Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA



The opportunities & challenges of distributed energy resources for the Australian electricity network service providers

Iain MacGill
CEEM, University of NSW

IIR Electricity Substations and Network Management Conference
Sydney, February 24-25th,2010

Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA

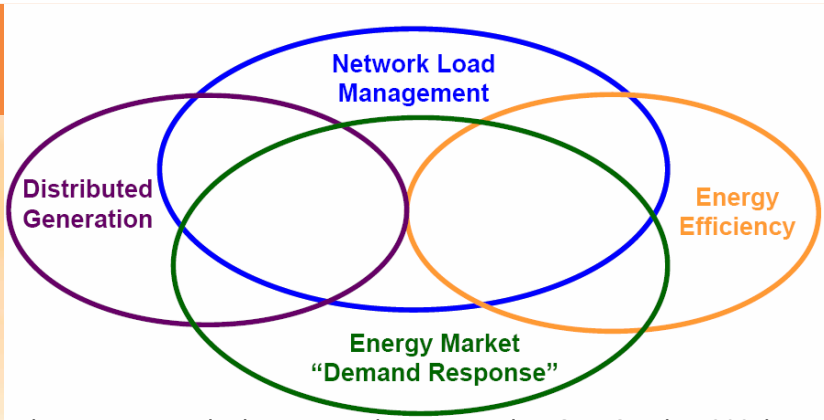
CEEM

- *A formal collaboration between the* **Faculties of Engineering, Business (Economics and Management),** also Arts and Social Sciences, Science, Law
- *through a UNSW Centre* aiming to provide Australian research leadership in interdisciplinary analysis + design of energy and environmental markets
- *focussing in the areas* of
  - Energy markets within restructured electricity industries
  - Related environmental markets – emissions trading, renewable obligations, energy efficiency certificate trading, Greenpower…
  - Wider policy frameworks and instruments for achieving overall energy and environmental objectives and including technology innovation, infrastructure, energy efficiency, behavioural change…

Outline

- Potential value of distributed energy resources in achieving electricity industry objectives
- Challenges for distributed energy; bringing transformational technologies and new stakeholders into the present industry framework
- Models of end-user and industry decision making for distributed energy technologies
- Case studies of residential and commercial energy services provision with distributed options
- Regulatory and policy opportunities to facilitate distributed energy

Distributed Energy options



(Dunstan, *Developing Demand Response in NSW*, October 2005)

- *Technical options within Dx system that actively participate in EI decision making*
  - renewable energy sources including solar thermal, photovoltaics (PV) smaller-scale wind, biomass
  - small-scale fossil fuelled generation, combined heat and power (CHP) plants powered with engines, gas turbines or fuel cells,
  - direct energy storage; chemical 'battery' technologies, super-conducting magnetic systems, flywheels
  - electrical end-uses that actively respond to changing conditions; eg. 'smart' buildings that control heating & cooling to exploit their inherent thermal energy storage
  - End-use energy efficiency
- A range of possible *functional* roles

DE's complex yet promising characteristics

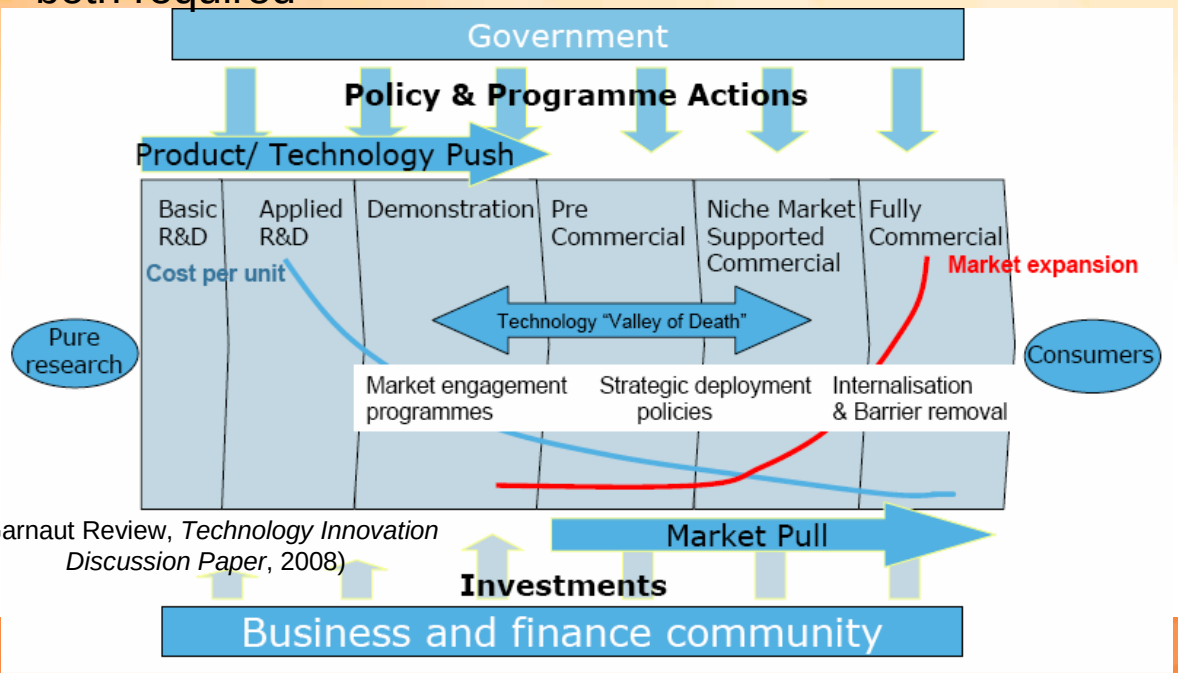
- Complex technical issues
  - Diverse technical characteristics – eg. intermittent renewable energy flows
  - Generation, storage or demand… can be fungible wrt industry operation
  - Small unit scale yet large numbers could aggregate to significant resources
  - Location in the distribution system
- Complex economics: "study of choices as affected by incentives & resources"
  - Wide range of potential decision makers – end users key, but also Network Service Providers (DNSP), Retailers, Energy Service Companies
  - Potential ownership by end-users & close integration with their processes & equipment; eg. Cogen… *and they may have little interest in energy decisions*
  - Location near the end of the energy industry value chain
- Potentially valuable characteristics
  - Some cost-effective alternatives to centralised supply and network options
  - Environmental benefits from renewable energy or highly efficient fossil-fuel use
  - Opportunities for greater end-user engagement in achieving energy services
- Challenge is to maximise total energy, environmental + social values of DE
- *Key issue: Is DE complexity manageable? Even if yes, is it worth the effort?*

Challenges and opportunities for Distributed Energy

- How well do energy industry and associated arrangements establish, and allow DE to suitably receive
  - Energy and network values (costs and benefits)
    - Locational, time varying + contingent value of energy and necessary network flows: *spot but also future value b/c decisions now impact on later decisions*
  - Environmental values (costs and benefits)
    - 'command and control' regulation yet also possible schemes including ETS, eRET and feed-in tariffs that internalise environmental & social externalities
- In restructured industries a question of wholesale & retail market design, network regulation & policy frameworks
  - Challenges of technology and participant neutrality for emerging DE options that have very different technical & economic characteristics, location near and ownership by end-users
  - *Retail markets where DE resides are the 'unfinished' business of many electricity industry restructuring processes*
  - *Intersection of regulated network and competitive supply/demand options invariably complex and imperfect*
  - No serious efforts yet in most jurisdictions to address environmental, energy security and wider social externalities of energy markets

What will it take to facilitate DE? **Innovation**

- Different DE technologies at various stages of progress
- Public policy support for technology push and market pull both required



(Garnaut Review, *Technology Innovation Discussion Paper*, 2008)

What will it take to facilitate DE? **Software+Orgware**

- DE poses significant challenges for existing industry knowledge and capabilities, and institutional frameworks

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.

Technology = Hardware + Software + "Orgware"

(IIASA, *What is technology?*, 2006)

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

Hardware
Software
Orgware

Hardware often arrives before software and orgware

Garrett under fire over dodgy solar installations

By Samantha Hawley for AM

Updated Thu Feb 18, 2010 9:38am AEDT

As Environment Minister Peter Garrett grapples to control his home insulation program, there are now concerns about the potential for house fires because of badly-installed solar panels.

ABC's Lateline program has revealed that up to 2,000 homes could be at risk of electrical fires from poorly installed roof-top solar panels, and Mr Garrett's department is now considering an audit into the scheme.

Ted Spooner, from Standards Australia's committee on renewable energy, has told Lateline that there is no restriction to stop panels which do not meet the Australian standards being imported into Australia.

Mr Spooner says there needs to be more inspectors and an audit of the scheme.

"There is very, very limited inspection of houses to make sure they actually meet those requirements," he said.

"If you have poor quality modules, you can have fractures in electrical joints, and that can lead to arcs and then fires, and these burn at quite high temperatures."

Peter Marshall from the United Firefighters Union of Australia says there are concerns faulty panels could cause high voltage fires.

"The problem is, there's been a rush towards installing this type of equipment," he said.

There have not been any solar panel fires in Australia yet, but it is understood that the Dep Environment is looking into whether an audit is needed.

Up to 2,000 homes could be at risk c from poorly installed roof-top solar p file photo)

VIDEO: Dodgy solar panels spark fi (Lateline)

AUDIO: More Garrett woes with qu solar panel installation (AM)

RELATED STORY: Industry rejects su insulation claims

RELATED STORY: Garrett phones mu insulation death

getsolar.com

Home | Residential Solar | Commercial Solar | Why Solar? | C

Australia's Solar Panel Safety Debacle

Posted by Margaret Collins in Thursday, February 18th 2010 under: International Solar, Residential solar Tags: Australia, safety, solar installation

Australian Environment Minister Peter Garrett has been under fire for a home insulation scheme gone wrong in which as many of 400,000 properties may have received below-grade insulation-and three installers have died of electrocution. And now, the safety of solar panel installations in the country has been called into question as well.

The insulation initiative was a result of economic stimulus monies for energy efficiency/insulation spurring a huge boom in the number not only of installations, but of installers; many of whom were poorly-if at all-qualified to do the work at hand. Plentiful government subsidies coupled with lack of oversight and training led to shoddy projects which now need to be reviewed en masse.

Home solar installations have also been funded by generous government subsidies in the past, and the fear now is that many of these-and more to come-will slip through similar cracks in regulatory oversight and safety standards. Garrett, backed by Prime Minister Kevin Rudd, is calling for a nationwide audit of solar panels to address these concerns. According to ABC, "The Clean Energy Council has raised fears that some of the panels – used to generate electricity – were wired with the wrong circuit breakers, which could overheat and cause a fire if the system was turned off for maintenance." If this turns out to be true, it's a serious and amateurish flaw-any experienced solar installer or electrician should be able to appropriately size a circuit breaker. This is the type of mistake most common to absolute beginners, and even then should be caught by a safety inspector before the system would be allowed to go live.

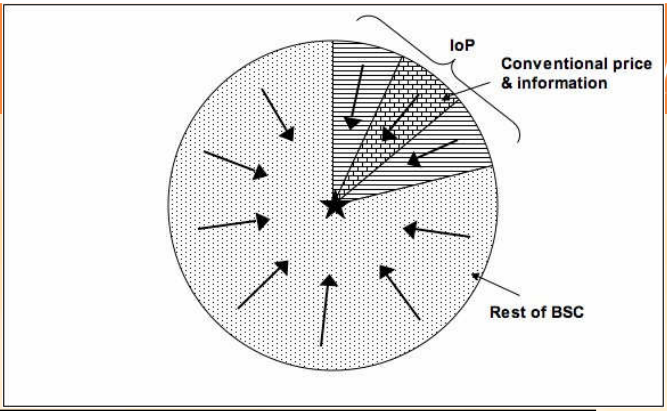
Decision-making framework 'software' and 'orgware' for a restructured energy industry

(Outhred, 2008)

Governance regime	▪ Formal institutions, legislation & policies ▪ *Informal social context including politics*
Security regime	▪ Responsible for core integrity on local or industry-wide basis, with power to override
Technical regime	▪ To allow connected industry components to function as industry-wide machine
Commercial regime	▪ To coordinate decentralised decision-making according to commercial criteria ▪ Includes formally designed markets

Decision-making influences

(Passey et al, *Economics of Distributed Energy,* 2009)

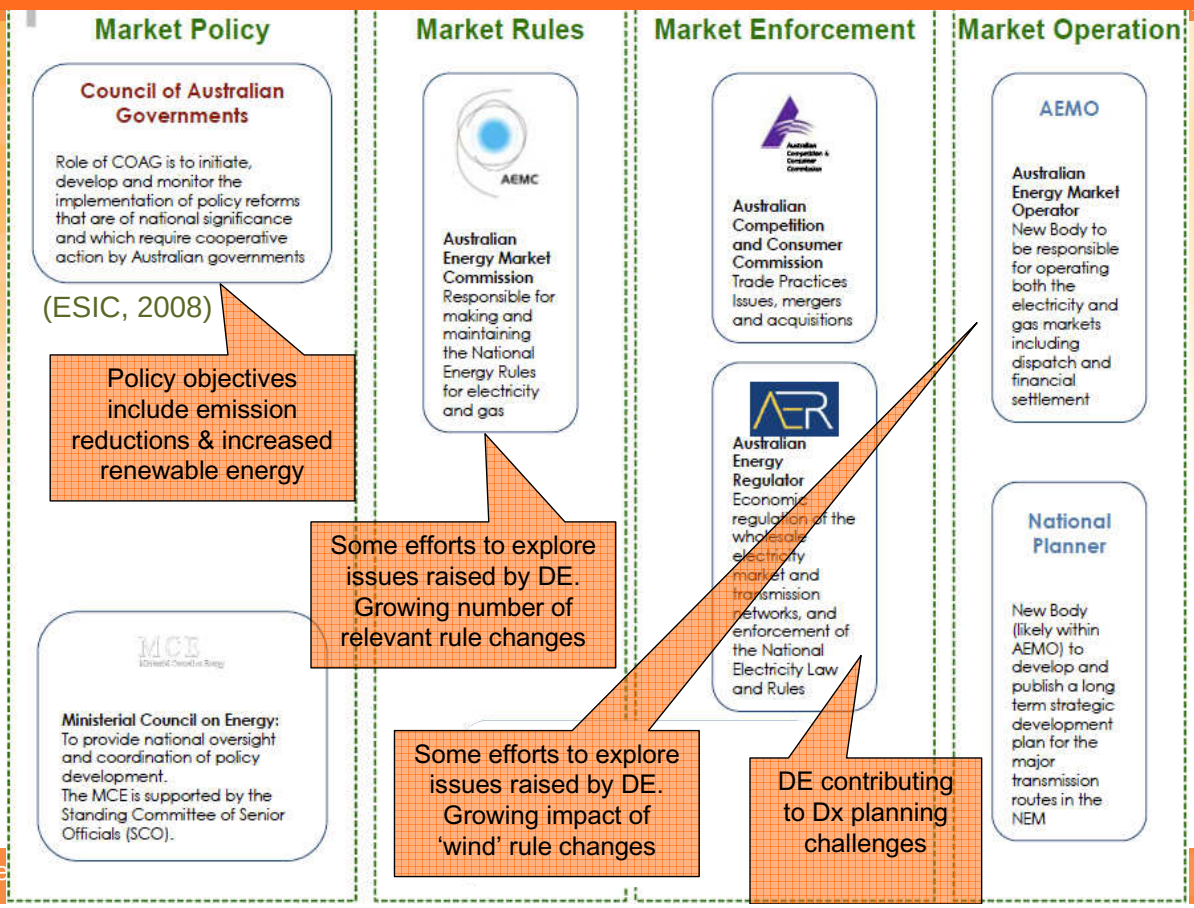


Prices & Information	▪ Appreciation of available options, anticipated costs and benefits subject to current commercial arrangements
Infrastructures of Provision	▪ Available options subject to infrastructure, linked markets, knowledge & wider institutional frameworks
Broader Social Context	▪ Decision making driven by factors far beyond rational preferences; learned behaviours, habits and practices

National Electricity Law: *Overall objective for the National Electricity Market (NEM)*

- *NEL Section 7:*
  - *The national electricity market objective is to promote efficient investment in, and efficient use of, electricity services for the long term interests of consumers of electricity with respect to price, quality, reliability and security of supply of electricity and the reliability, safety and security of the national electricity system*
- Security and Lack of environmental and wider sustainability objectives is a **design choice**
- *If societal desire that NEM contribute to achieving sustainability objectives then governments have to implement 'external' policies that will drive such changes Not an imposition but an obligation for market participants…*
- …and the NEM needs to facilitate technical, institutional and behavioural change towards such changes

Aust. stationary energy sector governance & security



DE and relevant Governance regimes

- For the NEM
  - Arrangements remain supply-side focussed; DE a disruptive set of technologies for these arrangements
  - Significant asymmetries between resources, knowledge and motivation of centralised vs DE participants
  - Insufficient attention to complex realities of end-user decision making
  - Immature gas market arrangements, DE equipment markets and more…
- More widely…
  - Poor governance in design of related environmental markets – proposed CPRS and eRET
  - Many relevant institutional and regulatory arrangements not supportive of DE – eg. planning laws, solar access, regional air quality and more

Some recent NEM developments for DE

- AEMC Review of Demand-Side Participation in the NEM, Nov 09
  - in the context of the current technology that supports DSP and subject to a number of proposed amendments to the NERs, the NEM framework does not materially bias against the use of DSP. We have found that overall the costs and opportunities to participate provided by the framework are appropriate. However, this finding is made in an environment where the vast majority of electricity use is not capable of being measured, priced, and controlled in real time. This limitation is likely to considerably constrain the ability for the demand-side to participate at low cost..."
- AEMC Review of Energy Market Frameworks wrt Climate Change Policies, Sept 09
  - "The existing Demand Management Incentive Allowance under the National Electricity Rules should be expanded to accommodate connections of embedded generators"
  - The AEMC Reliability Panel should take account of the likely interactions between the electricity and gas markets when reviewing reliability market standards and settings
  - MCE should review the existing timetable of the AEMC retail competition reviews."
- AEMC Review National Framework for Electricity Dx Planning & Expansion, Sep 09
  - "… each DNSP would establish and maintain a Demand Side Engagement Strategy. This strategy would involve DNSPs publishing a demand side engagement facilitation process document, establishing and maintaining a database of non-network case studies and proposals, and establishing and maintaining a Demand Side Engagement Register… It builds on current industry practice, and promotes a constructive working relationship between the distribution businesses and non-network providers. The strategy would work together with the Distribution Annual Planning Report and RIT-D to address a perceived failure by DNSPs to assess non-network alternatives in a neutral manner."

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

DE and the NEM technical regime

- *EI requires high levels of coordination and 'good behaviour'*
- Standards
  - **System:** required security, reliability & quality levels
  - **Access:** levels of plant performance required to connect. Technology standards that assure compliance with Access
  - *Challenges in appropriate alignment of system and access standards*
- Considerable challenges for new technologies
  - Rules generally evolve from historical practice and technologies
  - Potentially more onerous standards for new entrants than incumbents
- Ongoing efforts underway and likely to continue
  - Technical Standards for Wind Generation and other Generator Connections (2007)
- Technically immature and inadequate interface to end-users
- More general standards challenges for novel DE equipment

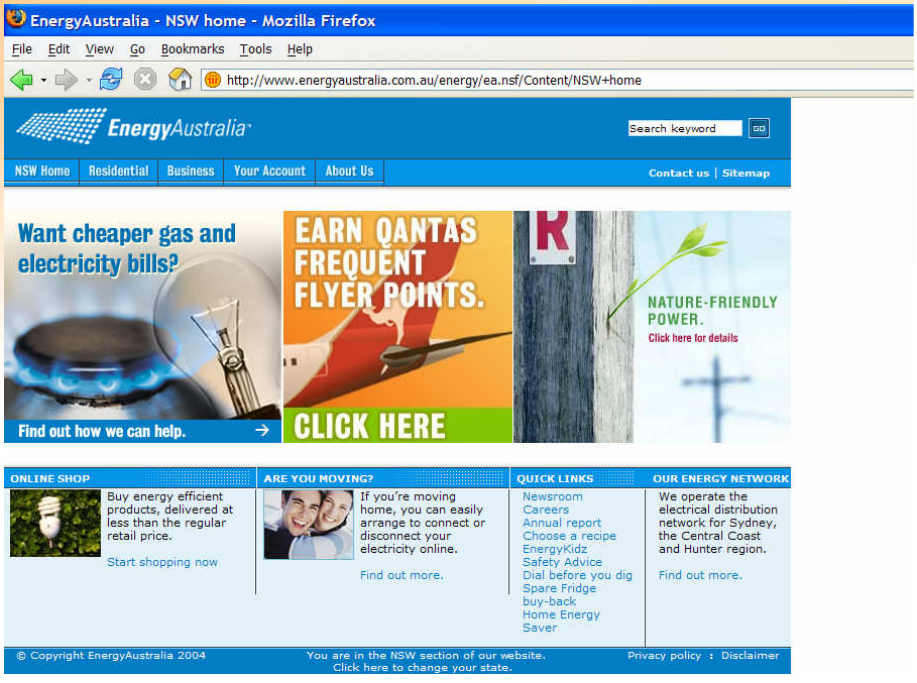
DE and NEM Security/Commercial Regimes

- NEM wholesale spot and ancillary service markets
  - appear to have performed reasonably well to date in securely & reasonably efficiently supplying growing demand & peak demand, integrating modest levels of novel technologies & managing brief periods of energy constraints
  - However, appears to be increasingly stressed and significant structural changes including 'gentailing'
- Network expenditure has grown considerably
- And retail markets where most DE resides
  - Immature competitive arrangements with inadequate metering for many end-users, simplified energy and network tariffs from flat, inclining block, TOU through to TOU and peak demand on energy and network
  - Little support for informed end-user decision making
  - *The unfinished business of restructuring*

Current Full Retail Competition limited

". an important reason there is effective competition in Victoria is "Because the provision of energy is viewed as a homogenous, low engagement service… "
AEMC, *Effectiveness of Competition in Victoria,* 2008

Current measures of competition have questionable relevance
Retail transfers – churn?
Price spreads – sticky market consumers?



Load growth driving major network expenditure

while highly attractive DE alternatives aren't taken up

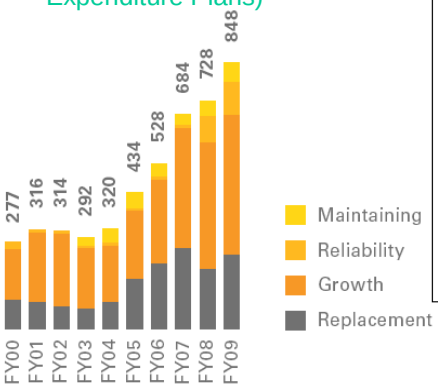
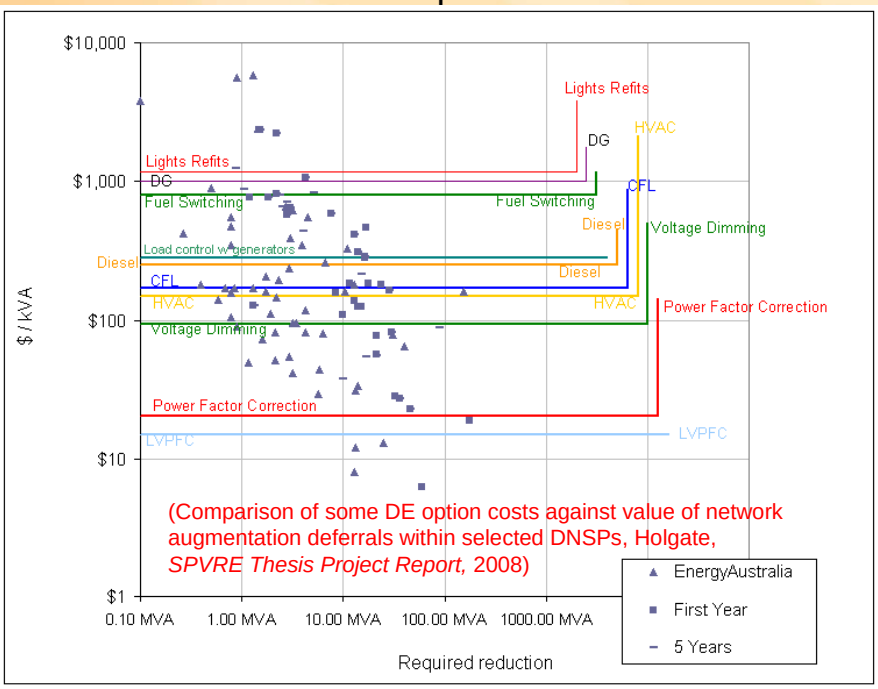


Figure 5.5: Capital expenditure by driver (FY07 $m real)

(Energy Australia, 20010-14 Expenditure Plans)



(Comparison of some DE option costs against value of network augmentation deferrals within selected DNSPs, Holgate, *SPVRE Thesis Project Report,* 2008)

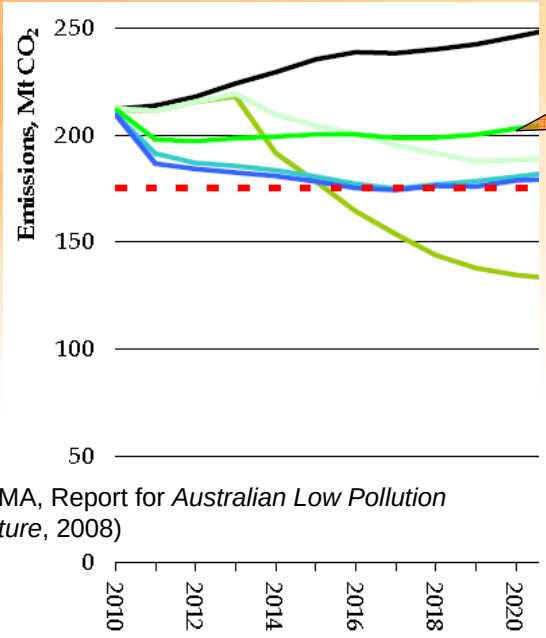
New commercial regimes relevant to DE

- **Expanded National Renewable Energy Target**
- Proposed national Carbon Pollution Reduction Scheme
  - Unclear if and when this might be implemented
- Demonstration & commercialisation funding
  - $500M Renewable Energy Fund
  - $500M National Clean Coal Fund … and counting
  - Solar Flagships (although focus is on large scale systems)
  - 'Smart grids, smart cities'
- *numerous diverse State Government policy efforts*

Possible CPRS impacts on electricity industry

- CPRS may drive little significant change to at least 2020
  - Proposed weak reduction targets, especially -5%
  - Proposed CPRS design with borrowing, price cap, unlimited use of international CDM credits, forestry opt-in, ongoing subsidies to large EITE, significant so-called 'compensation' to large electricity industry emitters subject to ongoing contribution to 'reliability', very limited targeted assistance to drive efficiency improvements or bring in low emission technologies, initial subsidies to offset fuel price increases…
  - Electricity Industry seen as the key sector for CPRS impact, however Government White Paper acknowledges CPRS unlikely to have major impacts to 2020 beyond changing new investment to lower emission options
    …. Only limited opportunities for such investment if CPRS doesn't drive exit of high emitting activities and plants… will only drive exit if destroys value of large emitters – is there political will for this?

Treasury modelling – EI emission reductions

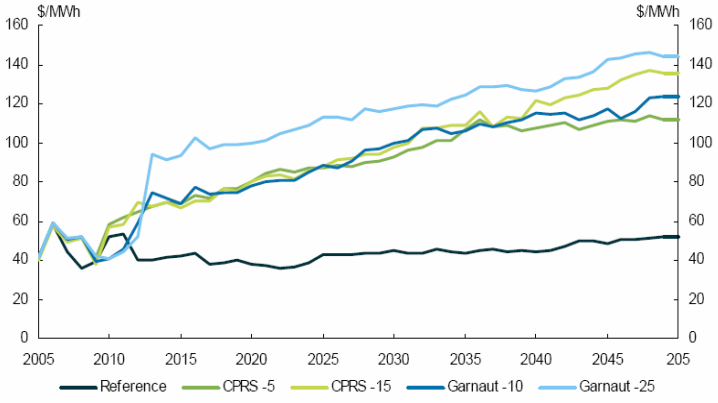


(MMA, Report for *Australian Low Pollution Future*, 2008)

CPRS without eRET scenario: virtually no reduction from current emission levels to 2020

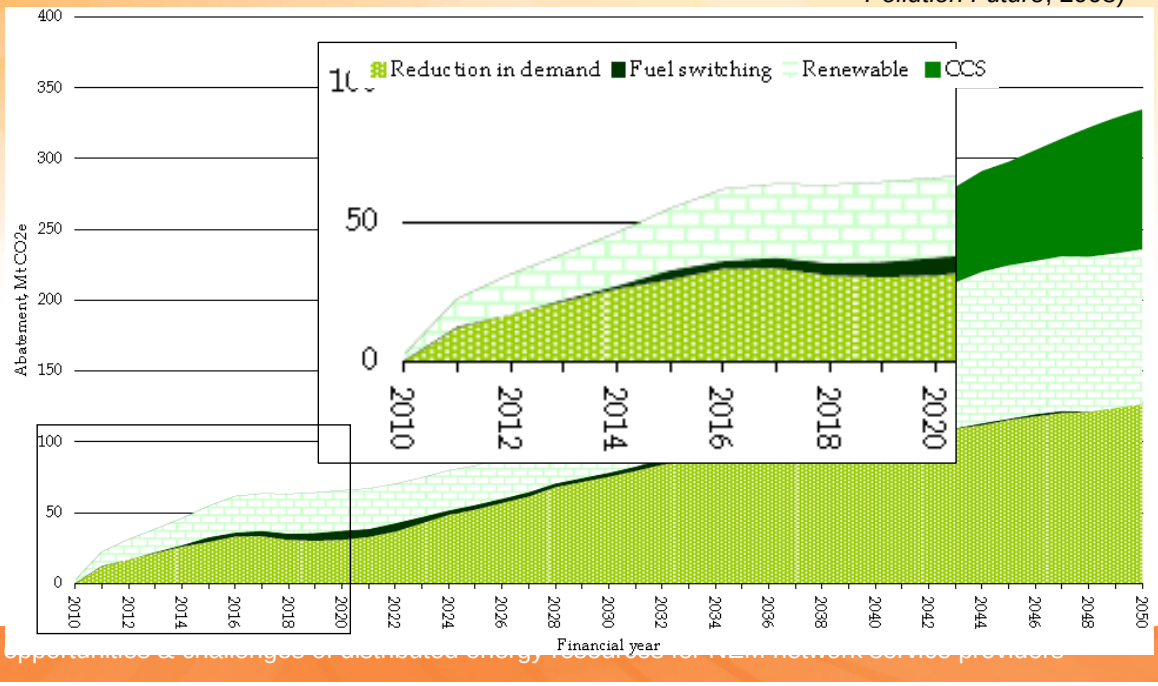
Scenarios suggest significant cashflows … but what do they actually achieve?

Chart 6.27: Average Australian wholesale electricity prices



Treasury modelling – source of EI emission reductions

(MMA, Report for *Australian Low Pollution Future*, 2008)



MRET… + eRET– 'designer' markets

Succeed or fail on quality of governance

The objects of this Act are:

(a) to encourage the additional generation of electricity from renewable sources; and

(b) to reduce emissions of greenhouse gases; and

(c) to ensure that renewable energy sources are ecologically sustainable.

RE Certificates representing 1 MWh of new 'renewables'

non-zero baseline if pre-1997

REC providers
Deliver certified new Renewables to create RECs

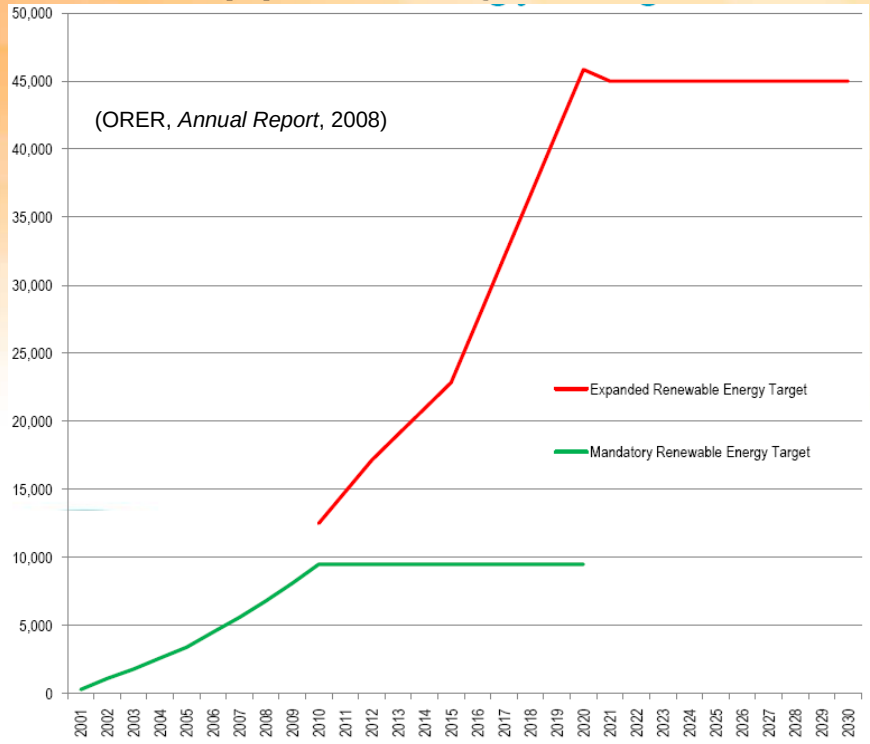
RE Certificate trading
To improve economic efficiency

Liable parties
Obliged to acquit RECs as part of societal obligation

Initially set as 9500 GWhyr 2010-20

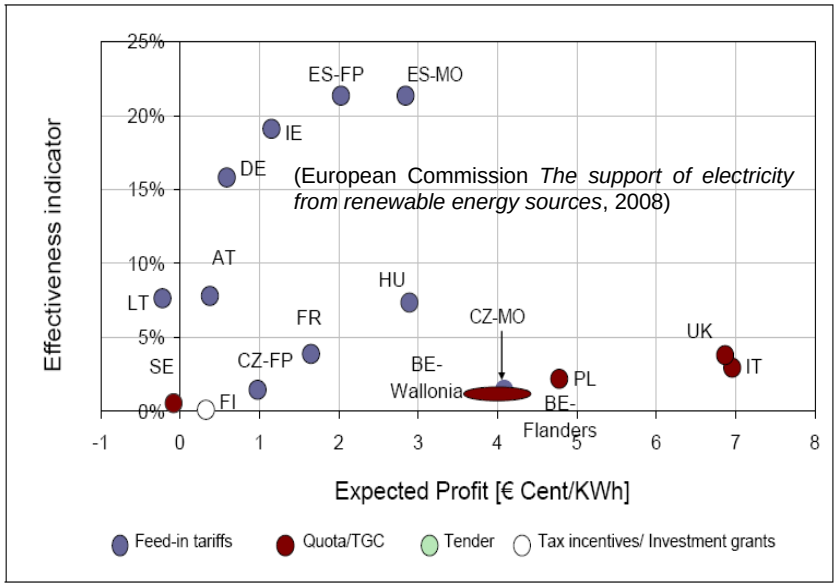
Certify Certificates | Maintain register | Ensure liable parties oblige
Scheme administrator

The eRET opportunity



MRET performance to date… and for 2020?

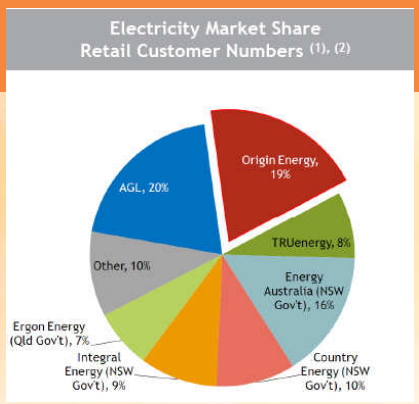
- **To date:** modest ramping target easily met + considerable new investment with apparent efficiency – low subsidy $/MWh by international standards
- **Yet:** international experience generally poor with certificate schemes for reasons that seem to include governance capture by incumbents, risks for developers, market power on 'buy' side, single price for all
- **NEM** increasingly stressed infrastructure, changing structure including gentailers
- **Hence,** past modest success no guarantee of future performance with a significant target



eRET design

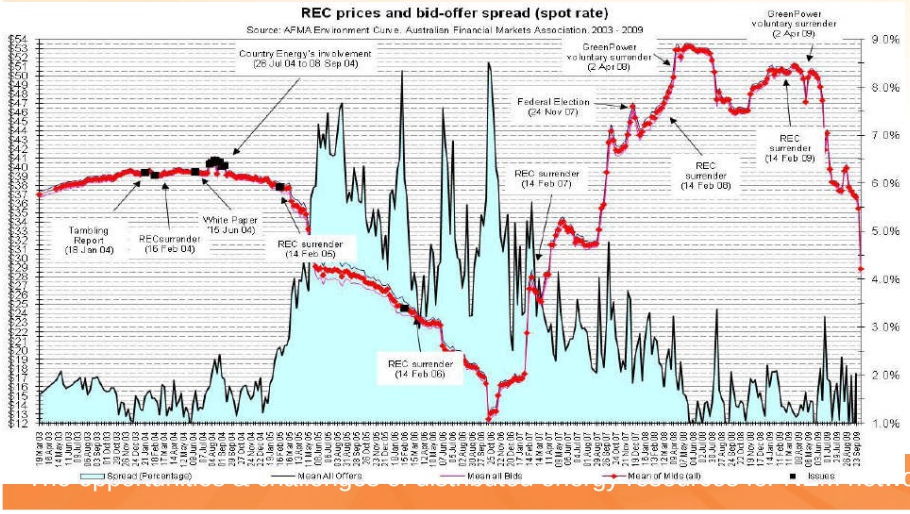
- Eligible sources
  - same criteria as current MRET scheme including solar hot water:
  - Comment: SHW is not renewable electricity generation – weakens target. Inclusion of Heat Pumps even more problematic – an energy efficiency option
- Project eligibility periods and treatment of existing generators
  - No limit to timeframe within which projects may create RECs.
  - All existing projects eligible under MRET eligible for eRET for life of scheme
  - Comment: projects financed on basis of 2020 target now earn RECs for another 10 years including 'old hydro' earning windfall profits
- REC multiplier for small generators (first 1.5kW of system capacity)
  - 5 RECs/MWh of deemed renewable energy to June 2012, ramping down to 1 REC/MWh from July 2015
  - Comment: Phantom RECs reduce real target. Feed-in tariffs likely a better choice for small generators. eRET should not be expected to address all policy 'gaps'
- Non-participation by EITE consumers in paying for eRET
  - Comment: governance appears to be going backwards – MRET 'principle' of paying according to usage abandoned

Early challenges for eRET



(Origin, *Presentation to JP Morgan Australian Corporate Access Days*, 2009)

(ORER, *2008 Annual Report*, 2009)



(IES, *eRET Report to CEC*, 2009)

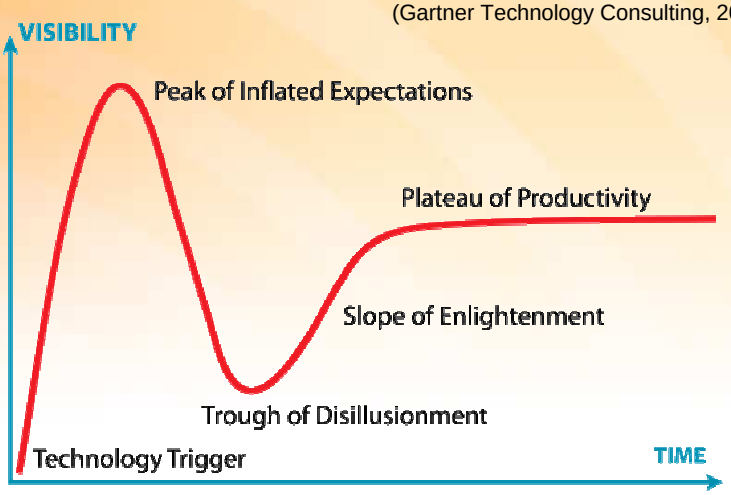
Fuel Type	2008	2009 (to 9/10)
Solar Water Heater	2,994,001	5,842,677
S.G.U. - Solar	377,241	868,839
Wood Waste	105,391	123,781
Energy Crops	-	9,705
S.G.U. - Wind	518	668
S.G.U. – Hydro	132	170
Photovoltaic	2	-
Agricultural Waste	375	329
Food Processing Waste	58	-
Solar	2,598	1,261
Food Waste	7,787	5,433
Agricultural Waste	13,469	10,151
Municipal Solid Waste	71,817	66,178
Sewage Gas	73,307	61,467
Black Liquor	100,823	63,393
Bagasse	518,503	393,655
Wind	3,126,324	2,995,505
Landfill Gas	712,664	557,436
Hydro	632,576	185,986
Total	8,737,586	11,186,634

DE, AMI and Smart Grids (Outhred, 2008)

- A wide range of claimed opportunities, many representing modest extensions to current industry arrangements
- **Our view**, the key objective for the "smart grid" concept is:
  - Coordinated, decentralised investment in & operation of distributed resources to deliver net societal benefits
- Key requirements in achieving this objective are:
  - Advanced metering and 'smart grid' infrastructure including communications, distributed intelligence
  - A formal decision-making framework to allocate authority & accountability to decentralised decision-makers
  - A formal incentive/penalty regime to align the incentives of decentralised decision-makers with societal objectives
- *AMI the missing technical interface for a restructured energy industry*

Smart grids and the hype cycle

(Gartner Technology Consulting, 2009)



- Technology Trigger: A potential technology breakthrough kicks things off. Early proof-of-concept stories and media interest trigger significant publicity. Often no usable products exist and commercial viability is unproven.
- Peak of Inflated Expectations: Early publicity produces a number of success stories—often accompanied by scores of failures. Some companies take action; many do not.
- Trough of Disillusionment: Interest wanes as experiments and implementations fail to deliver. Producers of the technology shake out or fail. Investments continue only if the surviving providers improve their products to the satisfaction of early adopters.
- Slope of Enlightenment: More instances of how the technology can benefit the enterprise start to crystallize and become more widely understood. Second- and third-generation products appear from technology providers. More enterprises fund pilots; conservative companies remain cautious.
- Plateau of Productivity: Mainstream adoption starts to take off. Criteria for assessing provider viability are more clearly defined. The technology's broad market applicability and relevance are clearly paying off.

Some Australian experience with commercial DE opportunities

- "THE THREE CASE STUDIES PARTICULARLY HIGHLIGHT THE KEY ROLE OF IOP INFLUENCES OTHER THAN STRICT PROJECT FINANCIALS IN DRIVING DECISION MAKING. FOR EXAMPLE:
  - Cogeneration presents excellent opportunities but delivering projects is hampered by poor information on network issues, onerous assessments of possible local air quality impacts, overly strict regulation of operation and poorly defined processes (Property Council, 2009)
  - Innovative HVAC options have been hampered by a lack of technical capacity and knowledge from local equipment suppliers, measurement and verification challenges and significant risk aversion by owners and occupiers (DMPP, 2006)
  - Backup generators have been identified as a Demand Management opportunity yet opportunities are extremely context specific, much of the existing plant isn't technically appropriate for connection while network protection and fault ratings can also preclude projects, Development Approvals, operating licences and EPA requirements may restrict operation to emergency standby and the planning process is highly onerous (DMPP, 2006; Orbis, 2006)"

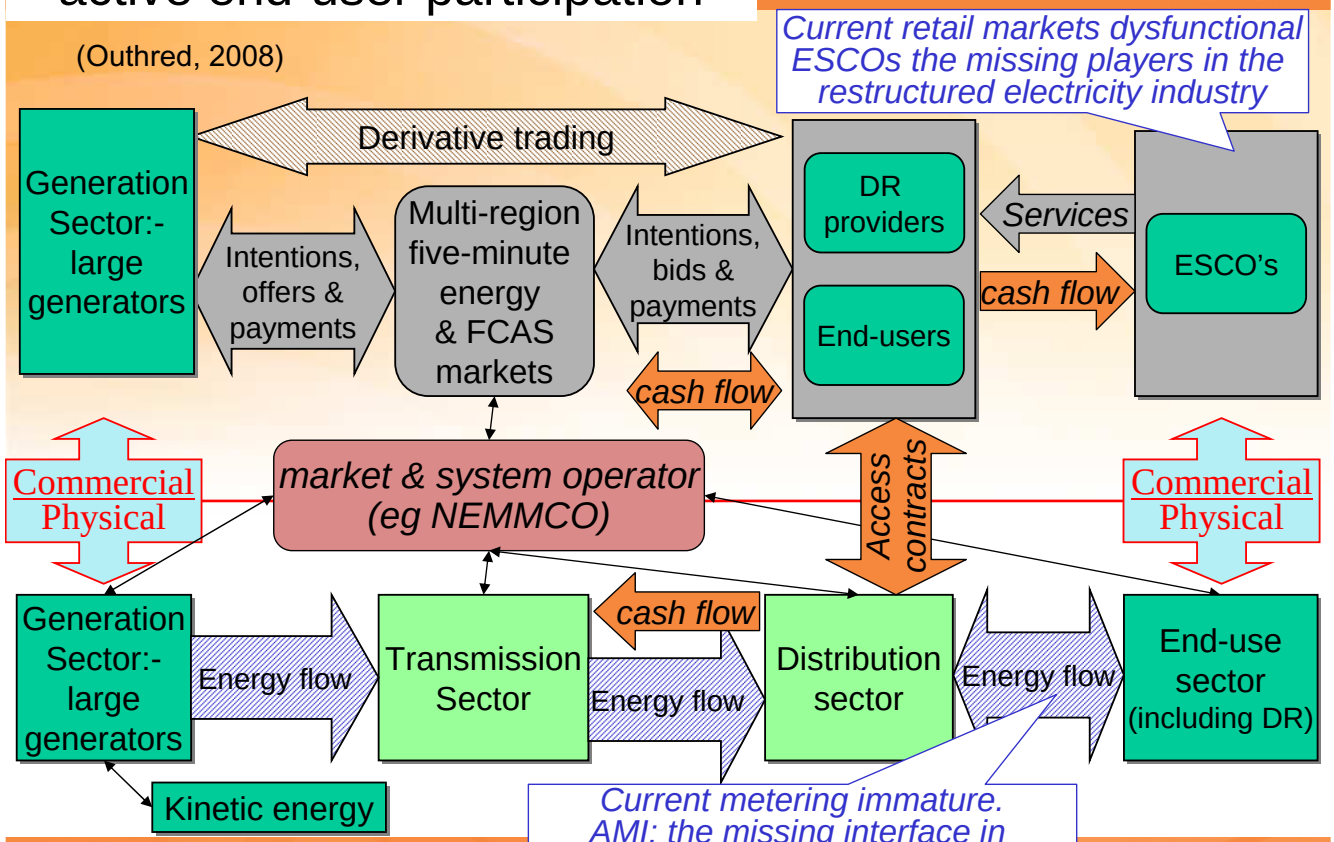
Passey and MacGill (2009) *Economics of Distributed Energy*, Report to CSIRO.

DE and Energy Service Companies (ESCOs)

- Role is to support end-users in meeting their energy service requirements in the most appropriate manner
- The complexity of some DE options is near overwhelming for the end-users who will often own and operate the equipment
- ESCOs can help manage this complexity through specialist knowledge and motivation that end-users lack
- Find it easier to work with commercial & industrial end-users (eg energy contracting) than residential end-users
- Require efficient energy market pricing – spot and forward – and hence the ability to receive appropriate value from DE options
- Require appropriate wider policy frameworks that recognise the wider values of DE options
- *ESCOs the missing institutional interface between end-users and the energy industry*

Enhanced NEM structure with active end-user participation

(Outhred, 2008)



Wider policy frameworks to address externalities

- Emissions trading to date largely a debacle
  - EU ETS has had very limited impact on emissions yet sending extraordinary cashflows to large emitters and other major energy market participants
    - Little support for DE beyond higher yet increasingly uncertain energy prices – will this be sufficient to drive major change?
- Renewables deployment
  - Some measures have achieved far greater success in reducing emissions, establishing new industries & beginning transformation of electricity industries
  - Challenge of finding policy approaches that maximise electricity industry value of DE while driving transformation
    - Mixed experience with some Green Certificate schemes
    - Feed-in tariffs demonstrated success but 'hide' energy market signals
- Distributed Energy
  - Diversity of technologies and opportunities will require comprehensive & coherent policies wrt information, regulation & incentives sufficient to overcome existing barriers

Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA

Thank you… and *questions*

Comments, suggestions and corrections regarding this presentation are all welcome. Please contact Iain at i.macgill@unsw.edu.au

This and many other of our publications and presentations are available at: www.ceem.unsw.edu.au