Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA

The economics of distributed energy - drivers for increasing uptake

IBC Decentralised Energy Conference
Sydney, 9-10 June 2009

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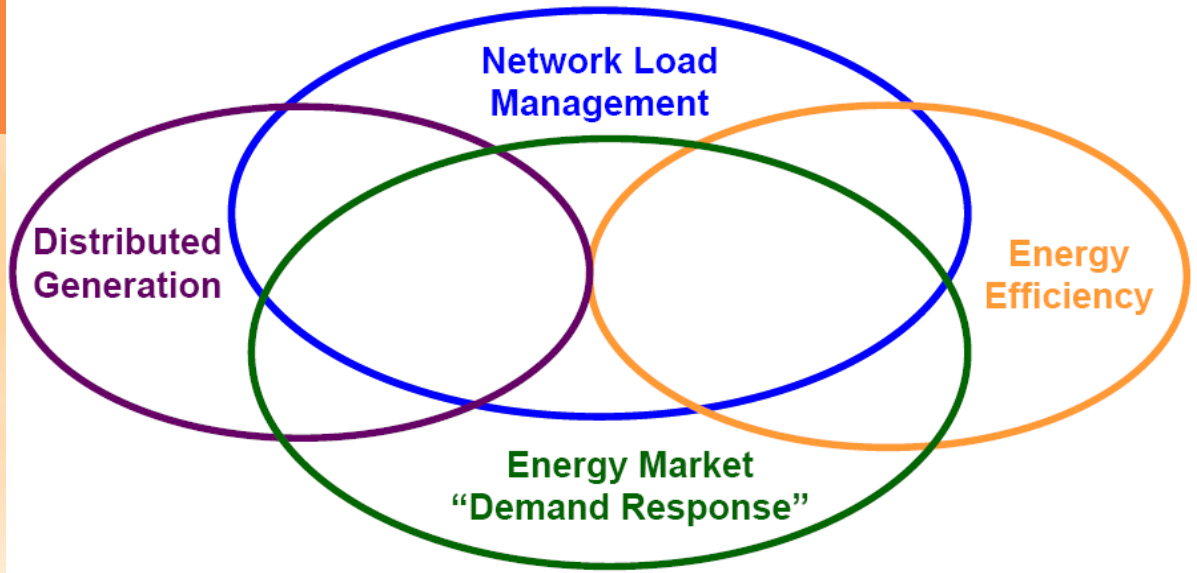
CEEM

- *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…

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 use of renewable energy resources or highly efficient fossil-fuel use (eg. Cogen)
  - Opportunities for greater end-user engagement in achieving energy services

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
    - 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
    - '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

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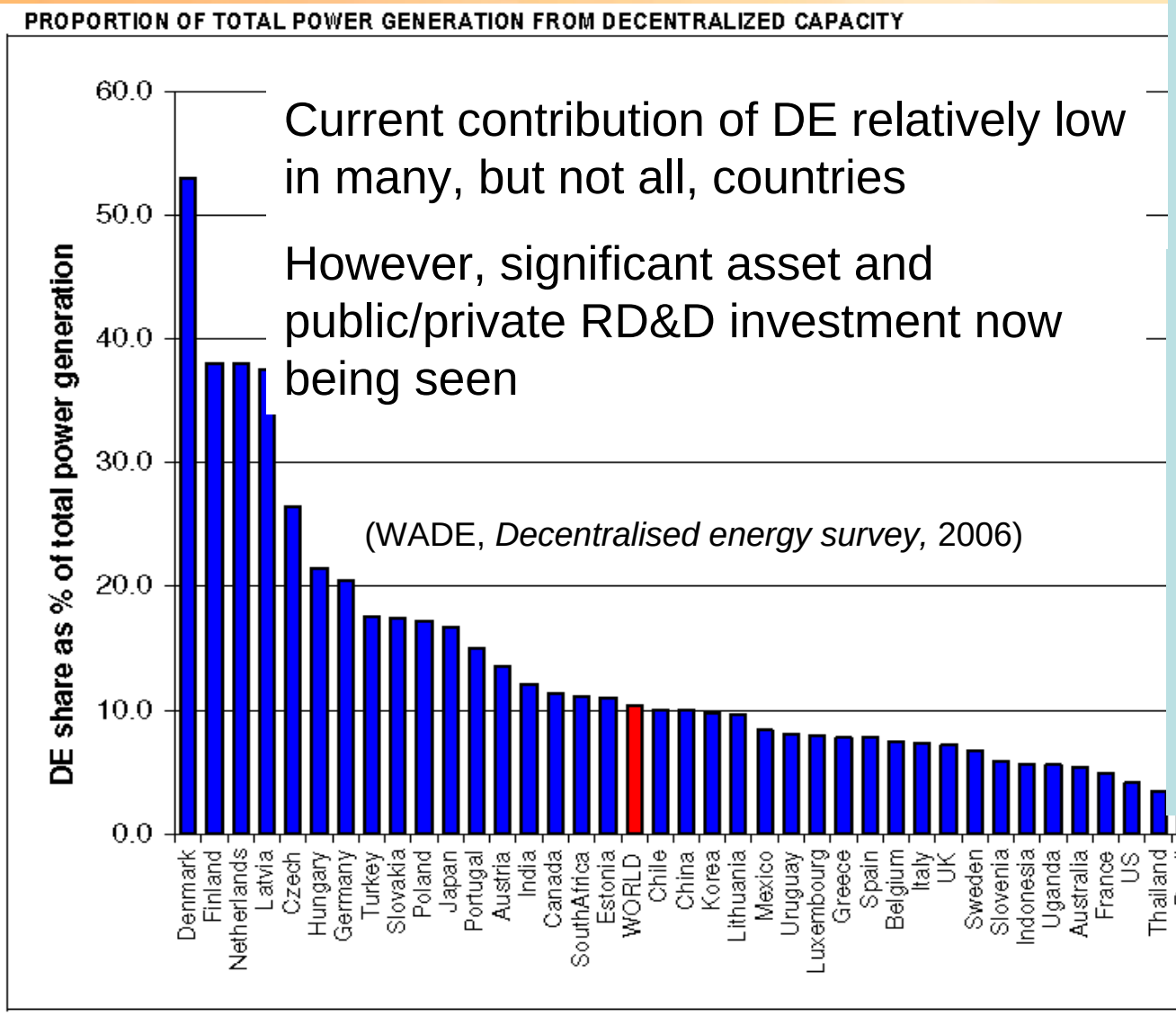
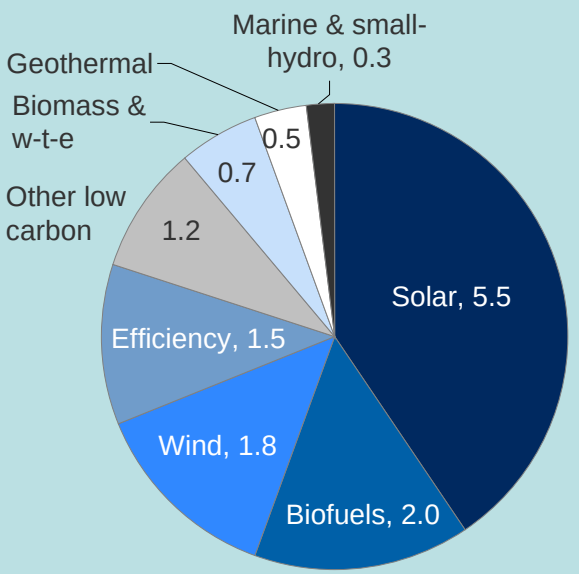
Current status of DE

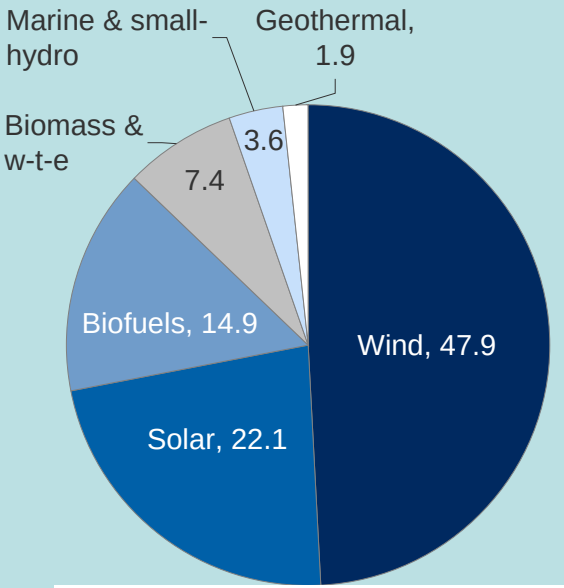


Current contribution of DE relatively low in many, but not all, countries

However, significant asset and public/private RD&D investment now being seen

(WADE, *Decentralised energy survey,* 2006)

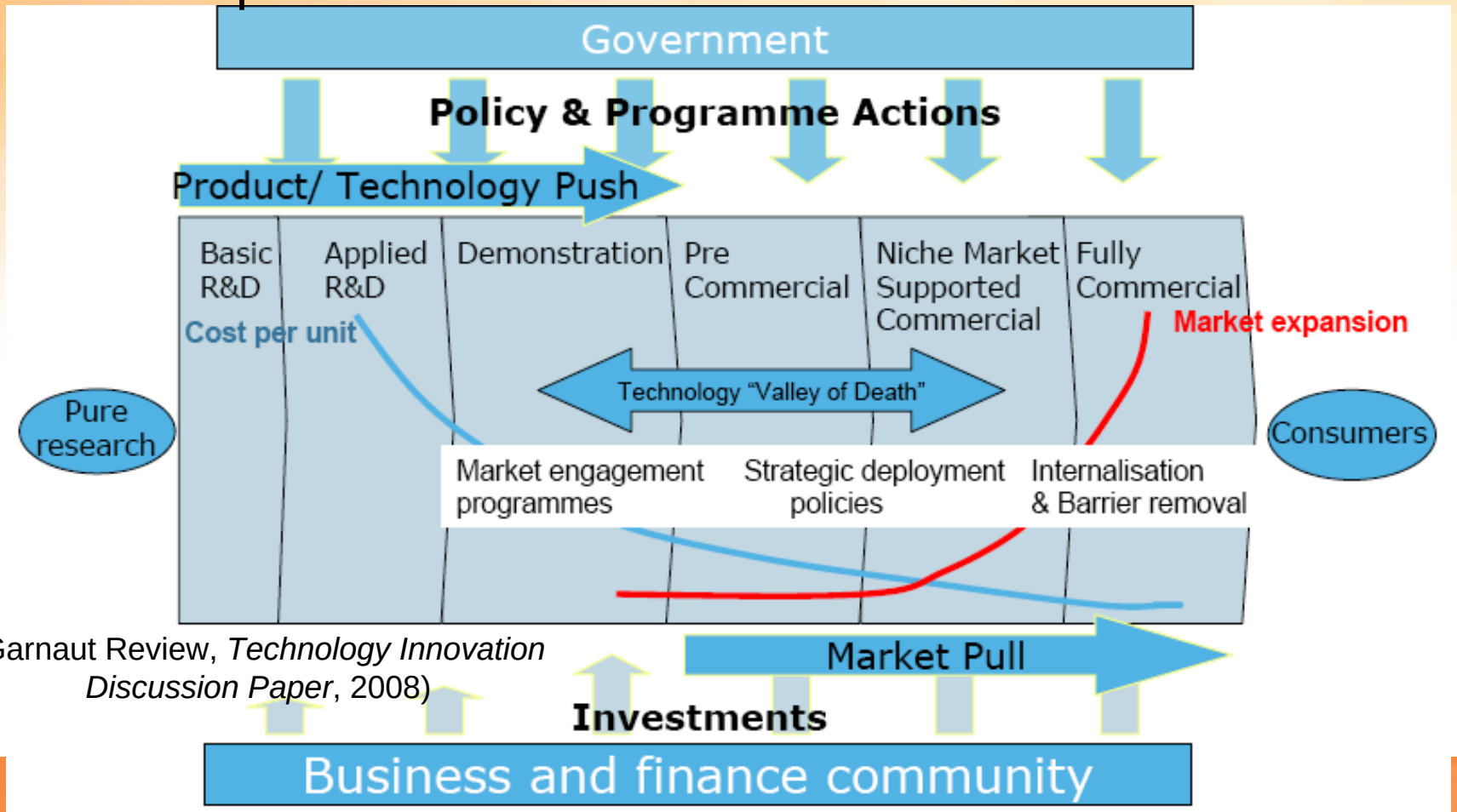




2008 US$b global investment in sustainable energy assets (above) and V/C PE (below) (UNEP, *Global Trends in Sustainable Energy,* 2009)

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

Software

Orgware

Hardware: Manufactured objects (artifacts)

Software: Knowledge required to design, manufacture, and use technology hardware

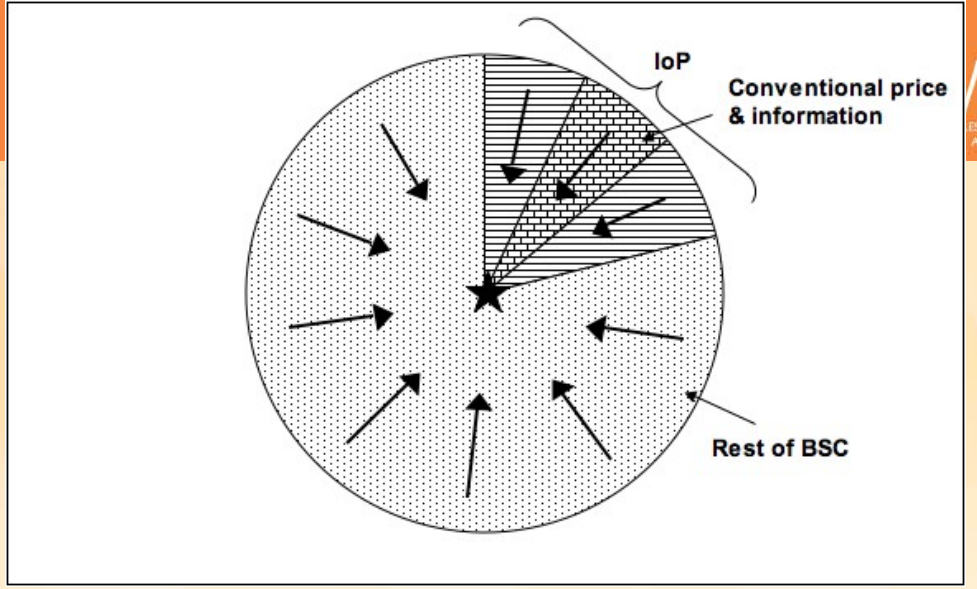
"Orgware": Institutional settings and rules for the generation of technological knowledge and for the use of technologies

Decision-making framework 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

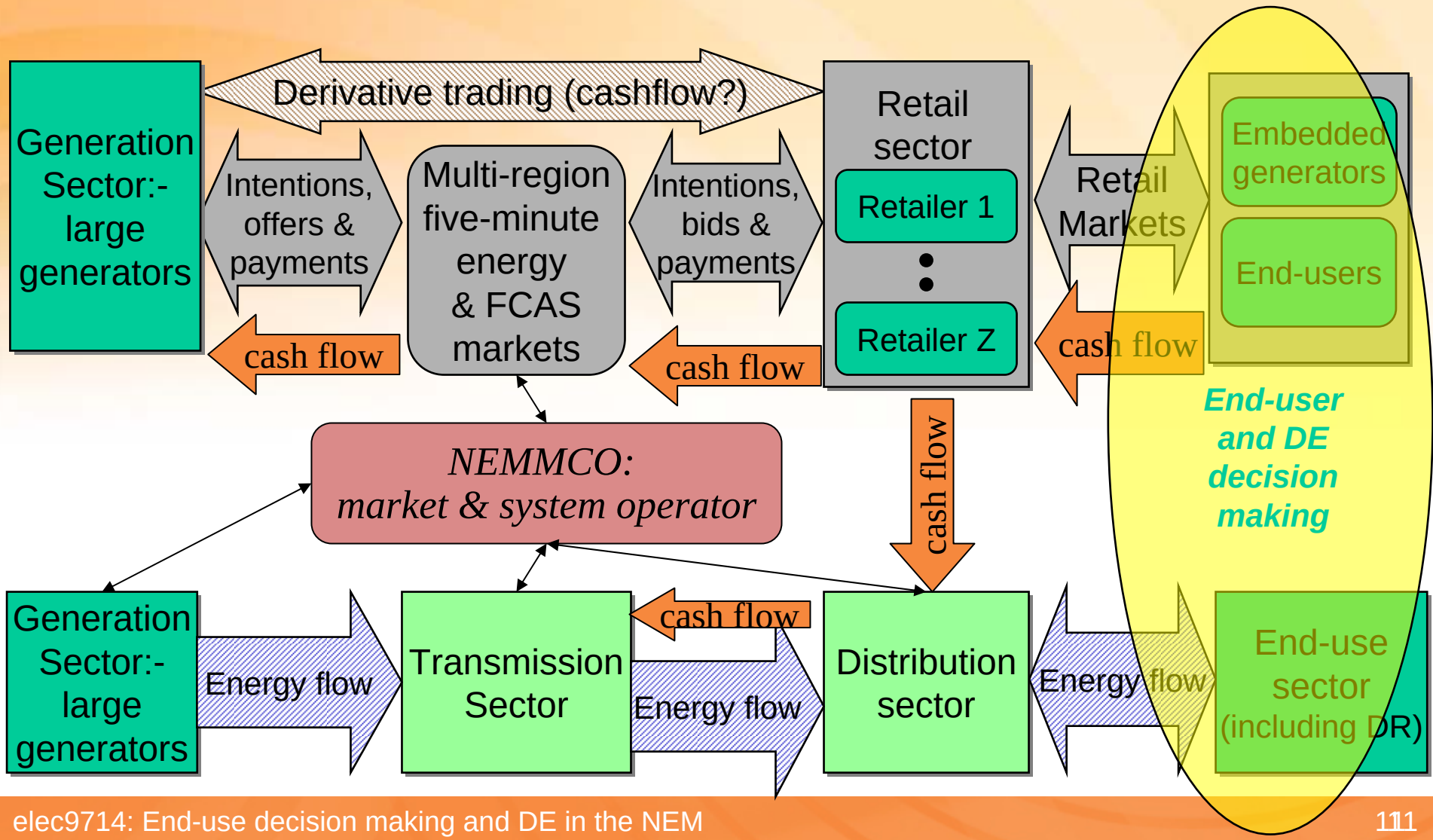
Decision-making influences

(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

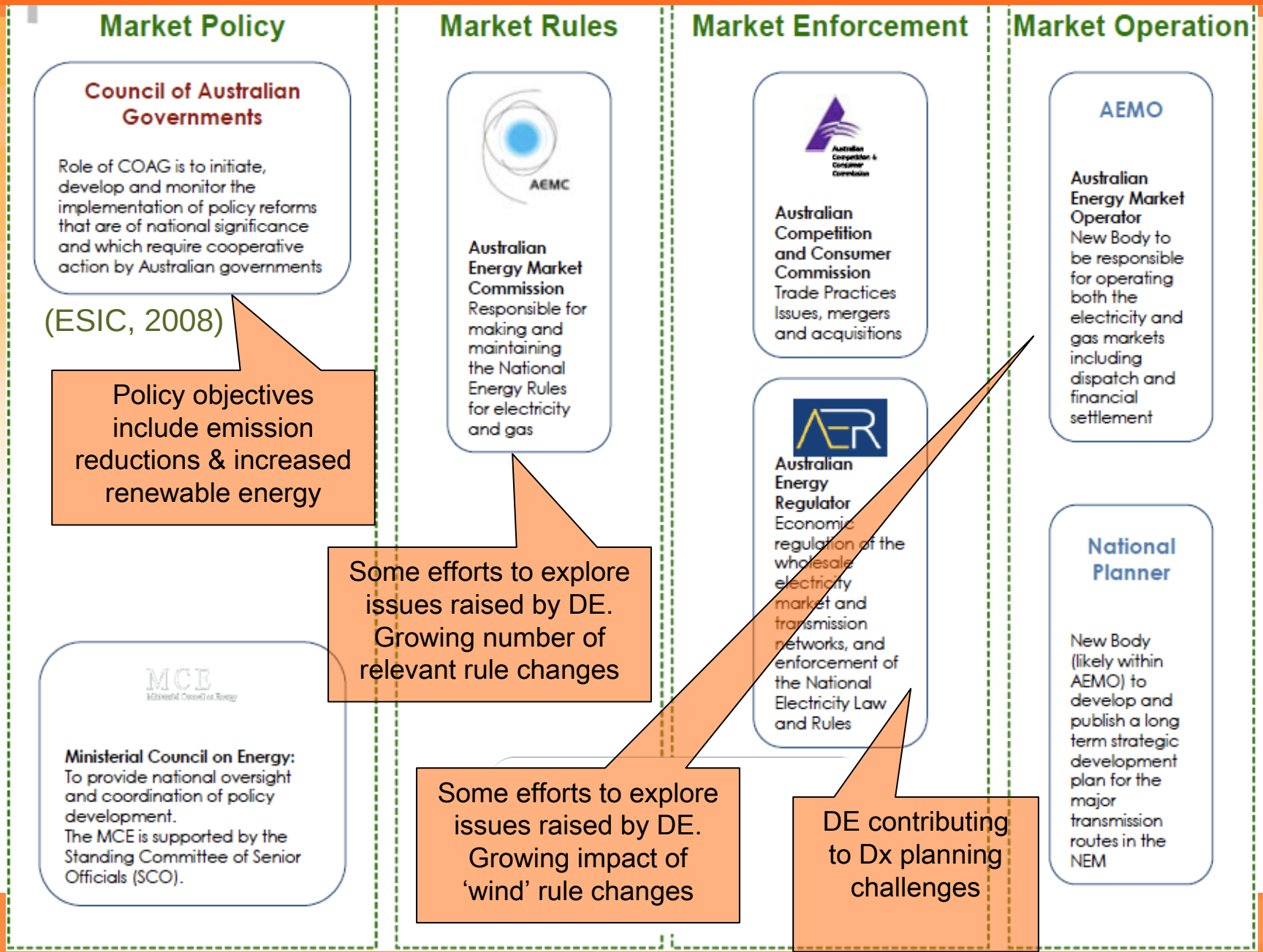
Industry structure & decision-making in the NEM



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*
- 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 very 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
- 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 ….

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

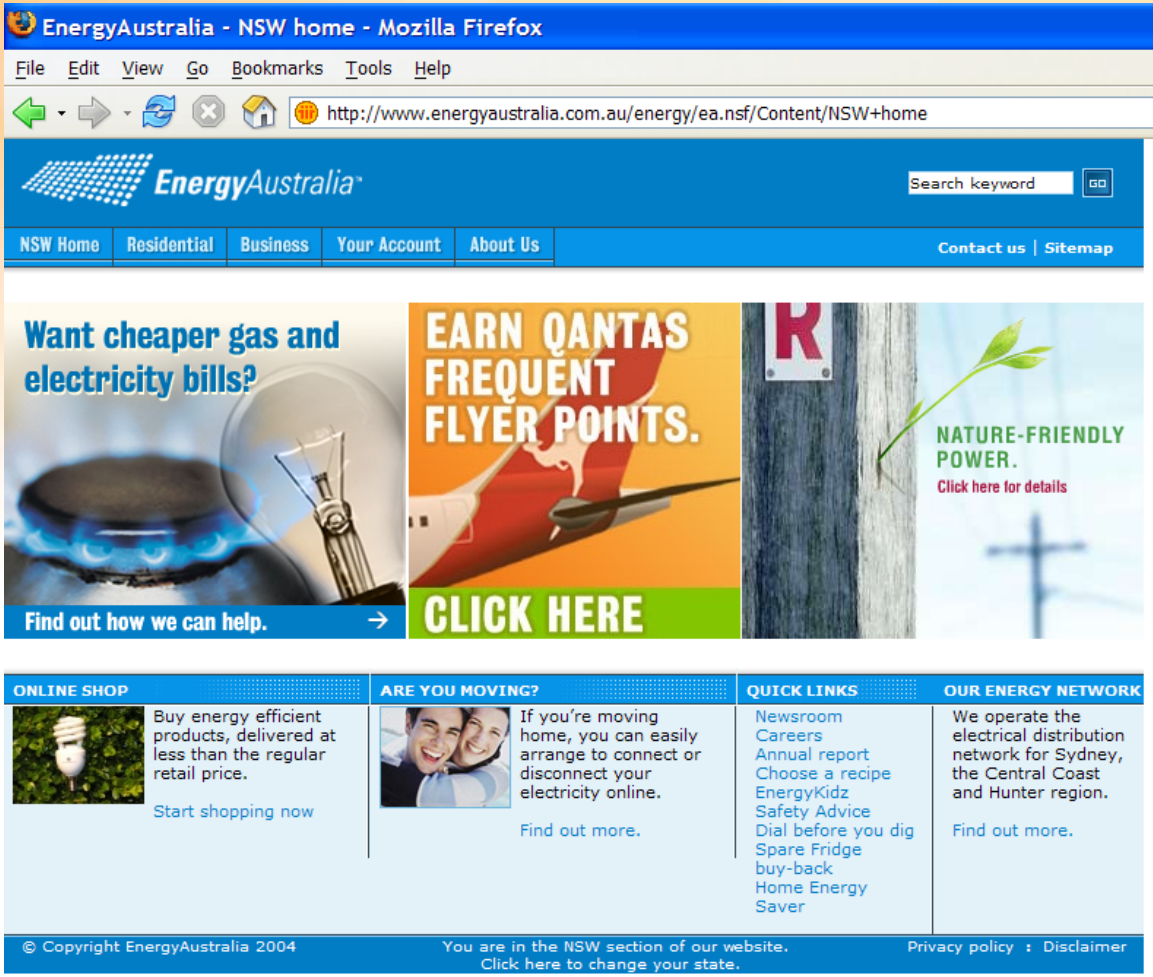
". an important reason there is effective competition in Victoria is "Because the provision of energy is viewed as a homogenous, low engagement service… "

AEMC, *Effectiveness of Competition in Victoria,* 2008

Current measures of competition have questionable relevance

Retail transfers – churn?

Price spreads – sticky market consumers?

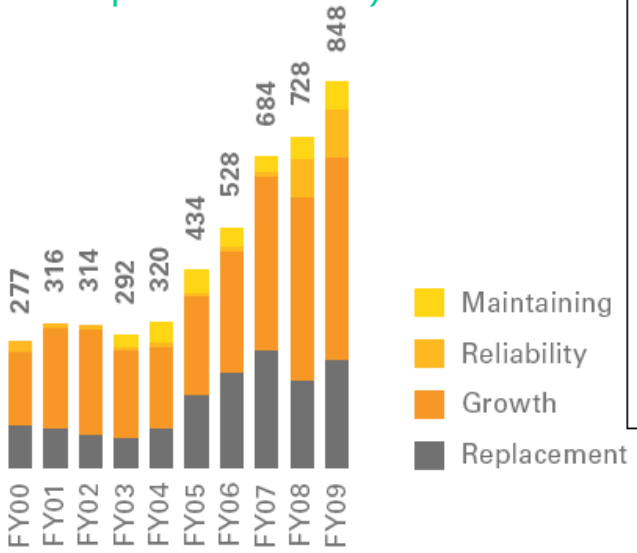


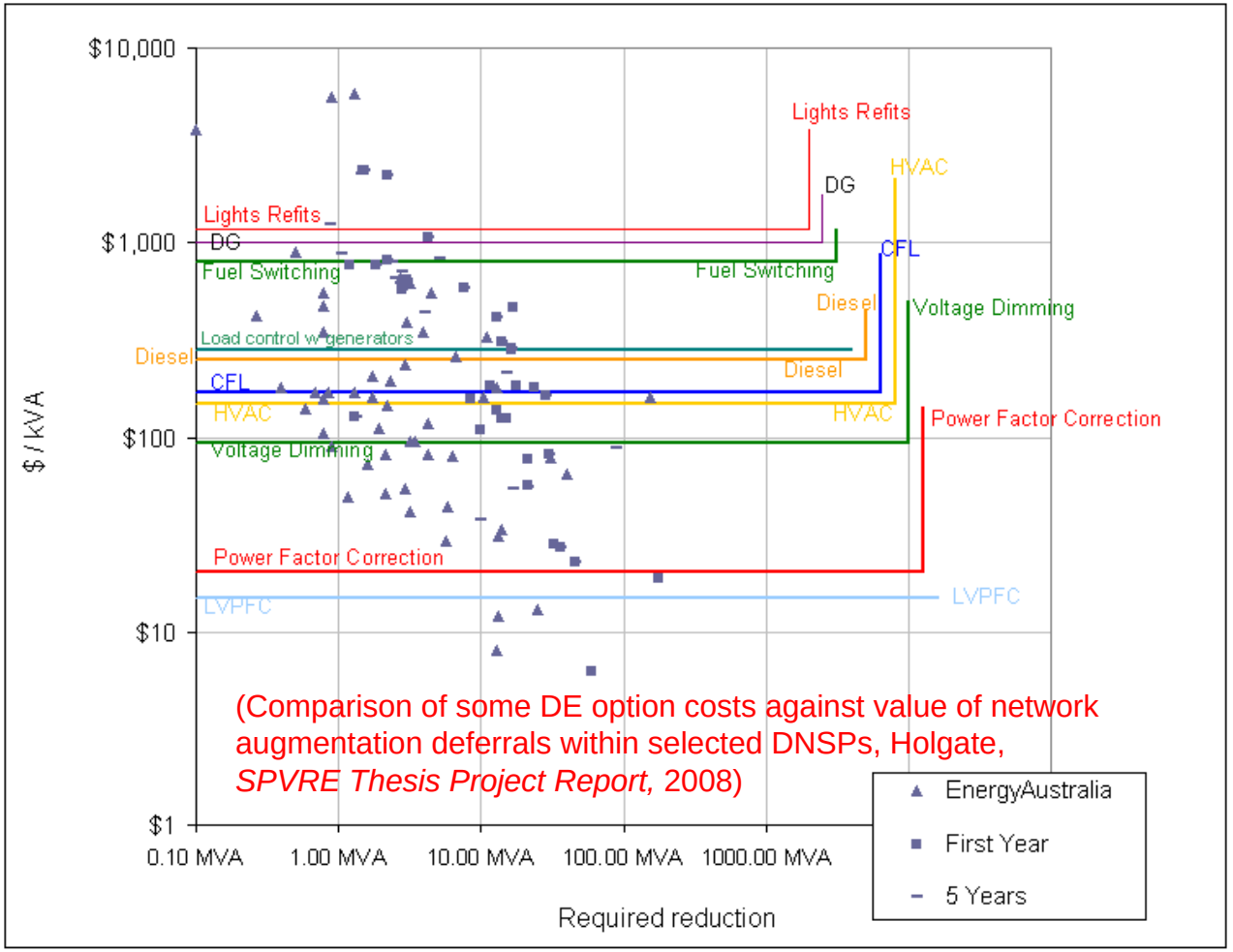
Load growth driving major network expenditure

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)

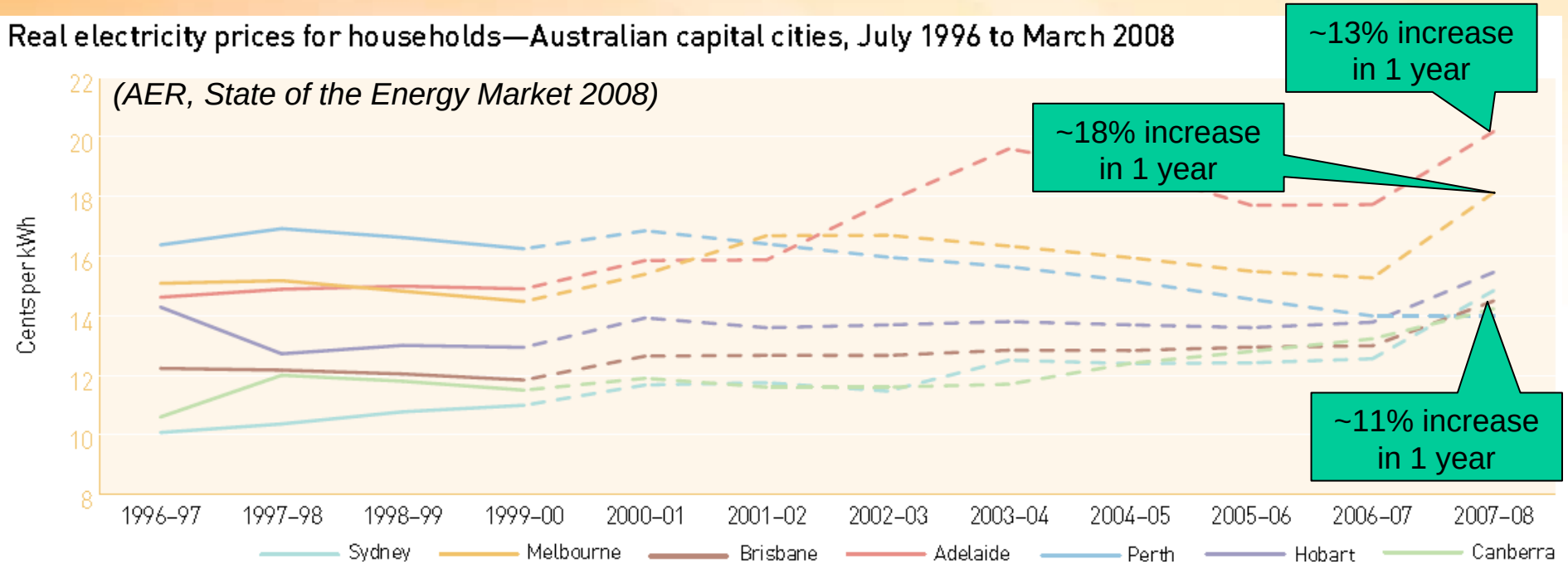




(Comparison of some DE option costs against value of network augmentation deferrals within selected DNSPs, Holgate, *SPVRE Thesis Project Report,* 2008)

Steady or falling end-user prices… are now rising

- Considerably greater price reductions for business than households… almost all energy user prices now rising



New commercial regimes relevant to DE

- **Expanded National Renewable Energy Target**
  - exposure draft legislation 12/08
- Carbon Pollution Reduction Scheme
  - exposure draft legislation 12/08
- Demonstration & commercialisation funding
  - $500M Renewable Energy Fund
  - $500M National Clean Coal Fund … and counting
- *numerous diverse State Government policy efforts*

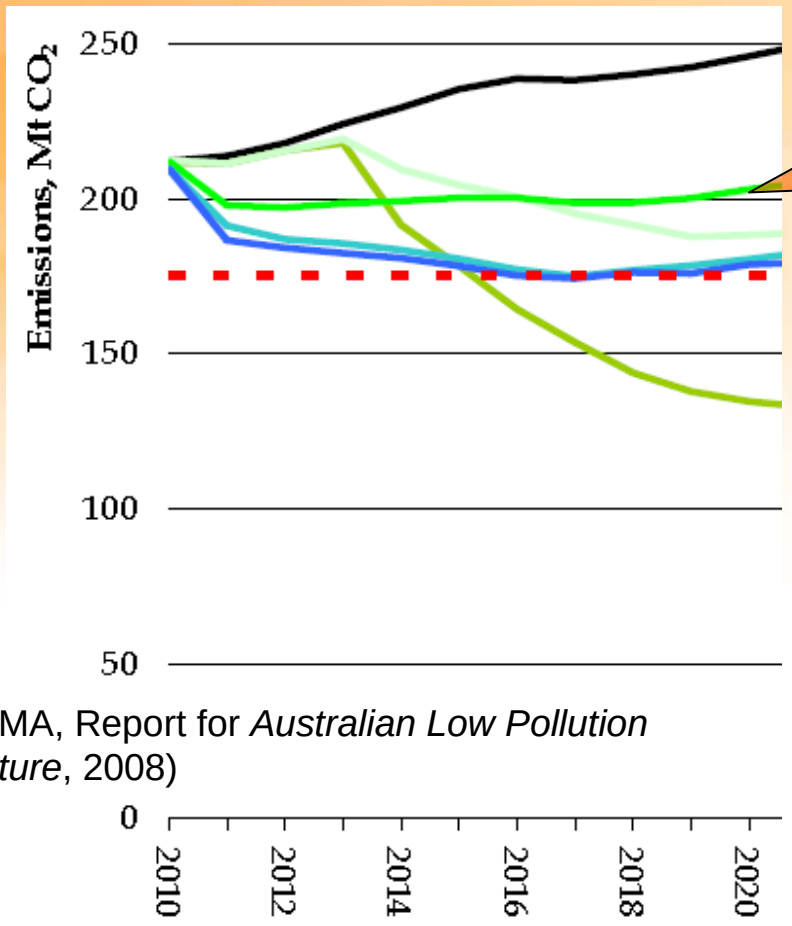
Australia's proposed CPRS

- Emissions Trading for Australia first proposed in late 1990s, have seen State-based efforts (GGAS) and proposals (NETT), fomer Federal Government task group design
- New Federal Govt's primary proposed climate policy response
  - Wide coverage: 70%+ of emissions
  - Carbon price intended to impact right across the economy
  - A set of existing and promised other policies for renewable energy, technology innovation but intention is such policies will be increasingly unnecessary as CPRS expands scope and influence
- Implementation closely linked to national emissions targets because CPRS covers and therefore caps most Australian emissions closely linked to national emission targets

Possible CPRS impacts on NEM

- CPRS risks driving little significant change in NEM to 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, very limited targeted assistance to drive electricity consumption reductions or bring in low emission technologies, subsidies & capacity requirements for high emitting coal plants
  - *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 plant… will only drive exit if destroys value of large emitters – is there political will for this?*
  - Uncertain impacts of global economic crisis on economic growth, electricity demand
- eRET may well prove to be a far more significant policy test of NEM design & structure

Treasury modelling – EI emission reductions

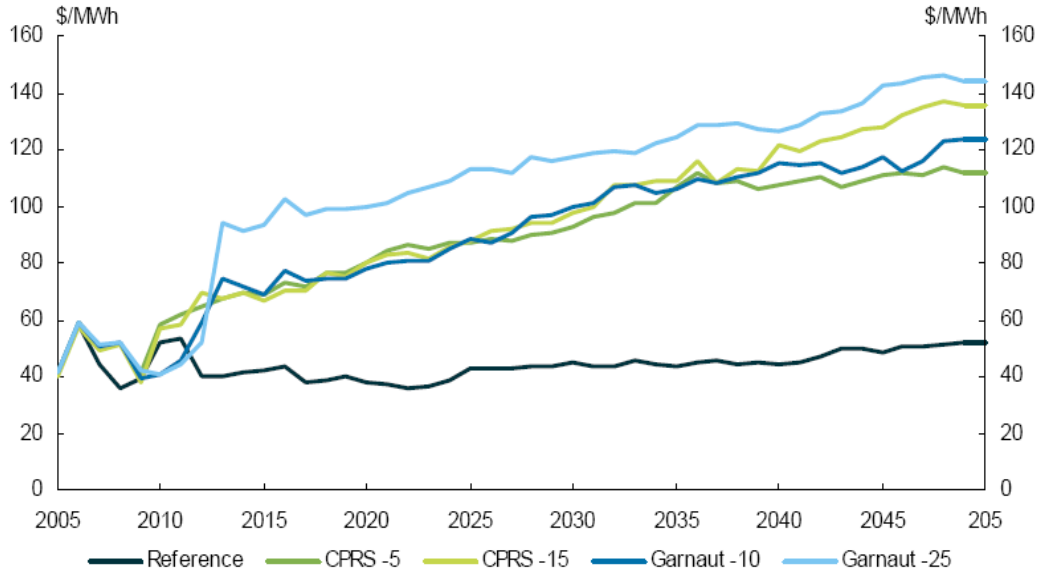


(MMA, Report for *Australian Low Pollution Future*, 2008)

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

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

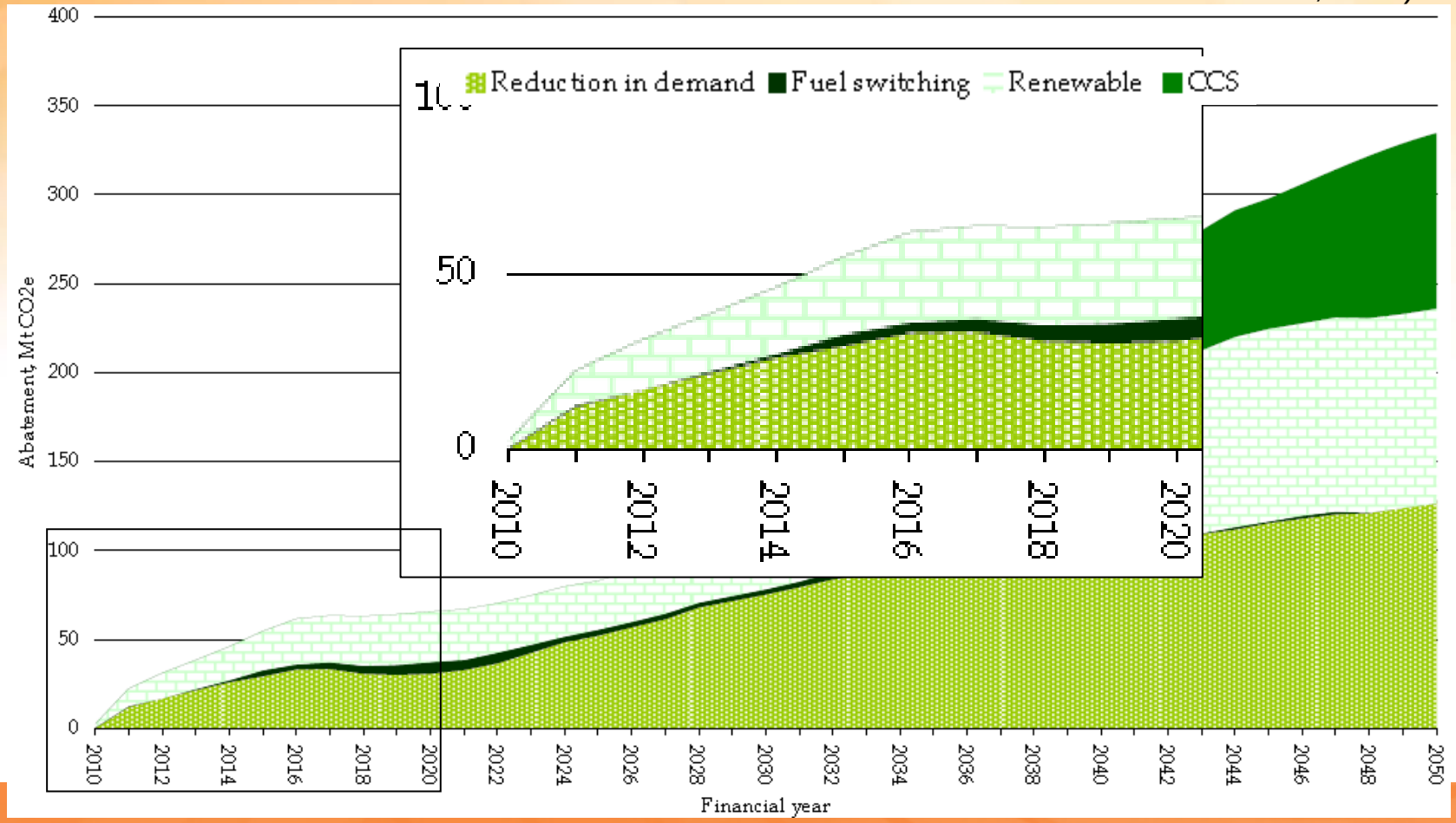
Chart 6.27: Average Australian wholesale electricity prices



Reference Garnaut -25 Garnaut -10 CPRS only CPRS -5 CPRS -15 2000 Emissions

Treasury modelling – source of EI emission reductions

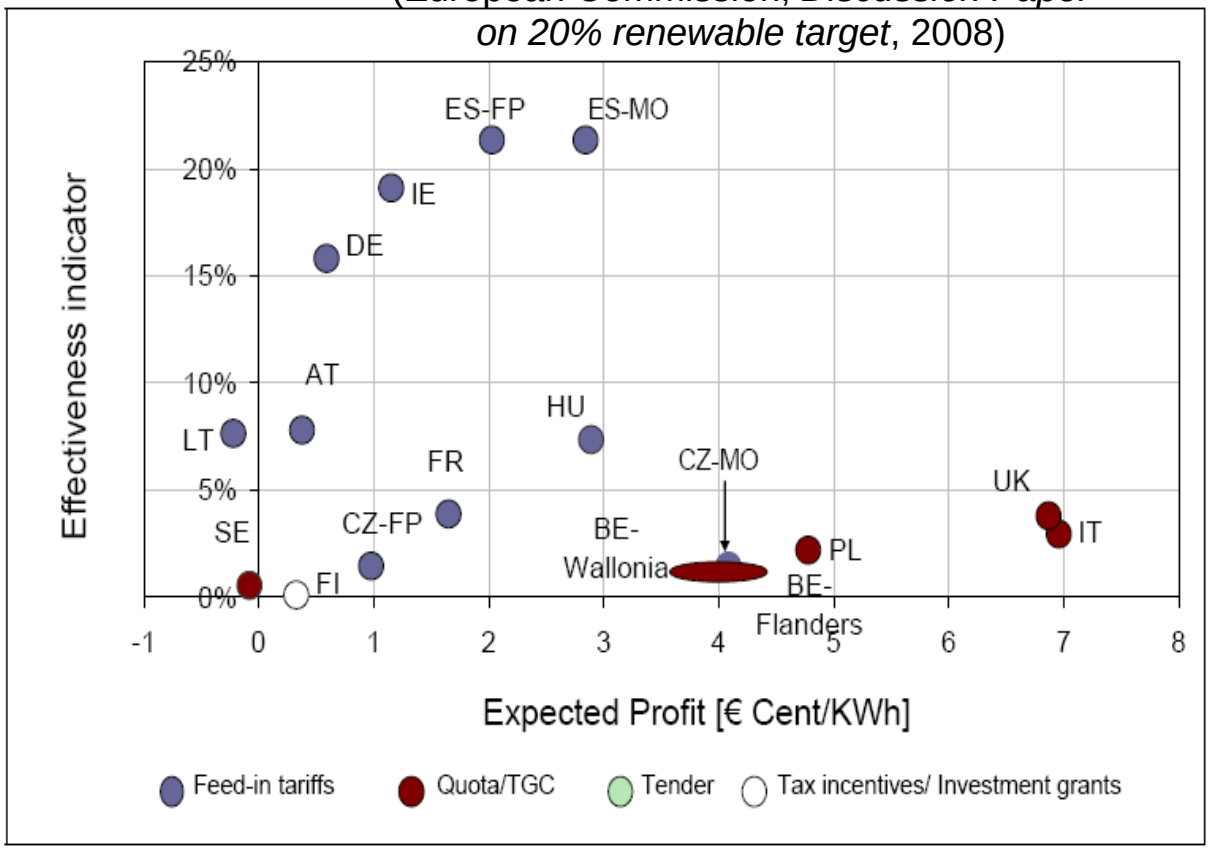
(MMA, Report for *Australian Low Pollution Future*, 2008)



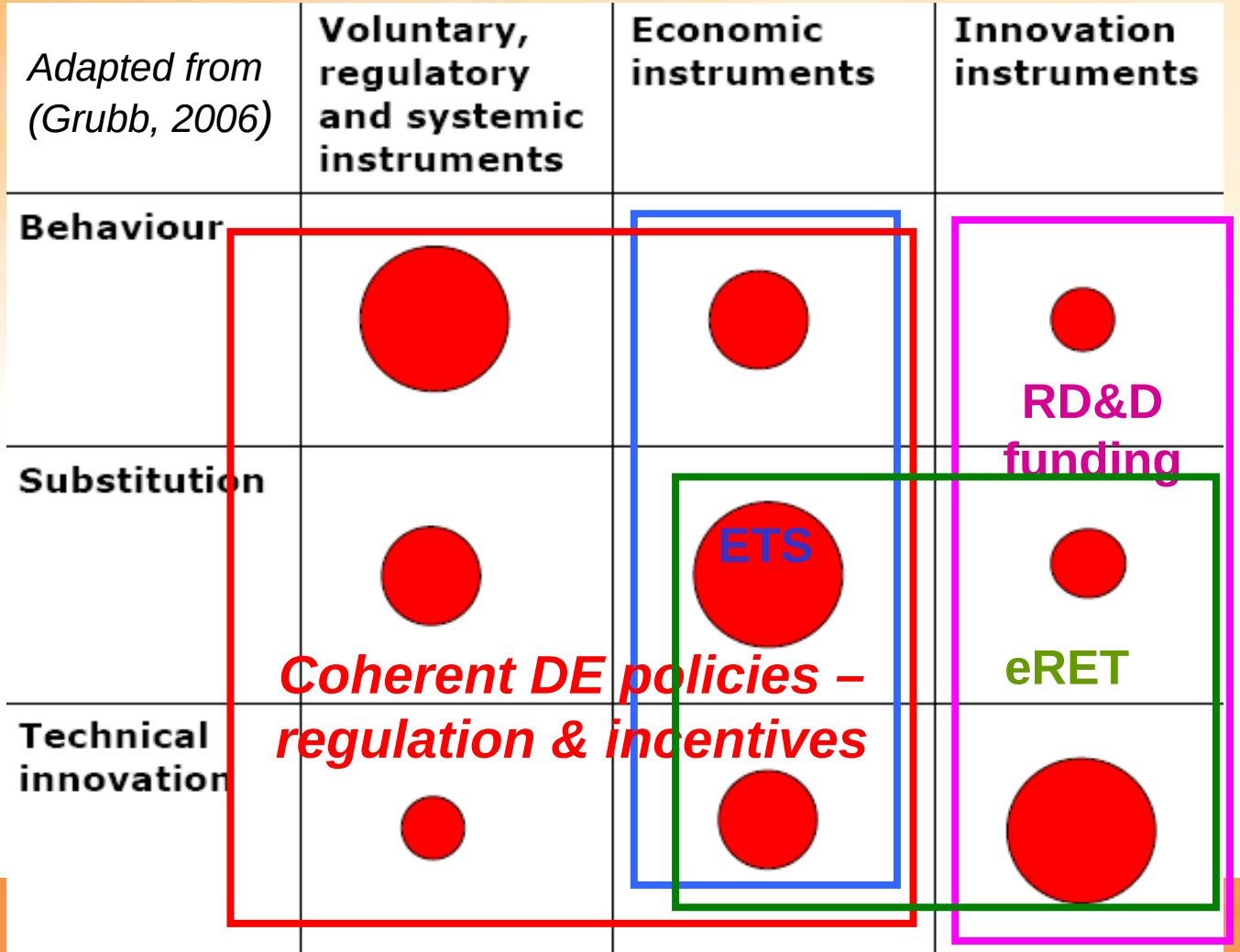
MRET performance to date… and for 2020?

- **To date:** modest ramping target easily met + considerable new investment with apparent efficiency – low subsidy $/MWh by internat'l standards
- **However:** internat'l 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
- *And unclear DE impact (deeming & multipliers for PV rather ad-hoc)*

(European Commission, *Discussion Paper on 20% renewable target*, 2008)



What's still missing for a coherent sustainable energy policy framework?



DE and AMI / Smart Grids (Outhred, 2008)

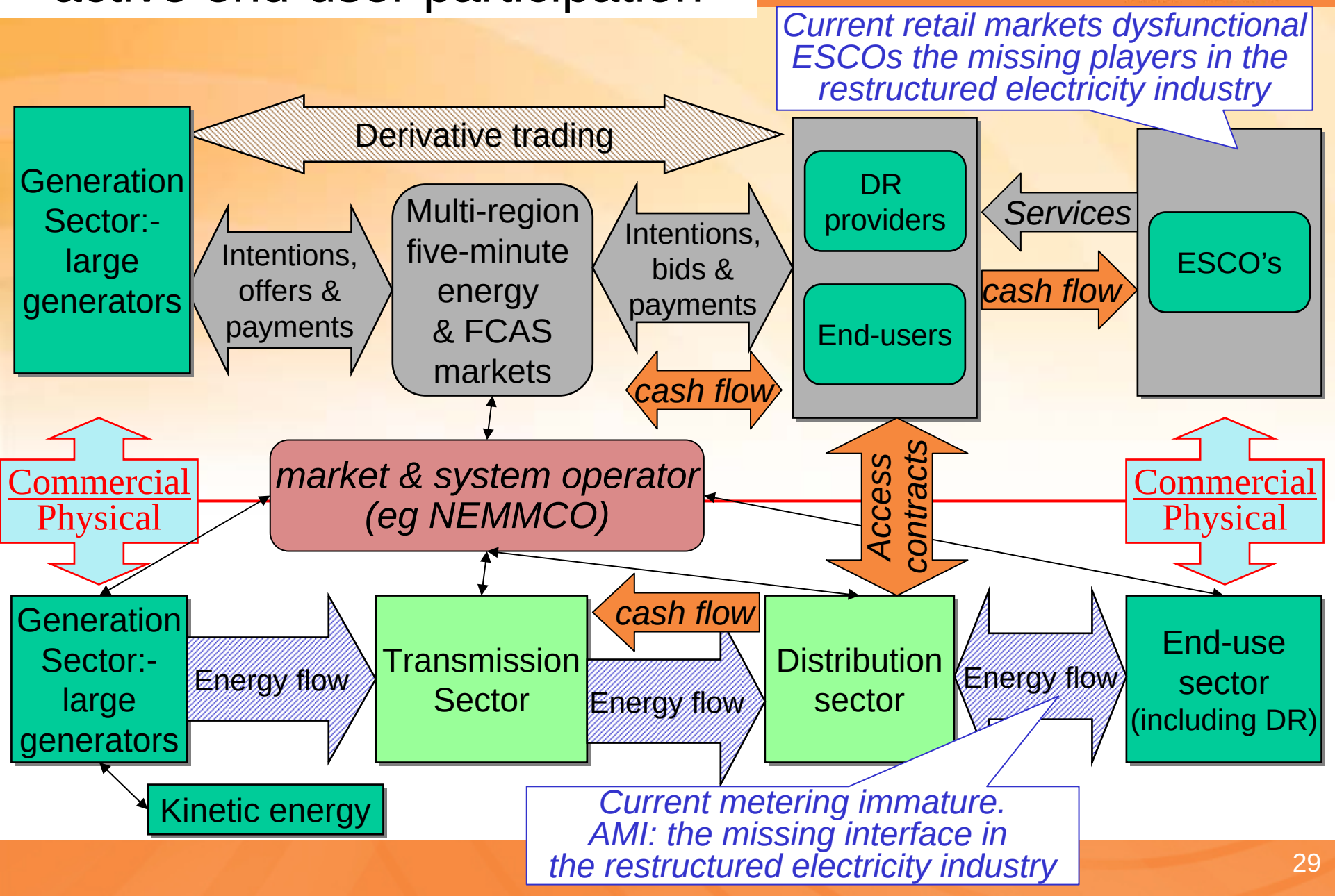
- The key objective for the “smart grid” concept is:
  - Coordinated, decentralised investment in & operation of distributed resources to deliver net societal benefits
- Key requirements in achieving this objective are:
  - Advanced metering and ‘smart grid’ infrastructure including communications, distributed 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*

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



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

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Thank you… and *questions*

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