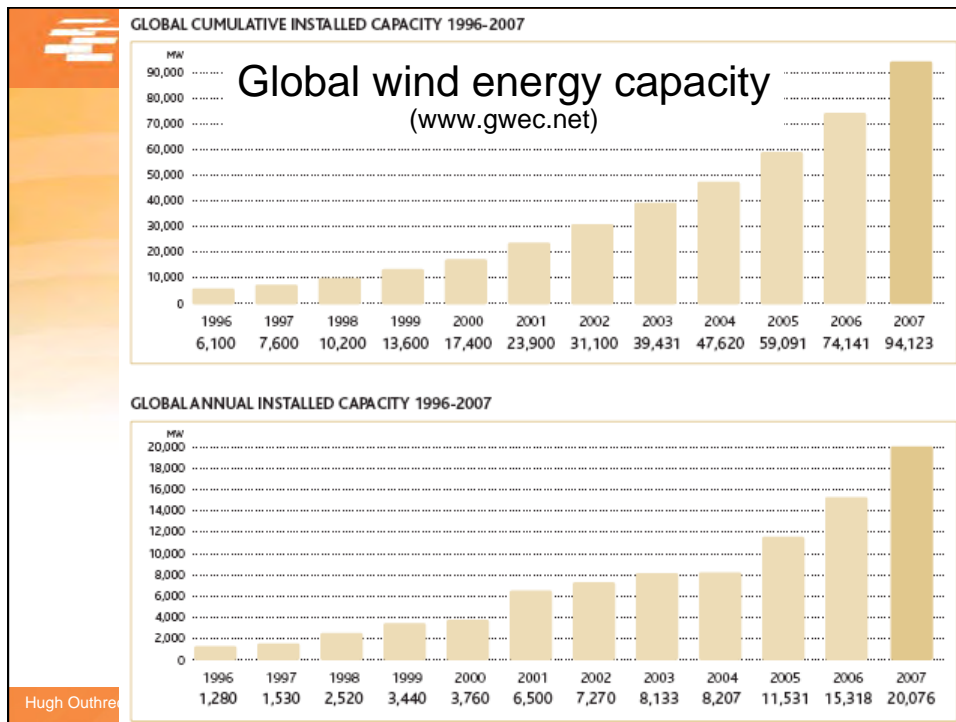
A modern 3MW wind turbine (www.vestas.com)

Technical specifications

1 Oil cooler	4 Service crane	7 Mechanical disc brake	10 Pitch cylinder
2 Water cooler for generator	5 OptiSpeed generator	8 Machine foundation	11 Hub controller
3 High voltage transformer	6 Composite disc coupling	9 Blade bearing	
4 Ultrasonic wind sensors	7 Yaw gears	12 Blade hub	
5 VAMP Top controller with converter	8 Gearbox	13 Blade	

Hugh Outhred, Prospects for wind energy







Centre for Energy and Environmental Markets UNSW
THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA

Some Wind Farms in Australia



Mt Millar, Tarong Energy



Wattle Point, Dave Clark



Blayney, Eraring Energy



Woolnorth, Hydro Tas



Albany, Verve Energy

Hugh Outhred, Prospects for wind energy in Australia 27



Rottnest Island, WA:
600kW



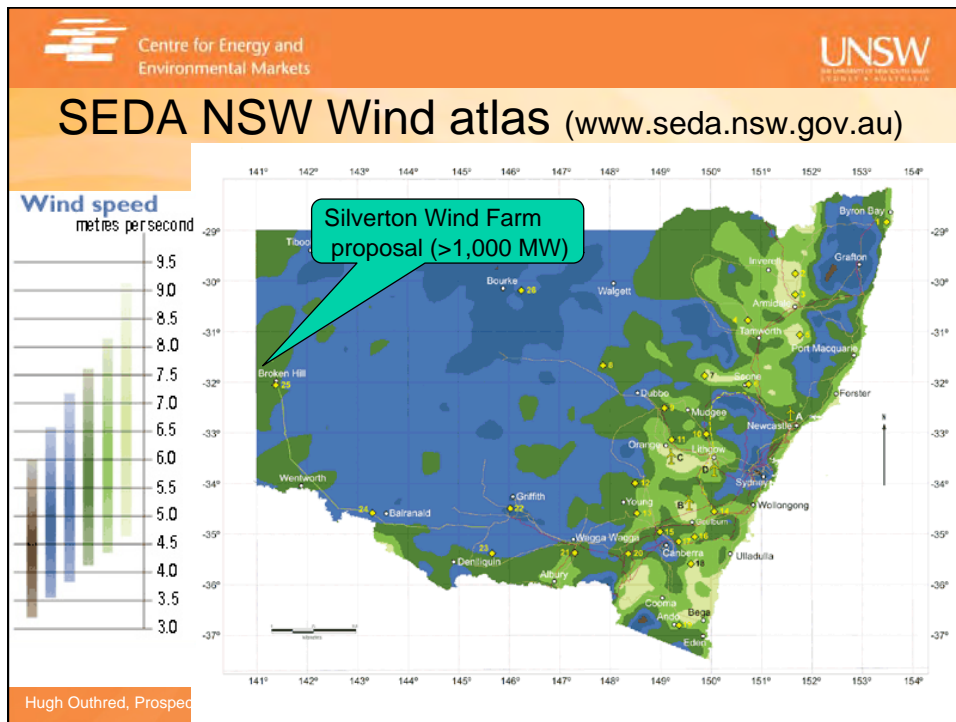
Emu Downs, Geraldton, WA:
80 MW, 48x1.65MW



Albany, WA: 22MW,
12x1.8MW



Alinta, Geraldton, WA:
90 MW, 55x1.65MW



Centre for Energy and Environmental Markets

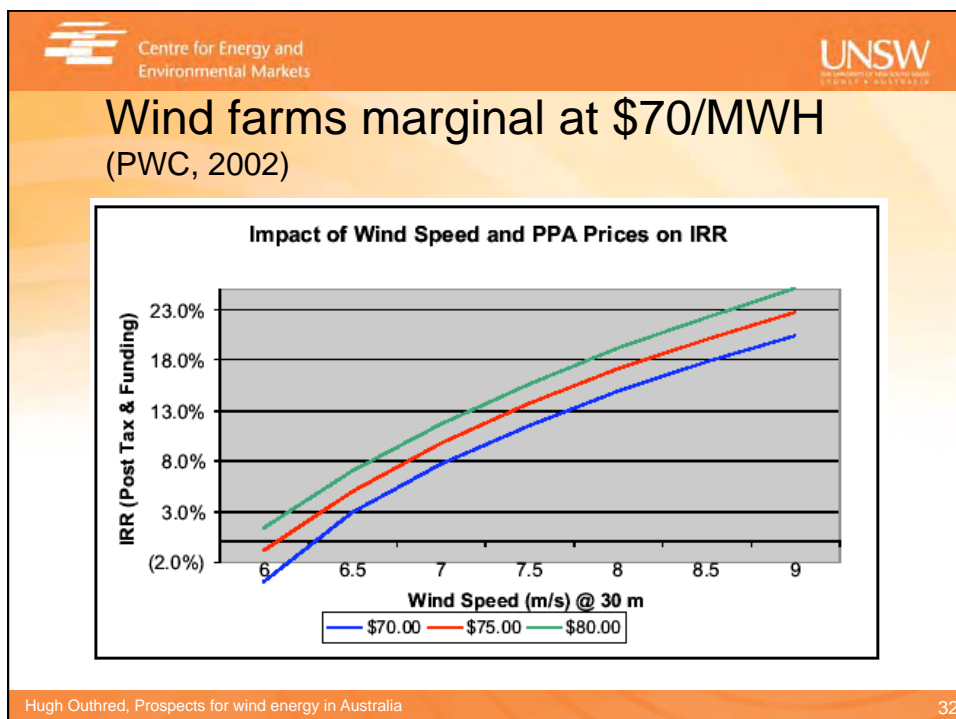
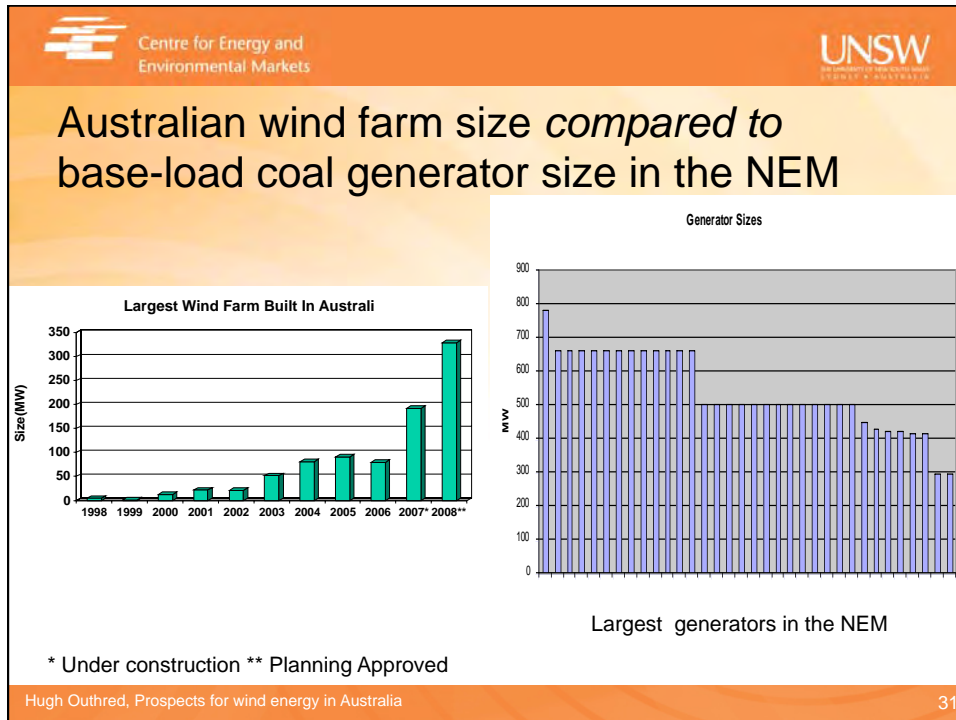
Blayney, NSW, 10MW, 15x660kW:

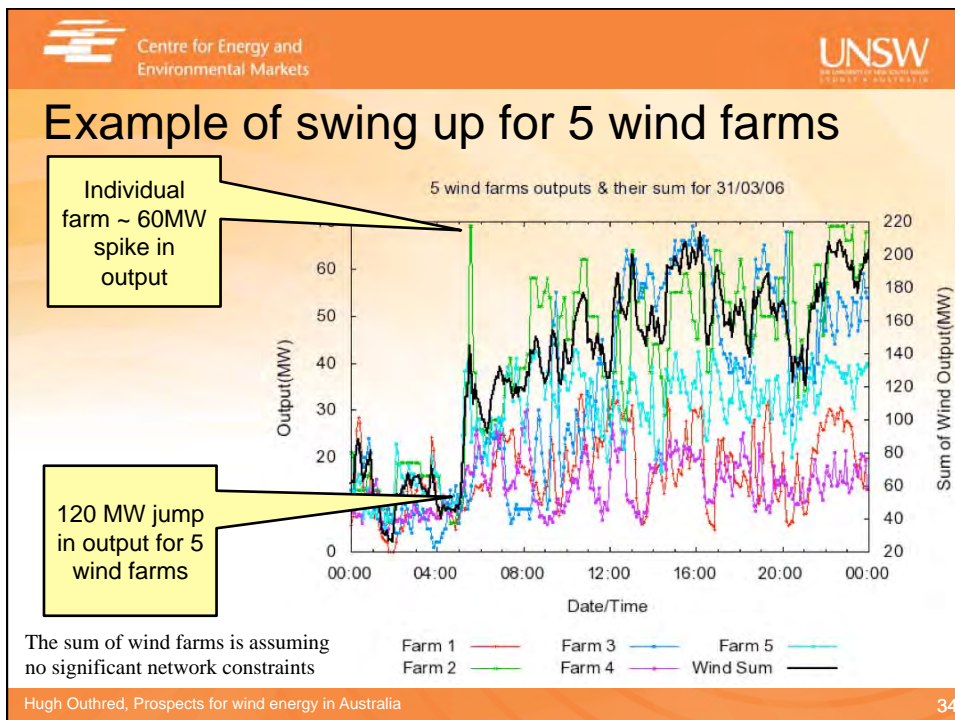
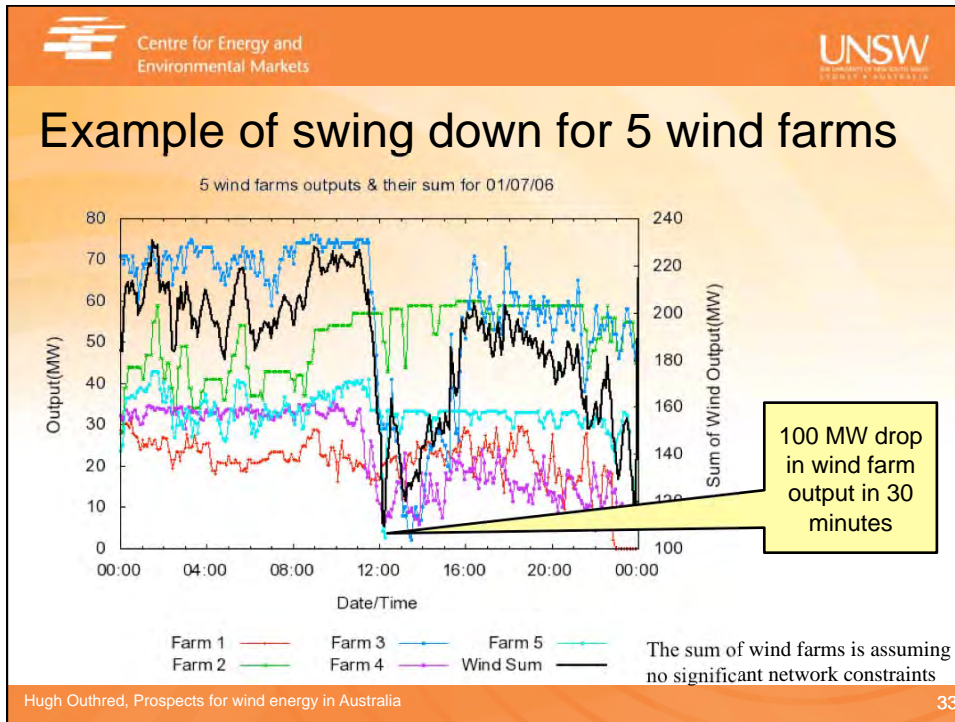
- Good ridge location
- Little interference with farming activity

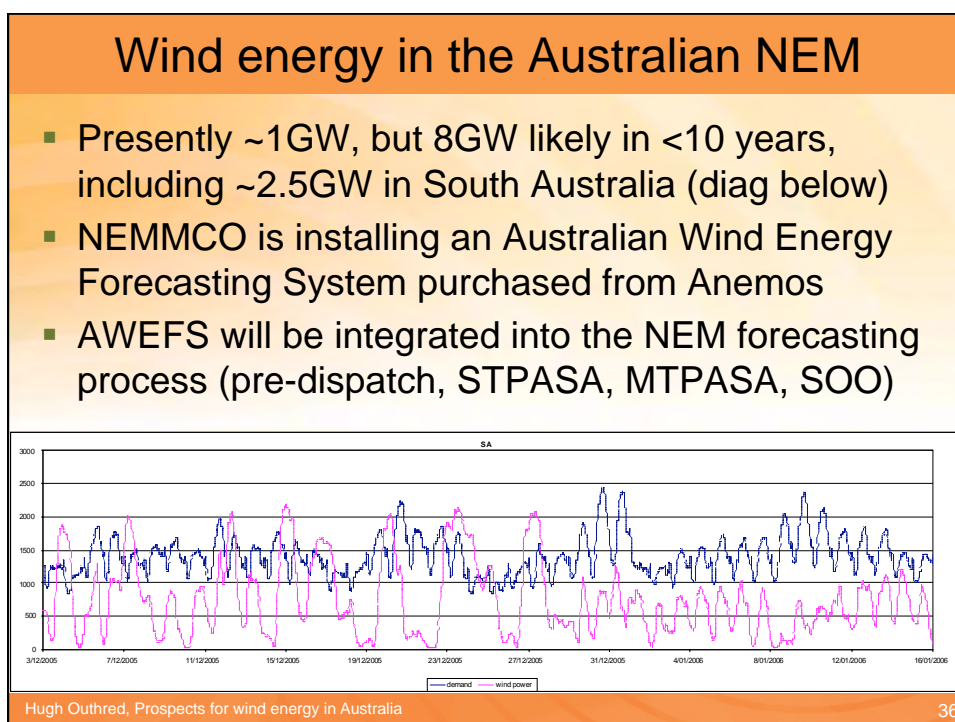
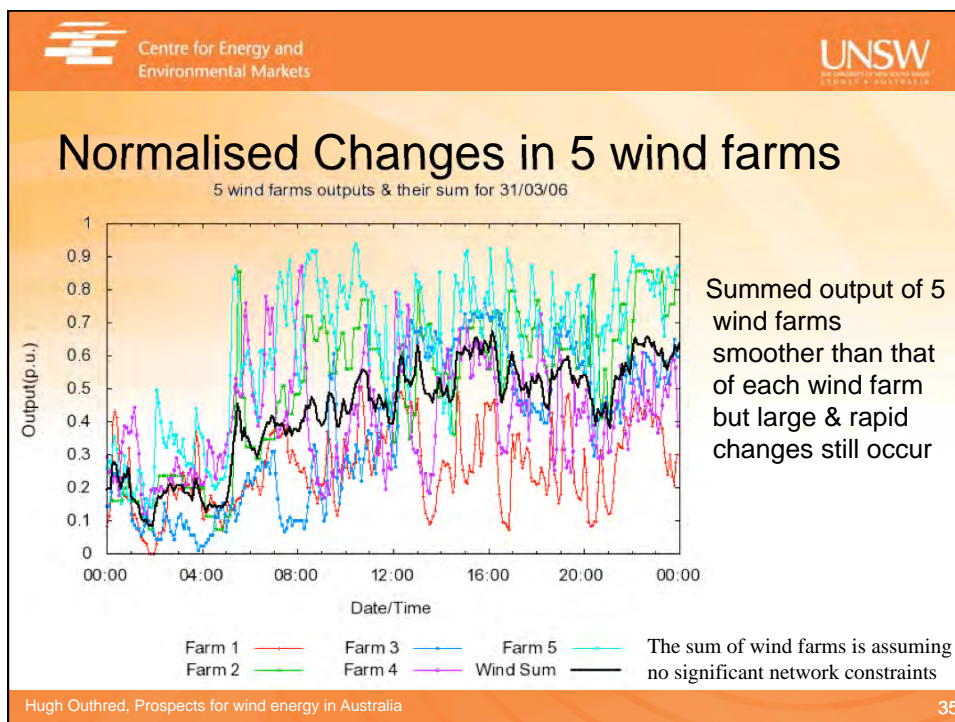
Hampton, NSW, 2x660kW:

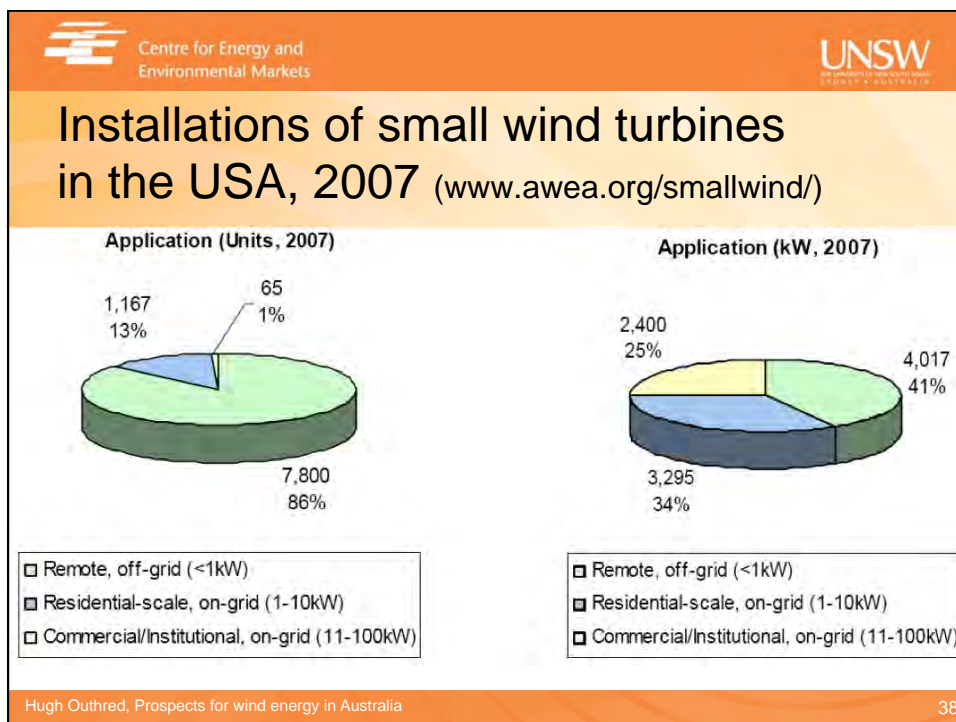
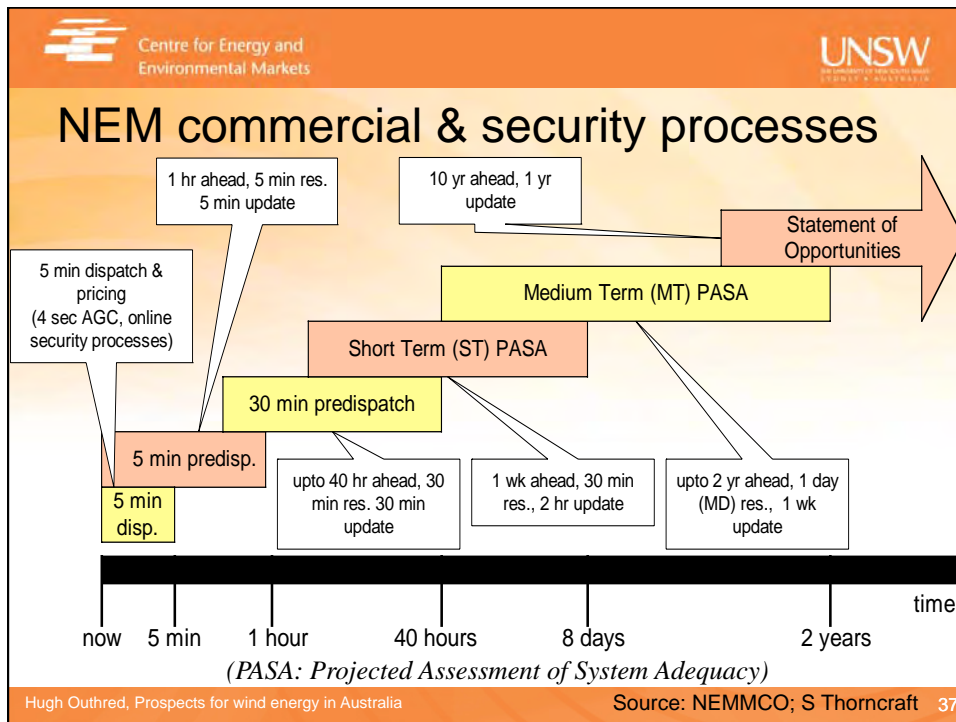
- Good ridge location but turbulence fairly high
- Easy connect to 11kV feeders
- Too small to capture economies of scale

Hugh Outhred, Prospects for wind energy in Australia











Small wind turbines



- Defined by AWEA as <math><100\text{kW}</math>
- Market growing more slowly than for large turbines:
 - More expensive (\$/W); turbines less reliable; less suited to grid connection; lower & more turbulent winds; concerns about noise, accidents & visual impacts
- Internet resources for small wind turbines:
 - www.awea.org/smallwind/; www.nrel.org/wind/
 - www.bergey.com/School/Primer.html

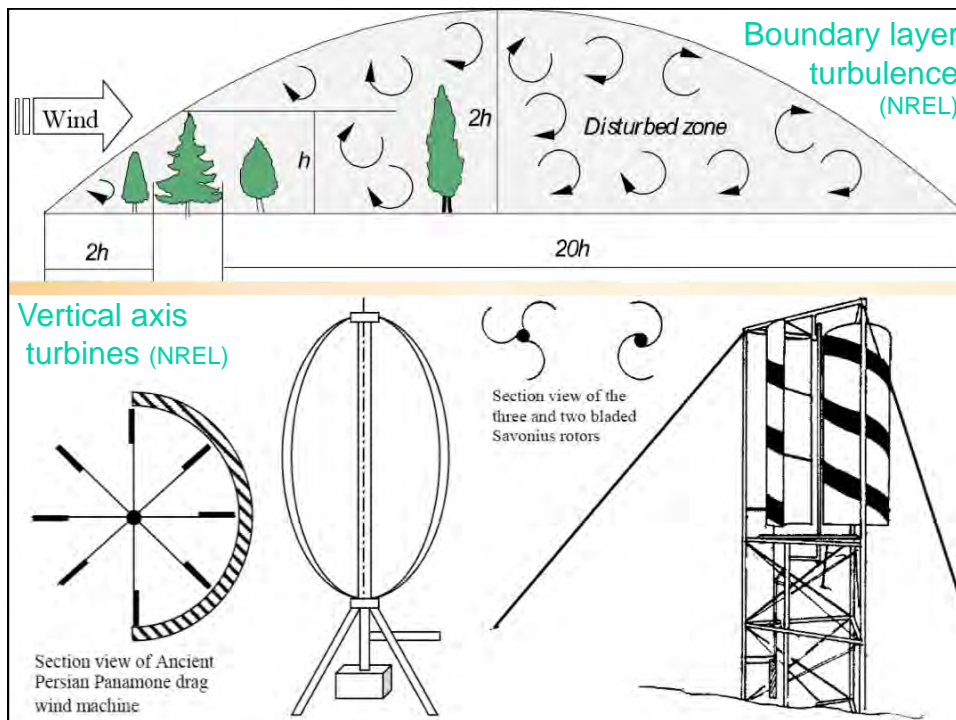
Small wind turbine examples (www.nrel.gov)





Residential wind turbine invention, Graeme Attey, Perth

(<http://www.youtube.com/watch?v=WZ5kX5Yw4eY>)
(<http://www.abc.net.au/news/stories/2007/06/27/1963676.htm?section=business>)





Conclusions

- Sustainability challenges are of global-scale:
 - Fossil fuel availability & pricing
 - Climate change
 - *Also food, water and other resources*
- Electricity industries must contribute to solutions:
 - Efficient & frugal end-use
 - Low-carbon, locally available primary energy resources
- Wind energy has an important role to play:
 - Active community participation to align projects with community attitudes & expectations
 - Enhanced forecasting & power system security regime



Email: h.outhred@unsw.edu.au

Many of our publications are available at:

www.ceem.unsw.edu.au

