Centre for Energy and Environmental Markets

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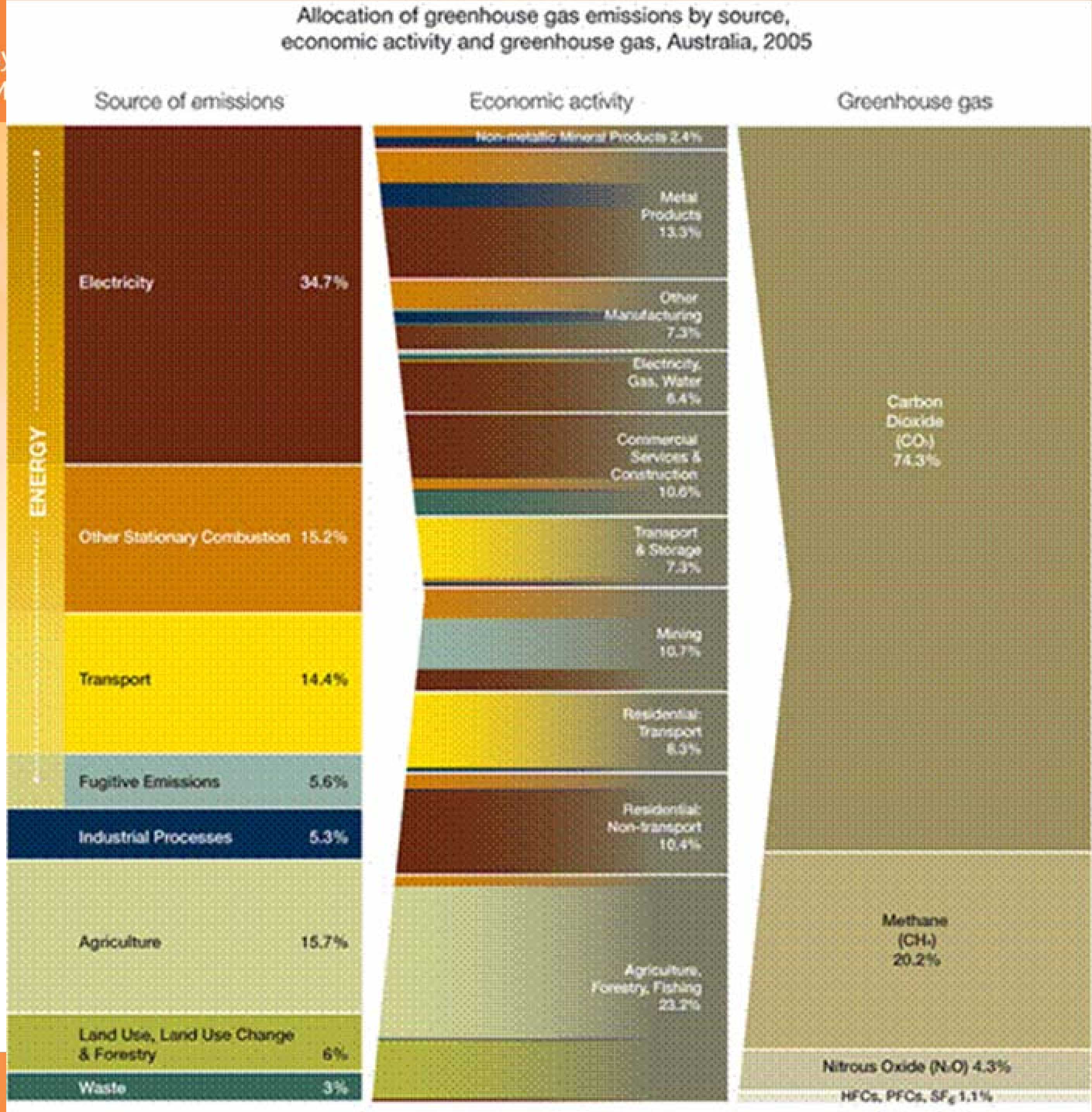
Australia's changing energy & environmental policy context, and it's implications for the Built Environment

FBE Course 'Energy and the Built Environment'

Iain MacGill

Centre for Energy
Environmental M

The Climate and Energy and Built Env. connection



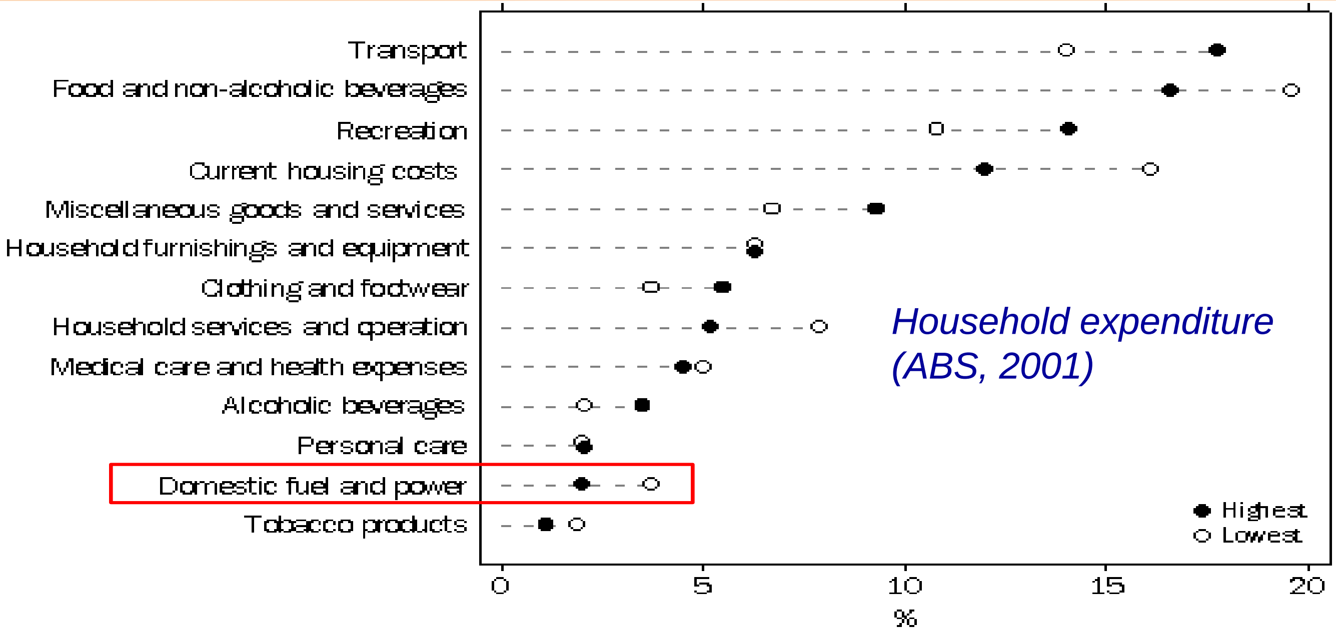
CEEM established …

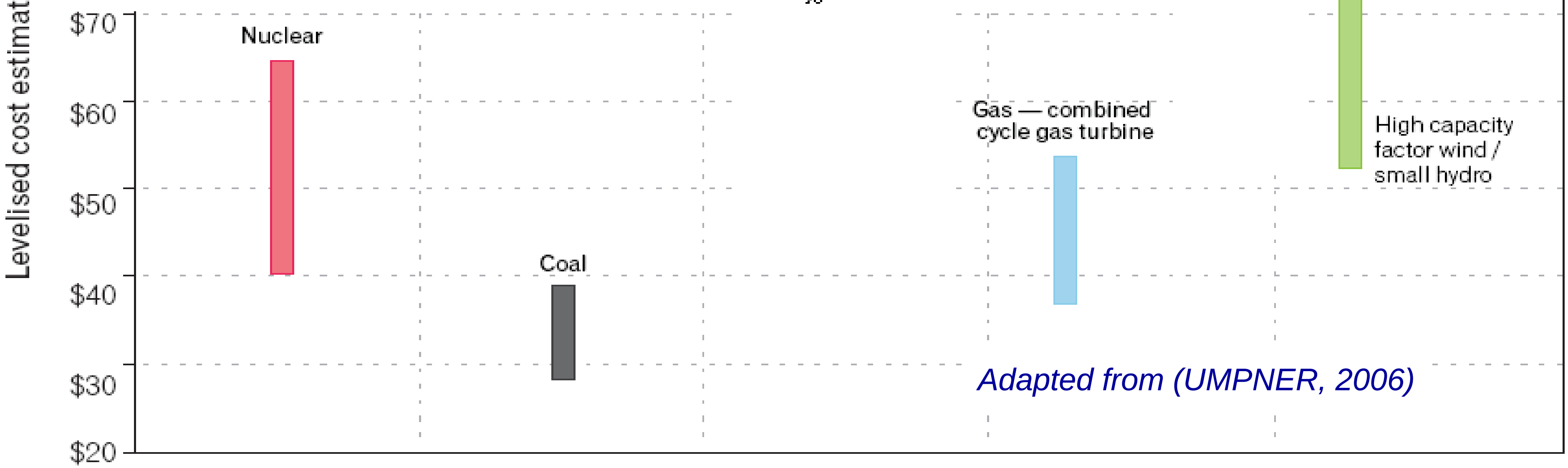
- *to formalise* growing interest + interactions between UNSW researchers in Engineering, Business, Social Sciences, Environmental Sciences…
- *through UNSW Centre* providing Australian research leadership in interdisciplinary design, analysis + performance monitoring of energy + environmental markets, associated policy frameworks
- *in the areas* of
  - Energy markets
    - spot, ancillary services and derivative markets, retail markets
    - *Primary focus on the Australian NEM*
  - Energy related environmental markets
    - Eg. National Emissions Trading, MRET, Energy Efficiency Certificate Trading, Renewable energy subsidies…
  - Broader policy frameworks and instruments to achieve desired societal energy and environmental outcomes: eg. EE policies

CEEM Research program areas

- Environmental market design
  - emissions trading and its interactions with energy markets
- Distributed Energy
  - Load management, energy efficiency and distributed generation opportunities, the challenges of behavioural change
- Renewable energy
  - Facilitating the integration of renewable energy into the National Electricity Market
- Electricity industry restructuring
  - with a focus on retail market design
- Technology Assessments for our sustainable energy options
  - EE, Renewables, Carbon Capture and Storage, Nuclear
- Market governance
  - the strengths and weaknesses of market mechanisms; oversight, regulation

A largely fossil-fuelled world …. for good reason



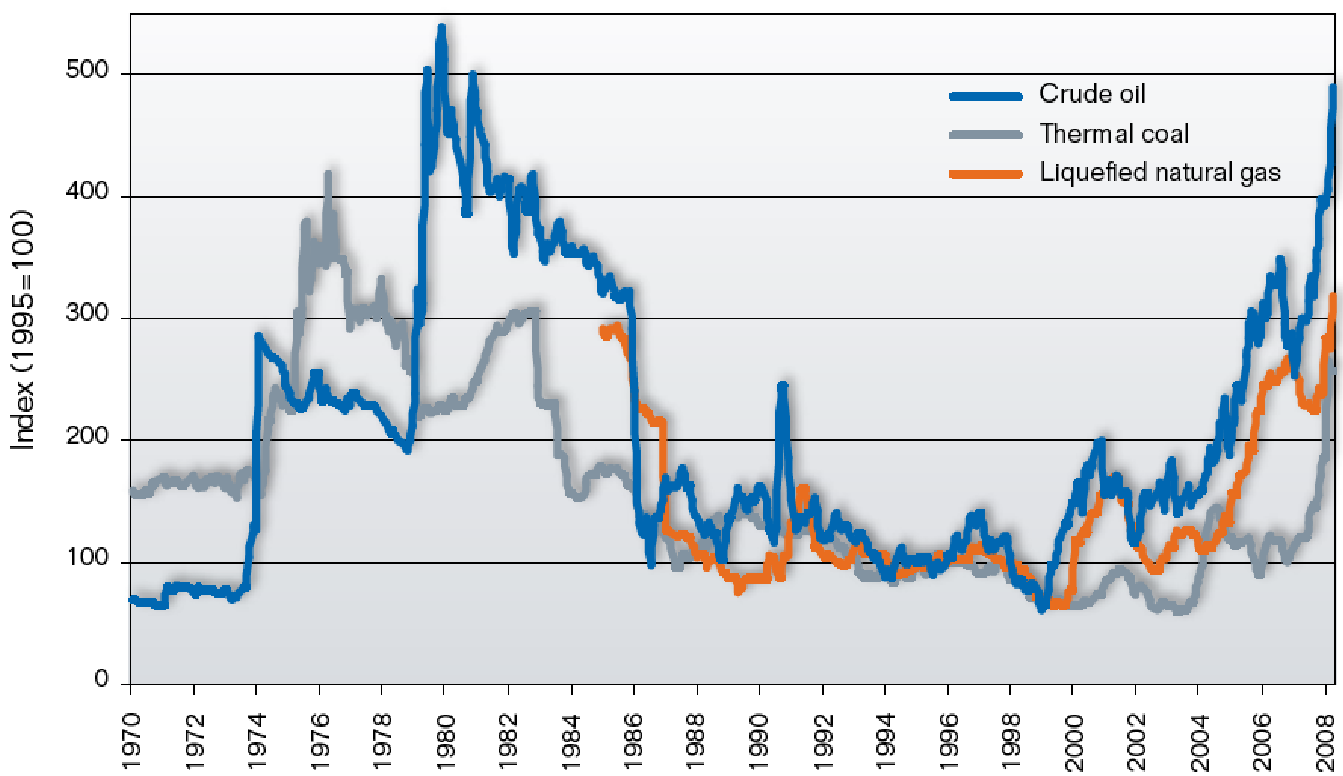


Nuclear costs are settled down costs for new plant
CCS estimates are indicative only
Renewables have large ranges and substantial overlaps

Fuel prices internationally moving… Australia may see similar changes over time

Figure 3.12 Oil, gas and coal prices, 1970 to 2008

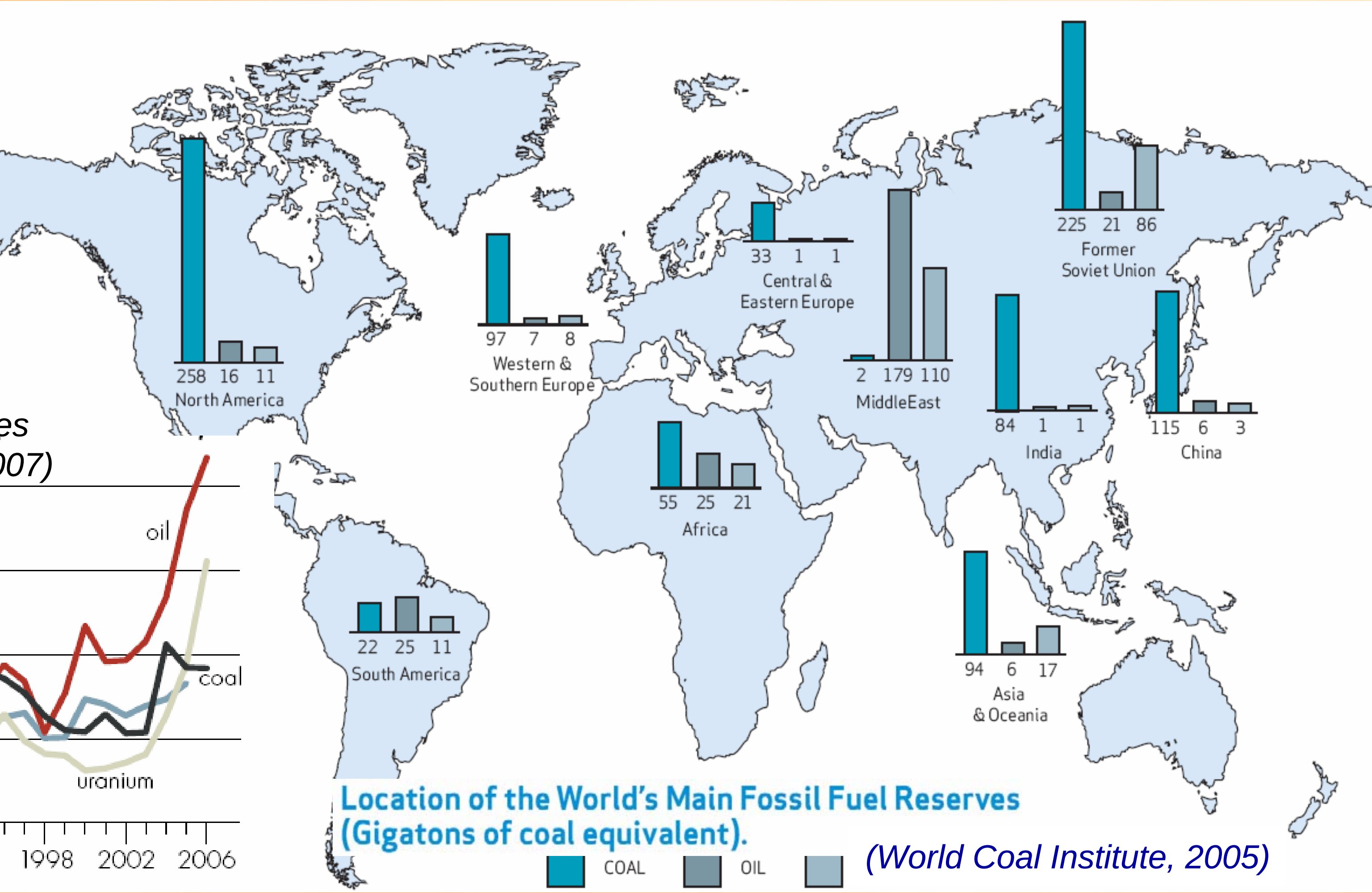
(Garnaut Report, 2008)



Note: Nominal prices converted to SDRs and deflated by the G7 CPI. Indexed to 1995. Prices are as at January for 1970–2007 and as at April for 2008.

Source: Table compiled by the Centre for International Economics based on IMF IFS Statistics, OECD Main Economic Indicators, *Financial Times*, and CIE estimates.

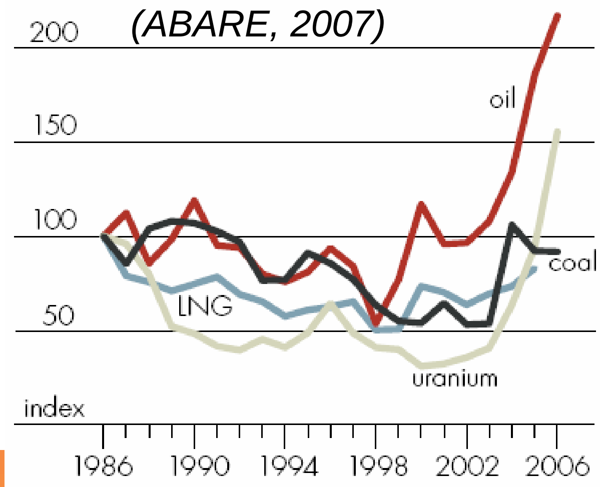
Energy security concerns growing, regional issues with oil & gas but plentiful coal … and we are unlikely to run out of fossil fuels….



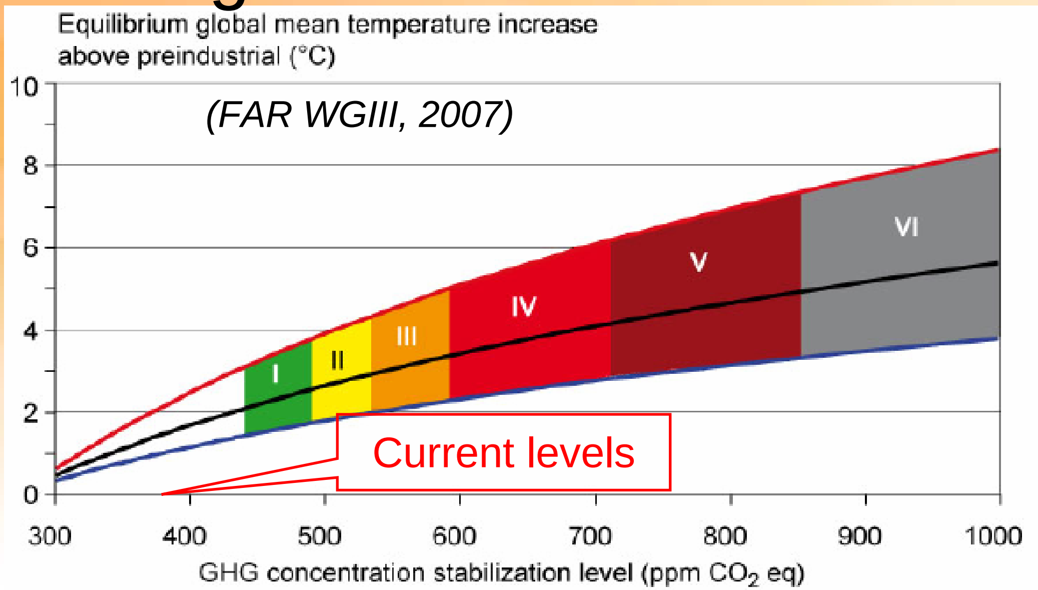
Location of the World's Main Fossil Fuel Reserves (Gigatons of coal equivalent).

(World Coal Institute, 2005)

Energy prices (ABARE, 2007)



….before global warming concerns dominate. The challenge – stabilisation…



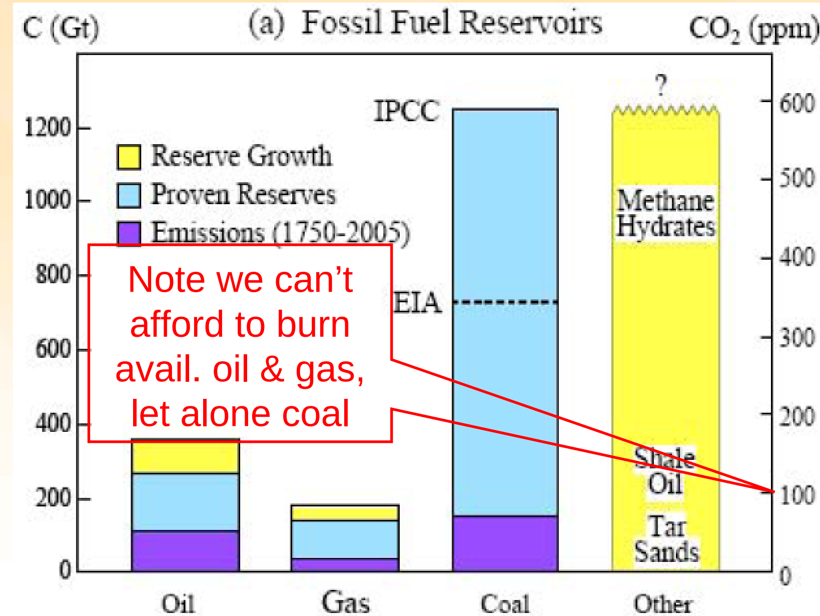


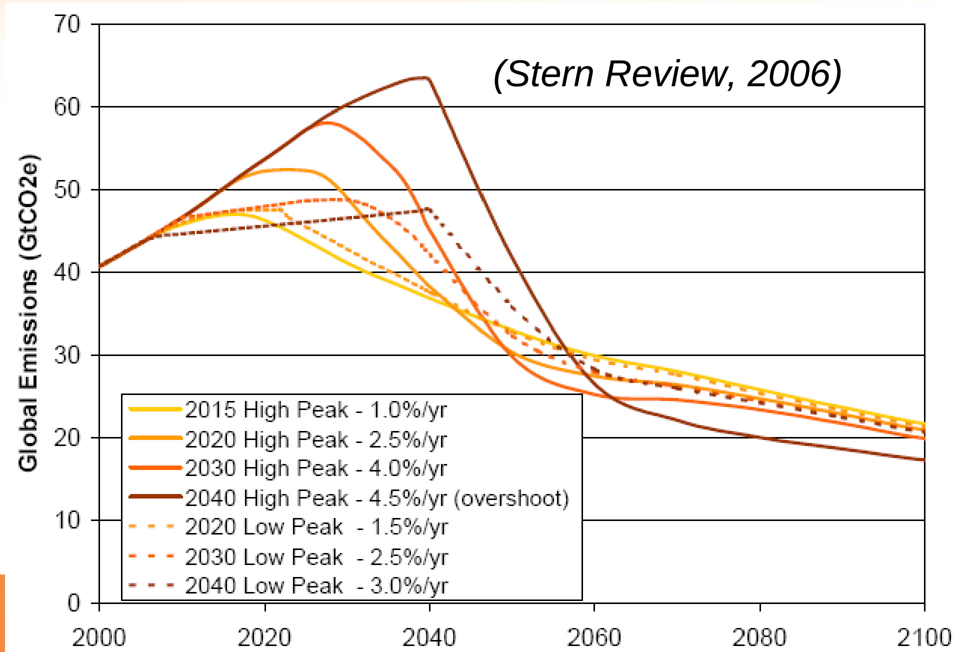
Table SPM.5: Characteristics of post-TAR stabilization scenarios [Table TS 2, 3.10][a)]

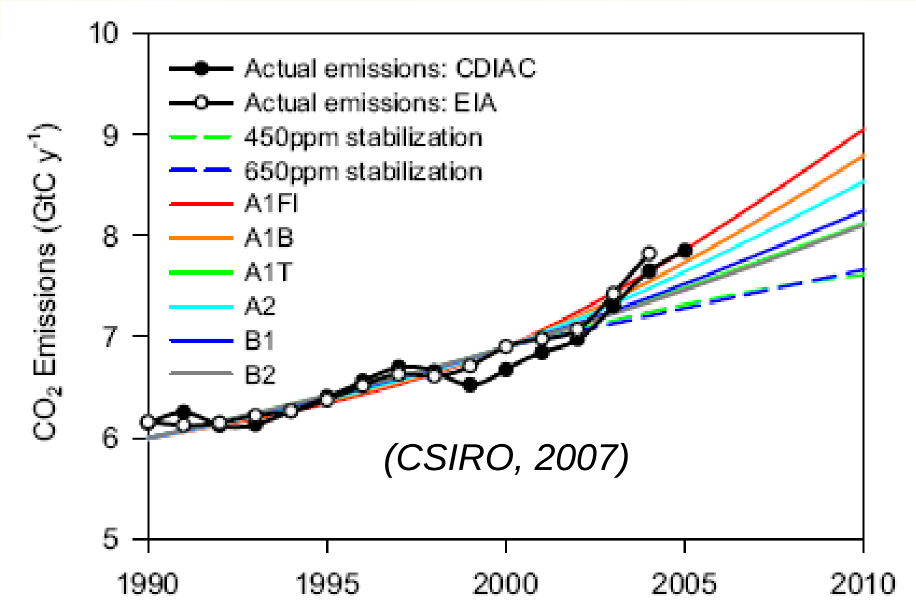
Category	Radiative Forcing (W/m[2)])	CO_2 Concentration[c)] (ppm)	CO_2-eq Concentration[c)] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b), c)] (°C)	Peaking year for CO_2 emissions[d)] (year)	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d)] (%)	No. of assessed scenarios
I	2.5 – 3.0	350 – 400	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50	6
II	3.0 – 3.5	400 – 440	490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30	18
III	3.5 – 4.0	440 – 485	535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5	21

…. and possible emission trajectories

- Note high 'price' of delay
  - Waiting 20 years to act requires emissions to fall 3-7 times faster to a lower level

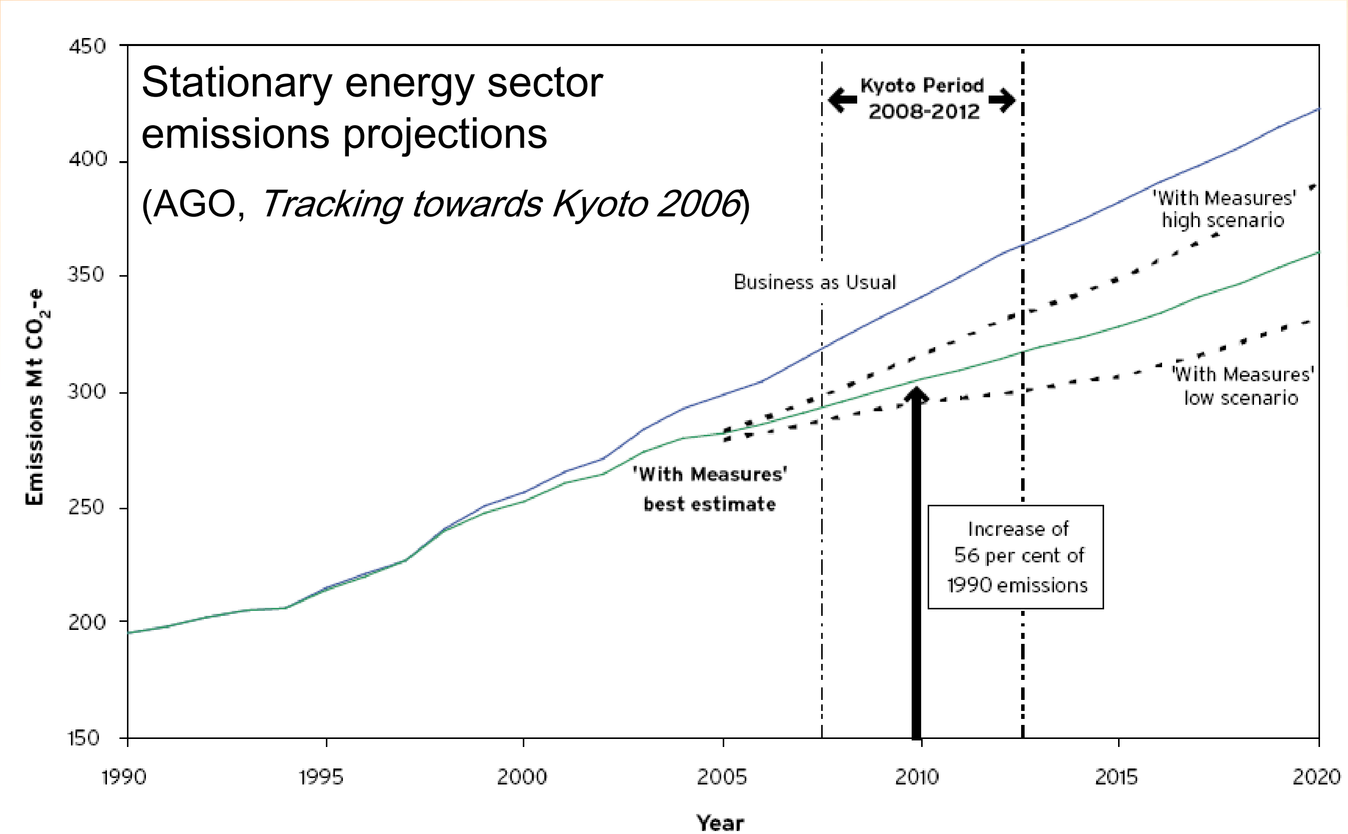
- *… current trajectory exceeds the 'worst case' IPCC scenarios from TAR*





Australia's challenging context for climate policy

- Energy-related emissions climbing – 70% of total
  - Estimated +35% over 1990–2004, projected +56% in 2010
  - 'On track' to meet Kyoto 108% target due to 'land clearing' hot air

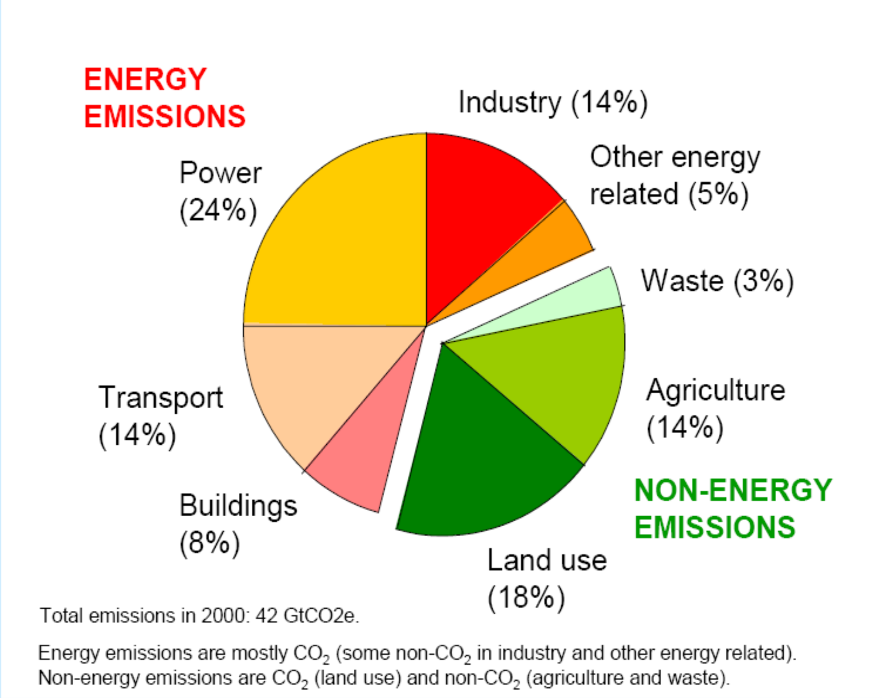


- Electricity generates 35% of total emissions + fastest growing sector.

Abatement options *(Stern, 2006)*

- Reducing demand for emissions-intensive goods + services
  - Energy conservation / frugality
- Increased efficiency
  - Particularly end-use efficiency, but also in supply + distribution
  - Can save both money and emissions
- Action on non-energy emissions
  - Land-use, agriculture, waste
  - non-CO2 industrial emissions
- Switching to lower-carbon technologies for power, heat and transport
  - Renewables, Nuclear, Gas Carbon Capture and Storage

Figure 1 Greenhouse-gas emissions in 2000, by source



Source: Prepared by Stern Review, from data drawn from World Resources Institute Climate Analysis Indicators Tool (CAIT) on-line database version 3.0.

Key drivers in assessing our energy options

- *Their ability to contribute to large, rapid and sustained global emission reductions while maintaining energy security*
  - Technical status
    - unproven => mature; niche => widespread
  - Delivered benefits
    - GHG emission reductions, flexibility, dispatchability
  - Present costs where known – + possible future costs
  - Potential scale of deployment
    - possible physical, technical + cost constraints
  - Potential speed of deployment
    - time and effort required to achieve scale
  - Other possible societal outcomes
    - eg. other environmental impacts, **energy security implications**

Key perspectives wrt these drivers

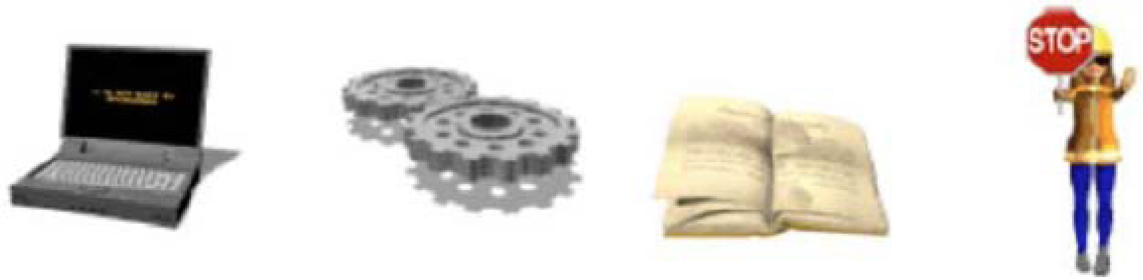
- Scientific
  - eg. impact of physical resource limits on potential scales of deployment
- Engineering and Design
  - wrt our ability to develop socio-technical systems; eg. engineering limitations to speed particular technology industries can grow, our abilities to integrate our options into sustainable solutions
- Economic
  - in the 'social welfare' sense; eg. direct & externality costs of options
- Commercial
  - role of commercial market 'settings' in driving individual decision making in areas like technology innovation
- Societal
  - including social expectations and governance required to deliver these including policy, mechanisms, measures and regulation: eg. social acceptability of nuclear power

Technology – the “art of knowing and doing”

- **‘Orgware’** has most vital role
  - The framework in which key markets (energy + ETS) operate
  - Appropriate frameworks require high levels of coordination
  - Markets will often fail to create appropriate framework themselves
    - often actively work against such frameworks *as a (temporary) source of competitive advantage – eg. Credit Crisis*

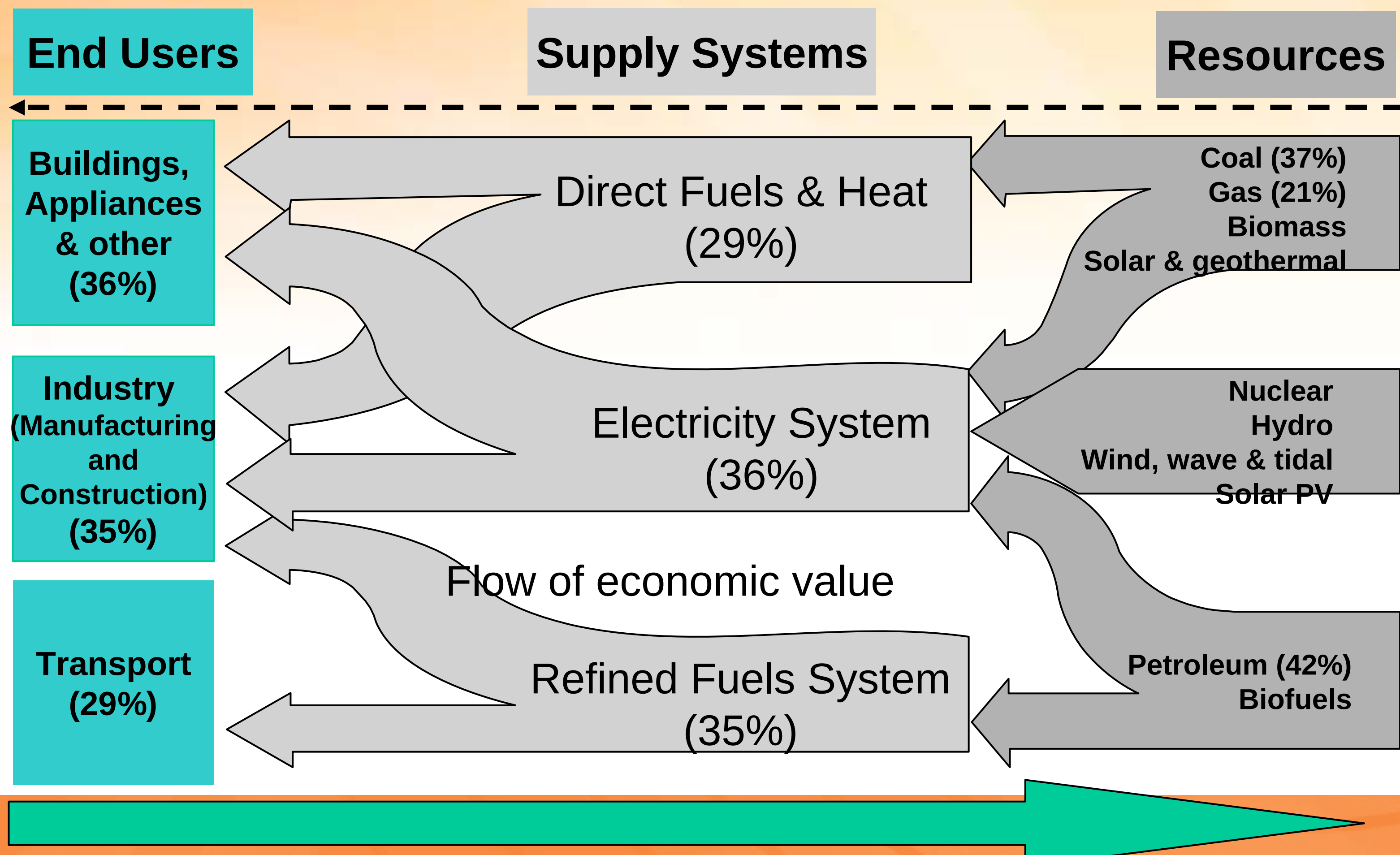
Technology = Hardware + Software + "Orgware"

(taken from www.iiasa.net)



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

The complexities of our energy systems – change requires enormous innovation in technology, infrastructure, behaviour and institutions

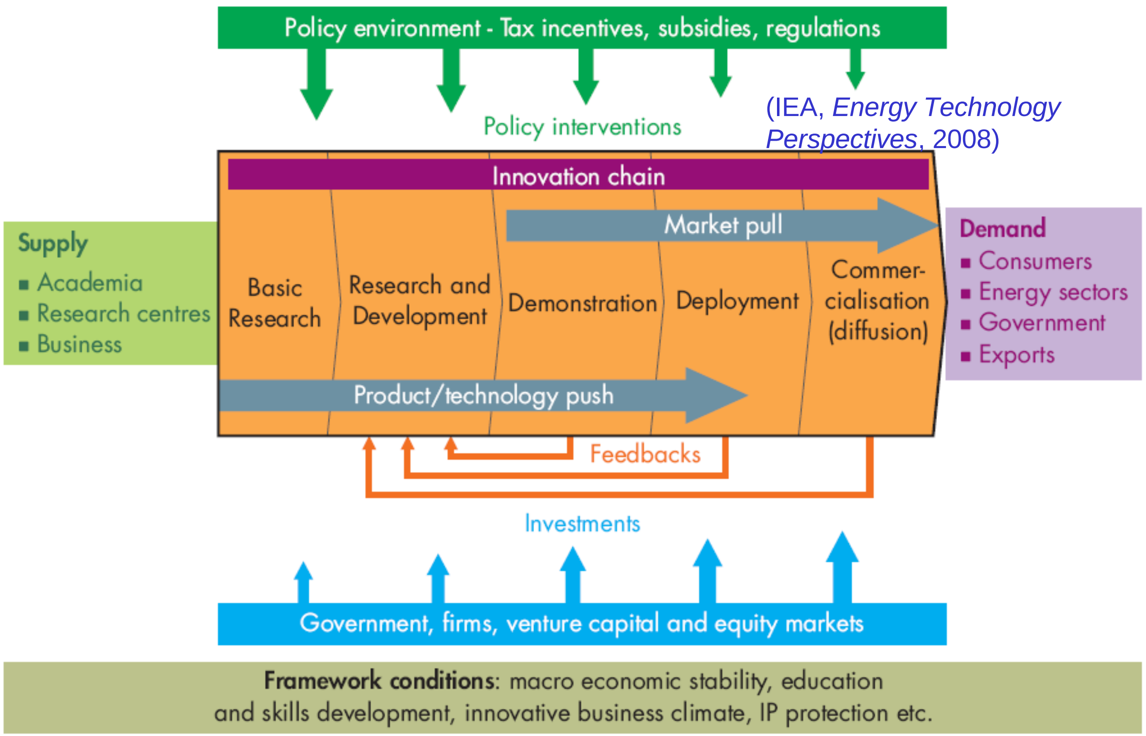


Innovation

"the path of conceiving, developing & implementing ideas through to generation of products, process & services" (Australian Parliament, *Inquiry into pathways to technological innovation*, 2006)

- Very high levels of complexity and uncertainty
- "..uptake & deployment of existing sustainable technologies required given urgency of addressing climate change challenge
- Government roles at every phase of innovation cycle
  - frameworks and funding
- Appropriate industry response critically dependent on frameworks
  - *Public $ alone unlikely to drive appropriate actions*

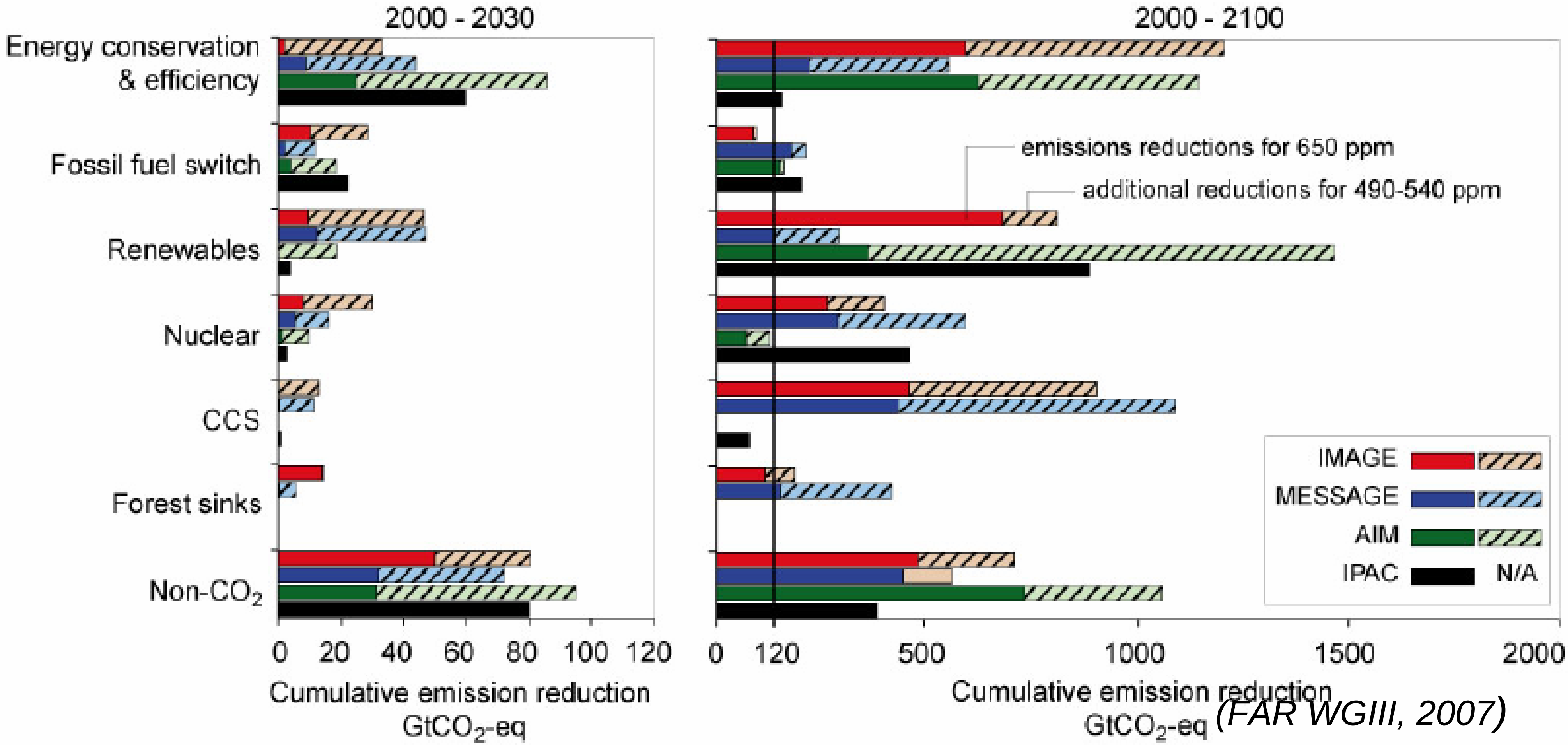
Figure 4.1 Schematic working of the innovation system



(IEA, *Energy Technology Perspectives*, 2008)

Sources: Adopted and modified from Grubb, 2004 and Foxon, 2003.

Putting it all together: future energy scenarios have mixed transparency wrt tech. assessment, generally poor incorporation of uncertainty, some agreement

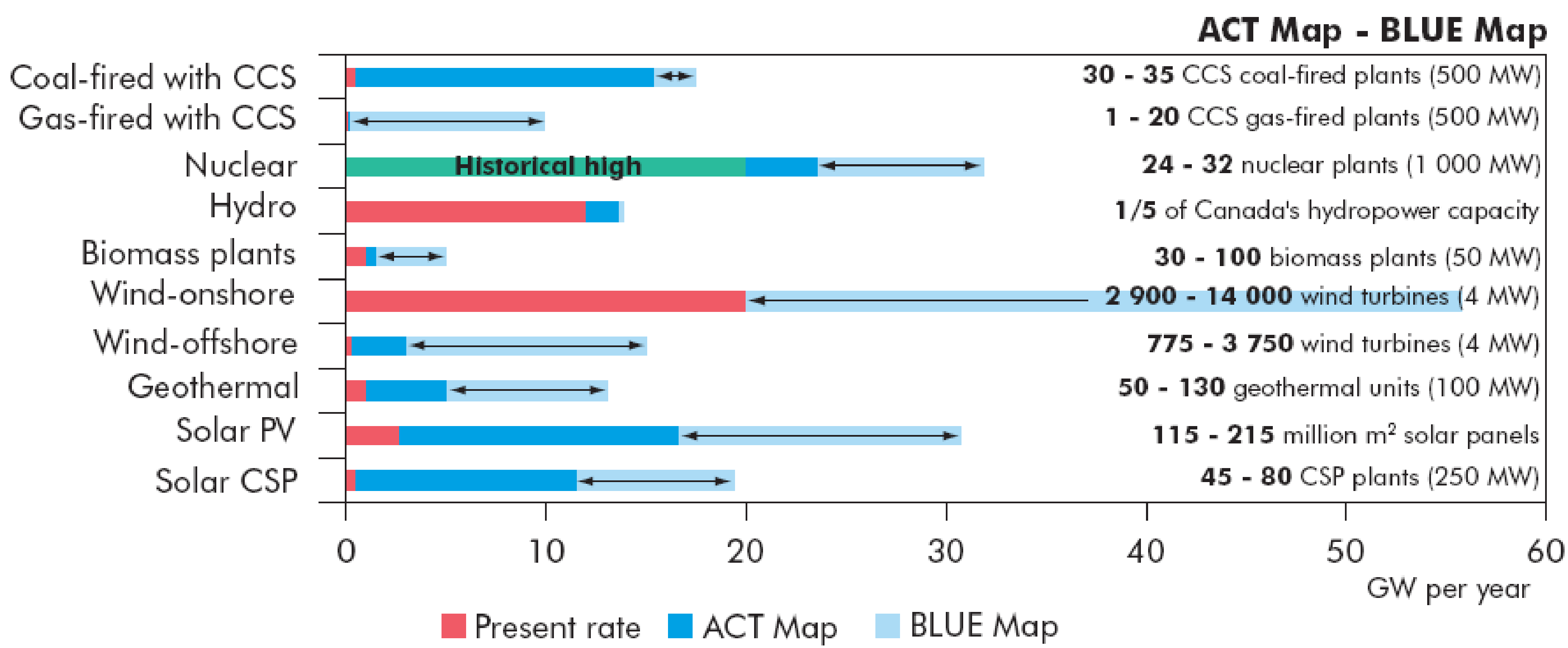


(FAR WGIII, 2007)

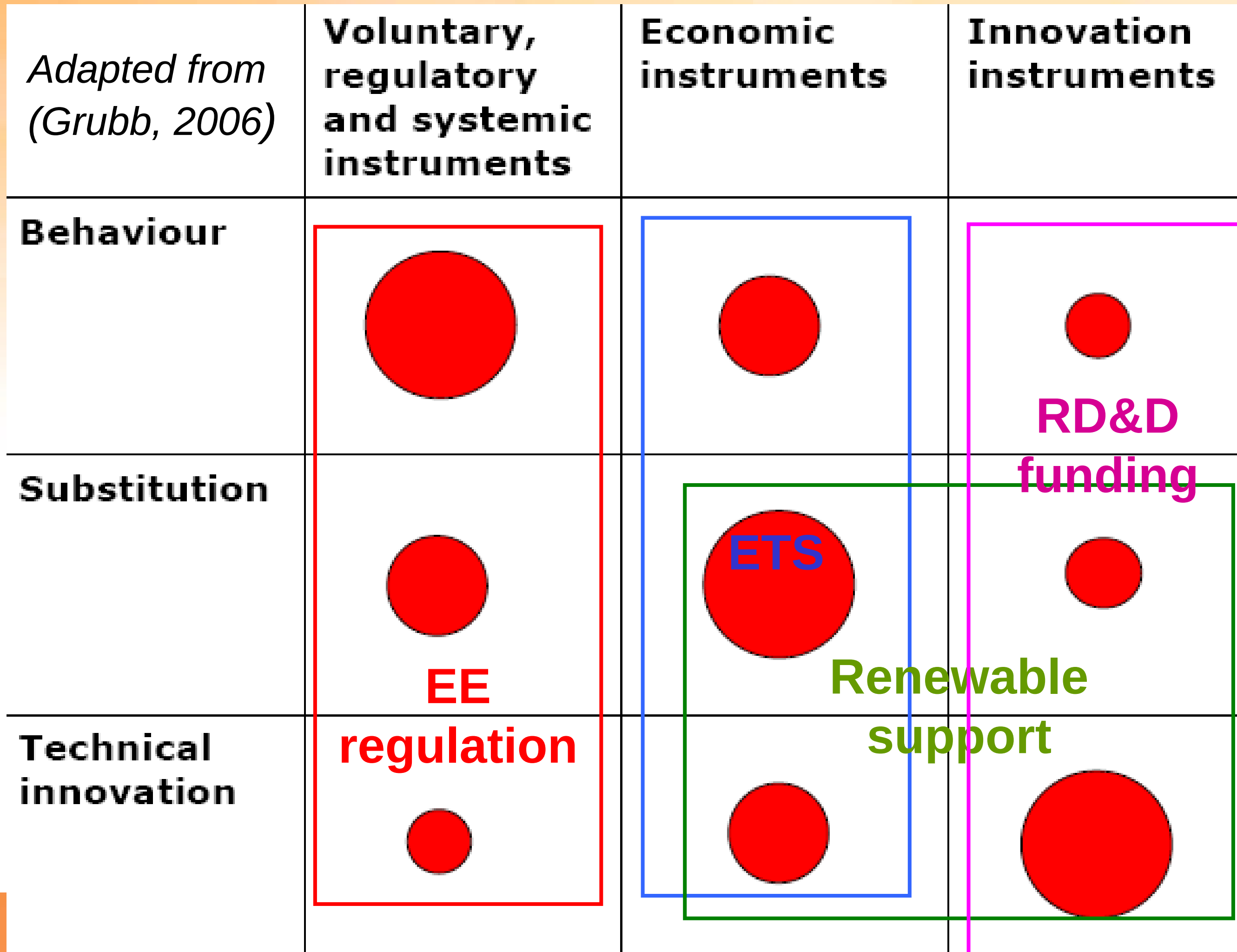
Considering proven + emerging options

- Likely CCS can play only modest role in climate protection in short-med term
  - Eg. IEA *Energy Perspectives Scenarios* (BLUE = 450ppm) see Coal CCS GW/year to 2050 similar to current wind and hydro rates, future off-shore wind, geothermal, similar to current hydro, future off-shore wind, geothermal, PV

Figure ES.3 ▶ Additional investment in the electricity sector in the ACT Map and BLUE Map scenarios (compared to the Baseline, 2005-2050)



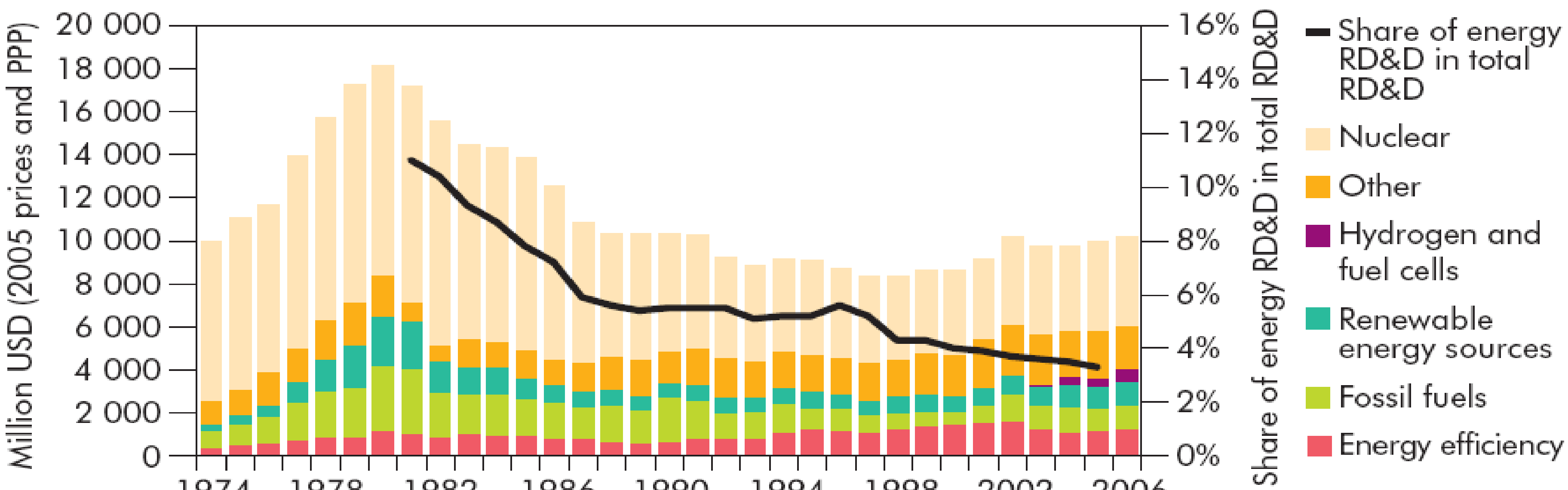
A coherent sustainable energy policy framework



R&D and Demonstration

- Generally falling public RD&D energy funding over last 3 decades - $ & % of total funding) although now changing
- Private RD&D difficult to estimate – greater than public funding but low wrt turnover (power sector $$ order of magnitude less than electronics and pharmaceuticals)

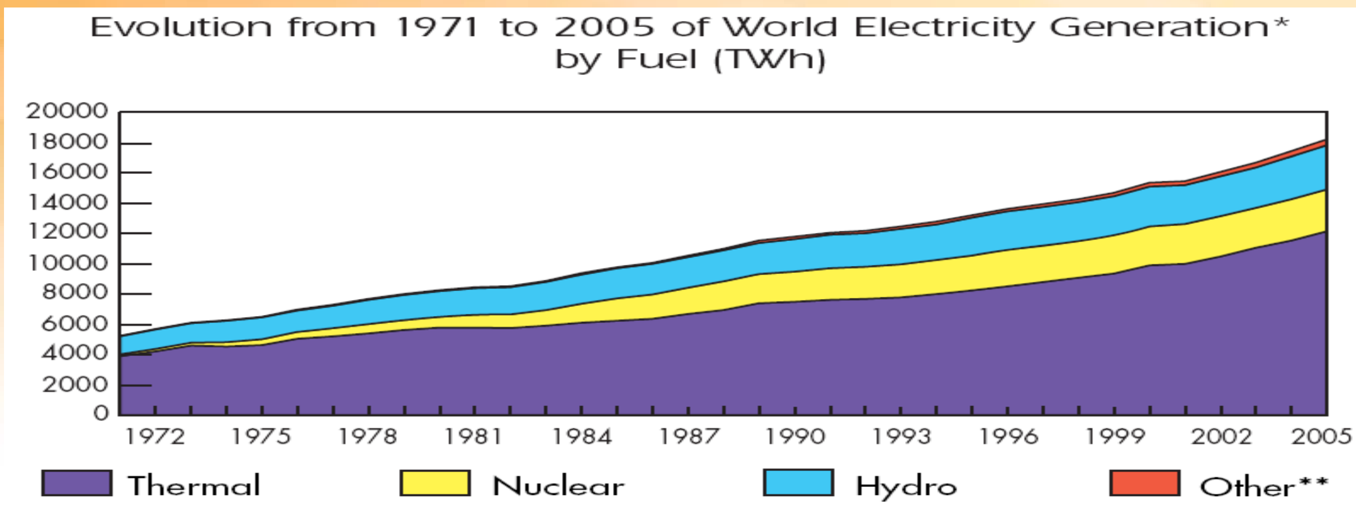
Figure 4.2 ▶ **Government budgets on energy RD&D of the IEA countries**



Note: RD&D budgets for the Czech Republic not included due to lack of available data.

Source: IEA 2007a, OECD 2007a.

- Impacts of RD&D uncertain & surprising
  - Fusion research yet to deliver, nuclear stalled in most of OECD
  - Emergence of GT techs driven by military RD&D in aerospace



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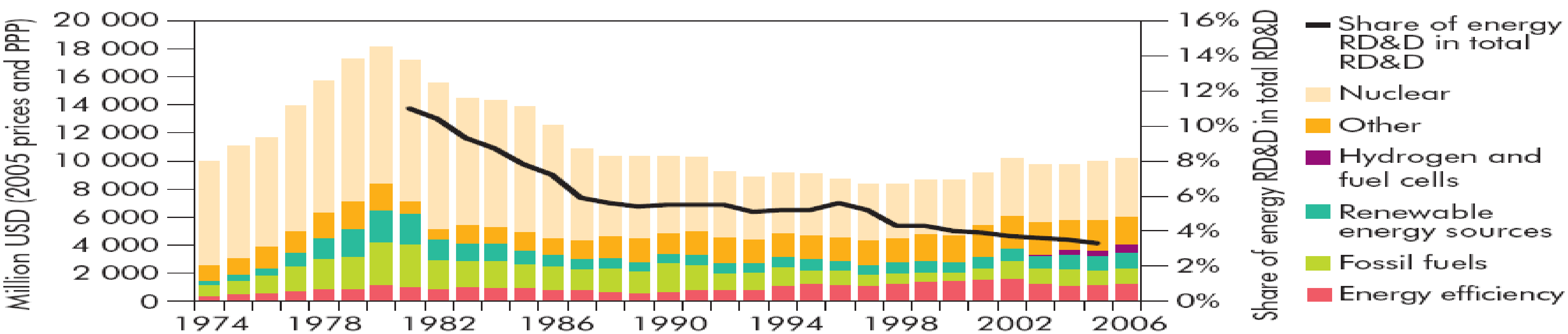

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Source: IEA 2007a, OECD 2007a.

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RD&D only a small part of innovation cycle..

ETS largely irrelevant at present

Deployment policies key to major investment (asset finance)

Figure 4. Global new investment by technology, 2007

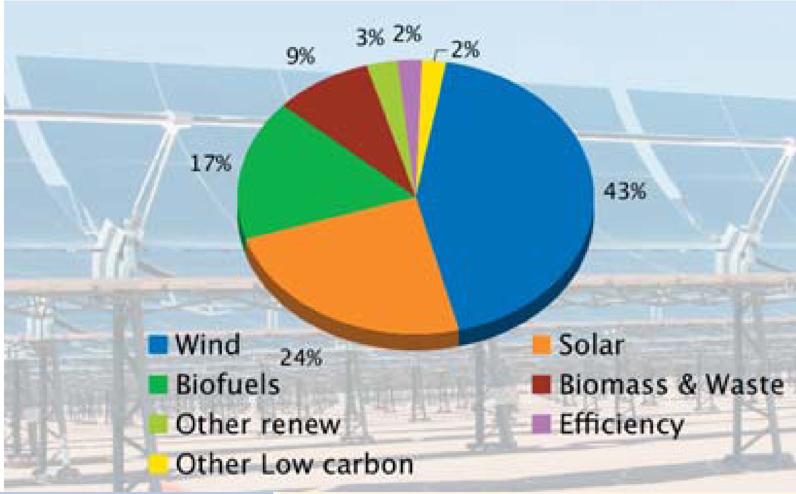
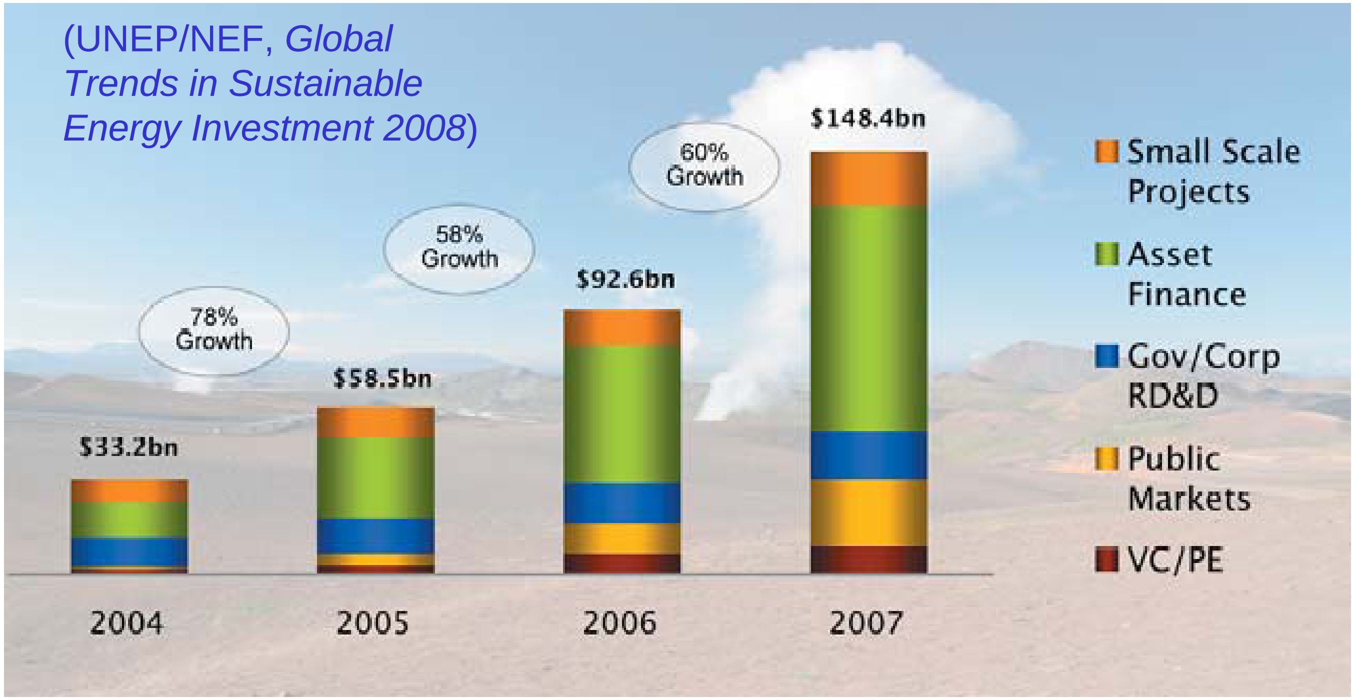
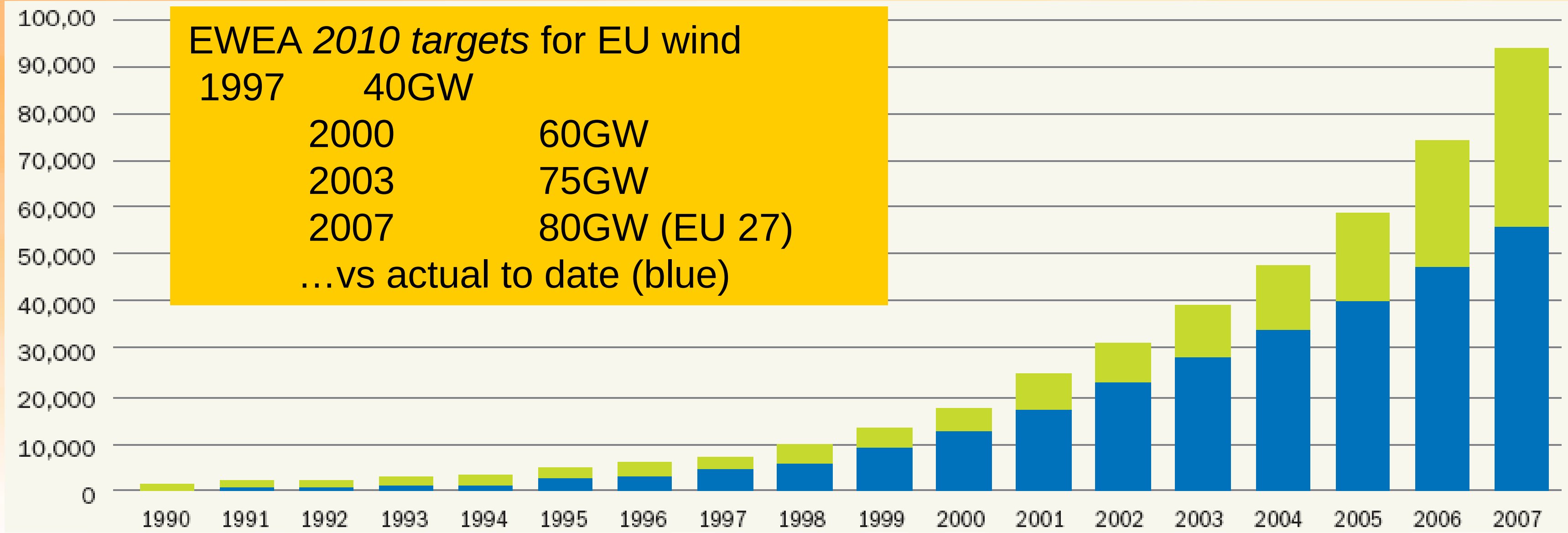


Figure 1. Global new investment in clean energy by asset class, 2004–2007



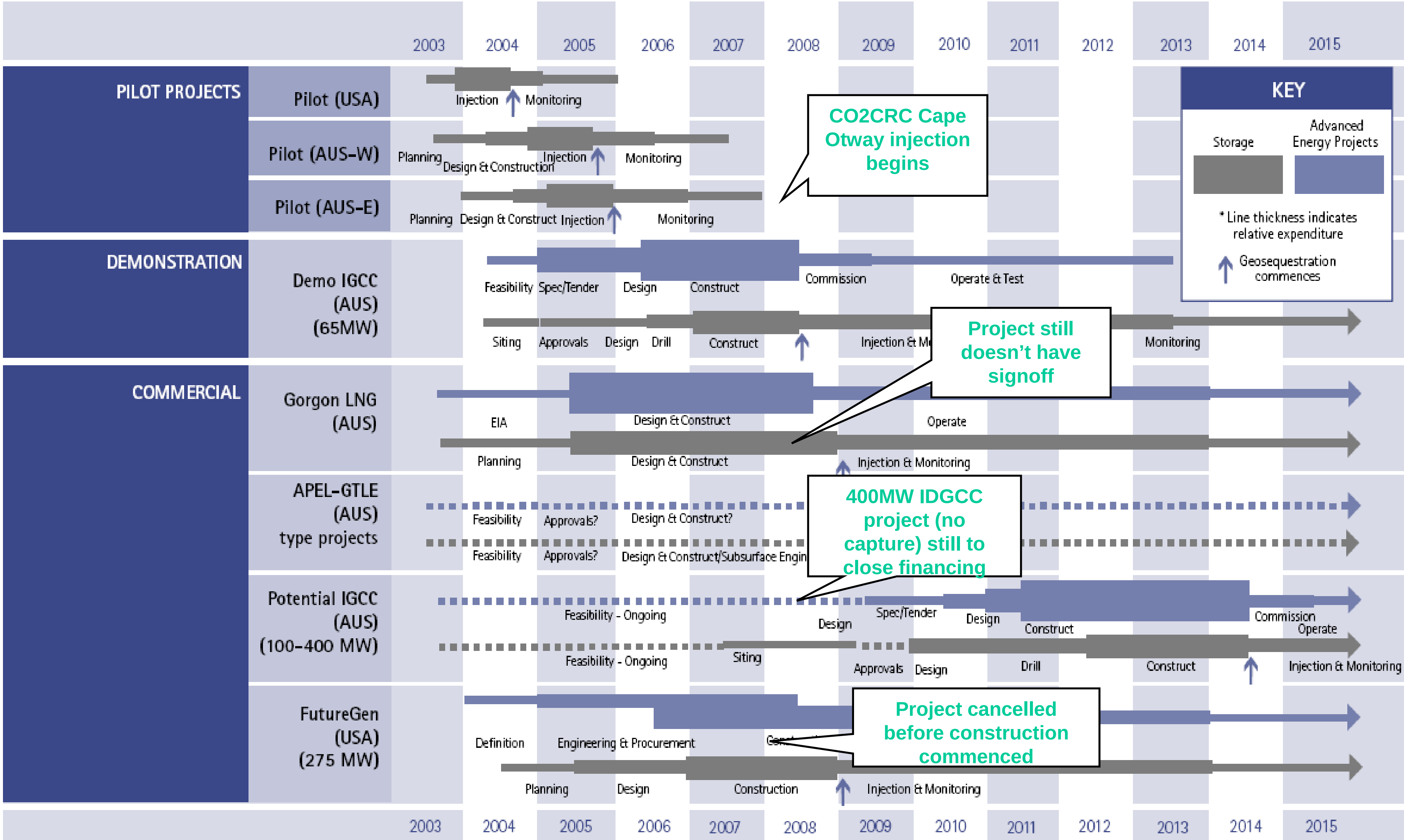
Deployment policies can have surprising impacts



- In 2010, EU wind might
  - Provide 5% of EU electricity supply
  - Reduce emissions 130Mt/yr (c.f. ETS reductions 50-100Mt/yr)
  - Support €11b/yr investment (c.f. ETS windfall profits of € 20+ b/yr)
  - be supporting a transition to lower emission generation around the world with significant green job creation in EU (c.f. ETS?)

(EWEA, *Wind energy scenarios to 2030*, 2008)

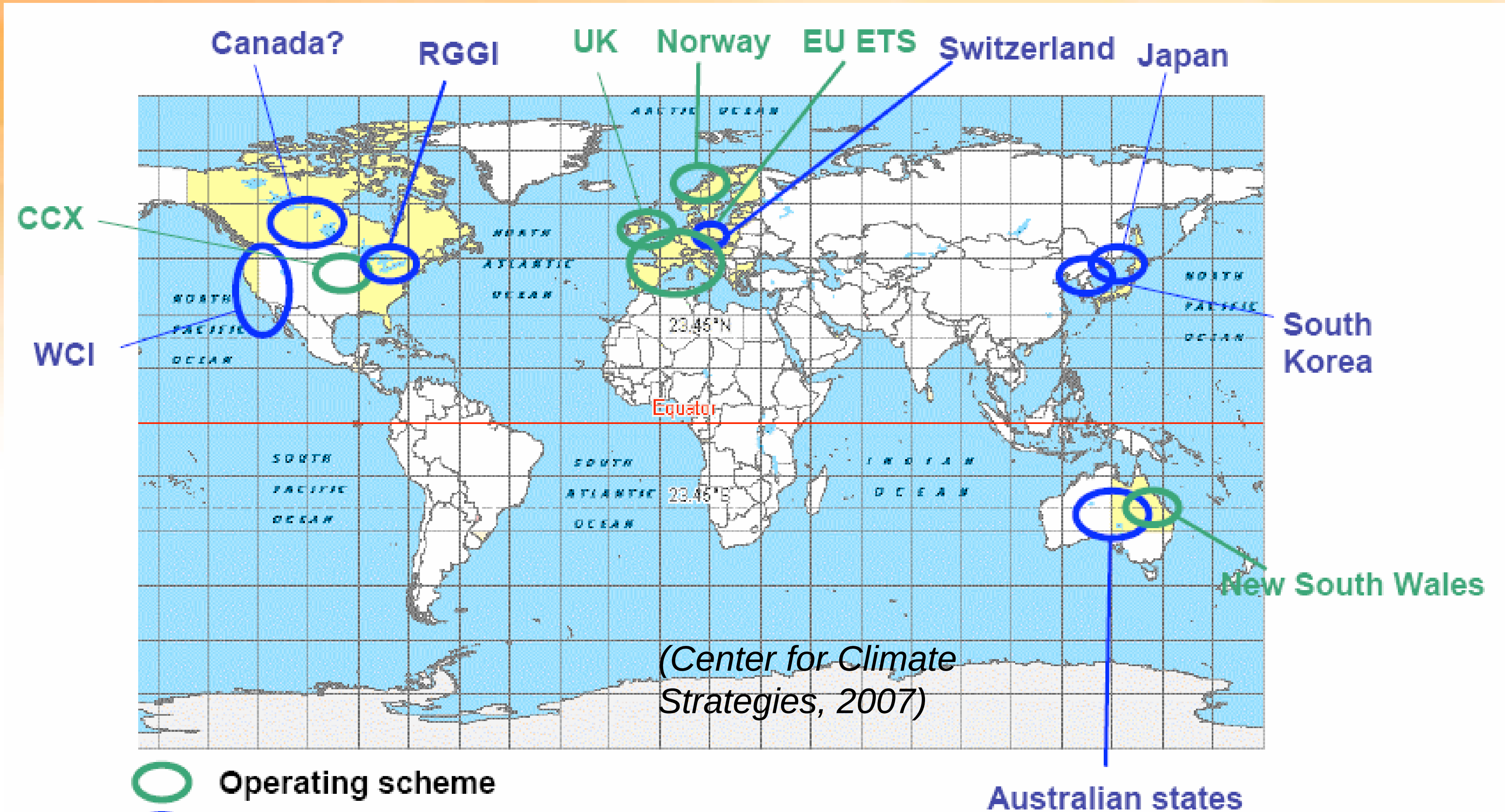
RD&D plans can have surprisingly little impact



What policy role can ETS play?

- ETS only effective wrt its ability to drive changes, operational but especially investment, in markets that drive physical emissions – most importantly energy markets
- In theory, assuming idealised markets,
  - universal ETS only policy required
  - any additional climate change policies can only increase the cost of meeting the cap while not changing its environmental effectiveness
- In practice, emissions trading markets + energy markets they have to drive
  - suffer from wide range of market failures
  - may struggle to appropriately ‘price’ uncertainties about future
  - Established by political process inevitably involving compromises that reduce effectiveness
- ETS contribution to policy mix
  - Major role is for driving substitution – ***if it can’t do this, try another approach***
    - Will still require other policies to drive behaviour + technology innovation
  - In theory, highly compatible with other policies including market-based
    - Prices of ETS and/or other policies adjust wrt changing marginal costs

Existing and proposed ETS around world



(Center for Climate Strategies, 2007)

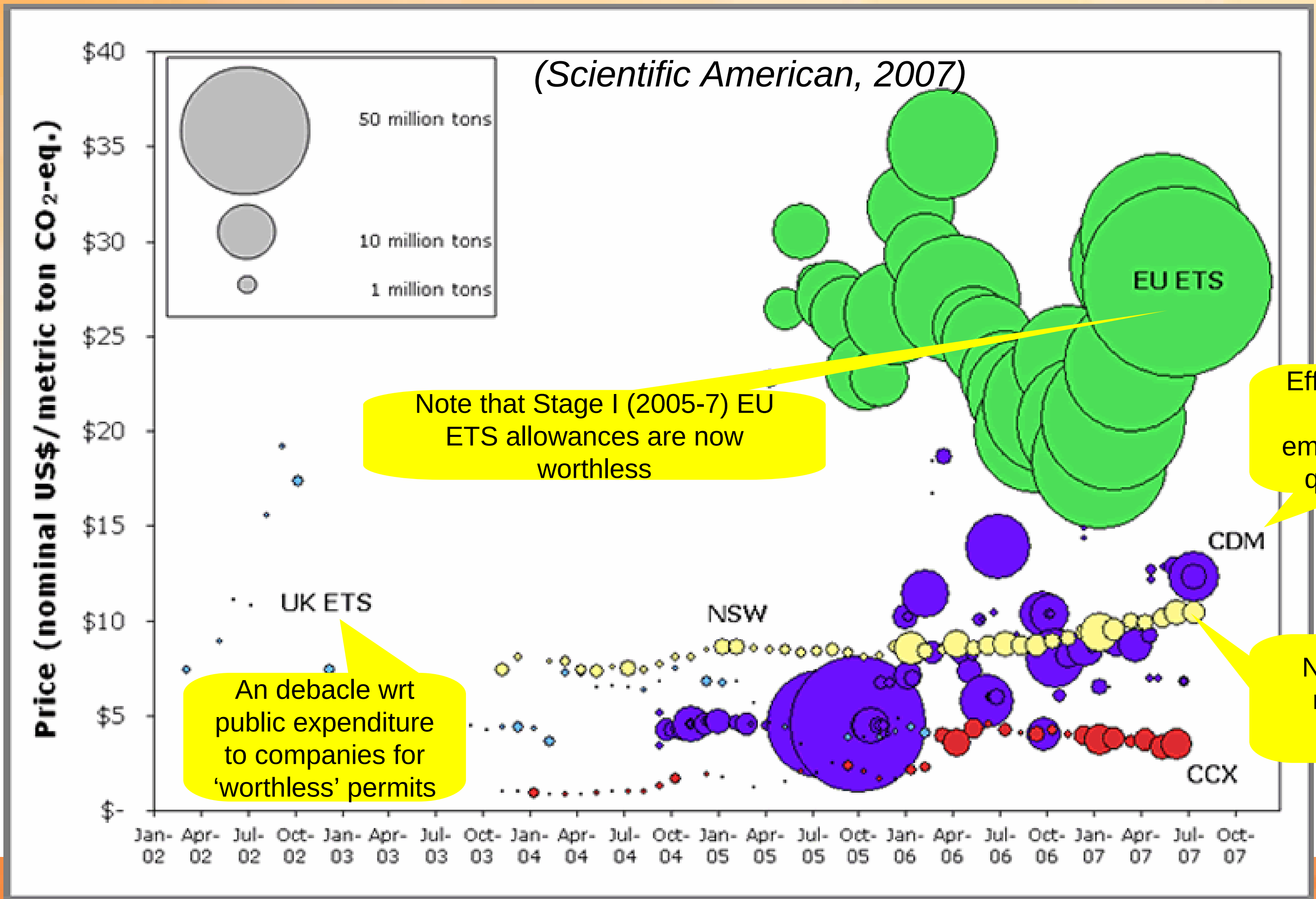
Operating scheme

Proposed or pilot scheme

Scheme	Emissions covered	Geographical reach	Emission sources targeted	Number of sources	Absolute or relative targets?	Start
EU ETS	CO_2	European Union	Large industrial and energy-intensive installations	~10,000 units	Absolute targets	2005
NSW GGAS	CO_2, CH_4, N_2O, PFCs, HFCs, SF_6	New South Wales (Australia)	Power generation, energy efficiency, industrial processes and carbon sequestration in forests	>160 projects so far and 32 benchmark participants	Relative targets	2003 (NSW) & 2005 (ACT)
JVETS	CO_2	Japan	Direct emissions from combustion of fuels and waste materials; direct emissions from processing chemicals and materials; and indirect emissions (e.g. use of grid-electricity)	90 entities	Absolute targets	2006/2007 (participant-dependent)
RGGI	CO_2	A group of Northeast and Mid-Atlantic US states	Electricity generating units that have a nameplate capacity equal to or larger than 25 MW and burn more than 50 per cent fossil fuels	Between a few and a few hundred units per state	Absolute targets	Compliance starts in 2009
CCX	CO_2, CH_4, N_2O, PFCs, HFCs, SF_6	US, Canada, Mexico, Brazil	Sources in the electric power sector and fossil fuel combustion and process emissions in the manufacturing sectors	43 entities ("Members")	Absolute targets	2003
CDM & JI	CO_2, CH_4, N_2O, PFCs, HFCs, SF_6	Global involvement	A wide range of activities	467 registered CDM projects, >100 JI projects in the pipeline	No targets	2005 (CDM) & 2008 (JI)

(PWC/IETA, 2007)

Performance to date has been mixed

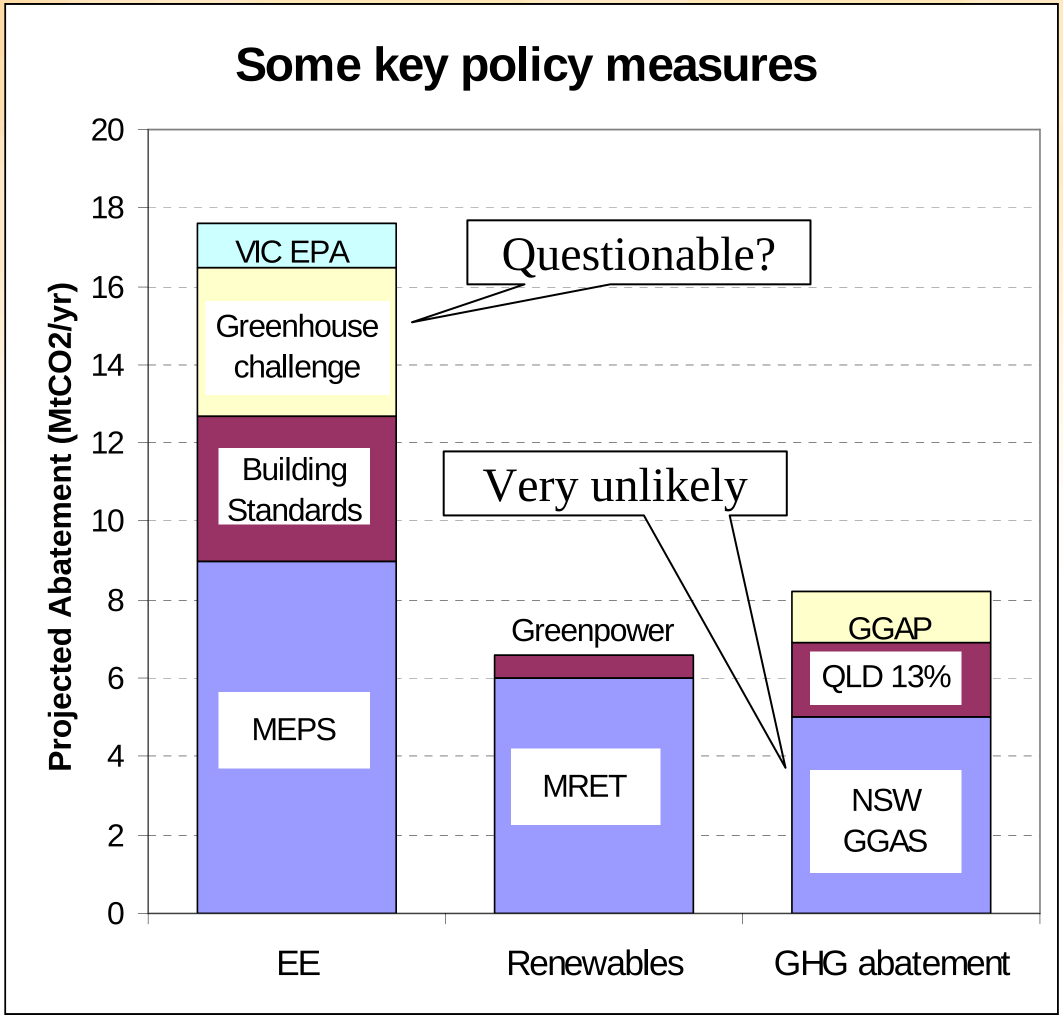


The EU ETS

- The primary instrument for reducing CO2 emissions across power generation and heavy industry in Europe
- However, to date (Phase I)
  - emissions reduced? yet likely €20bn+ windfall profits; most to emitters
  - Perverse incentives that likely reduced investment in appropriate low-emission technologies
  - EC under ‘intense pressure to restore credibility to scheme through their review of phase II NAPs and to demonstrate that ‘cap and trade’ schemes can deliver environmental benefits” (Betz and Sato, Climate Policy, 2006)
- And the future?
  - Phase II; Minor emissions reduction of covered sectors from 2005 levels; estimates of windfall profits of €20bn/year (Financial Times, June 2007) *(c.f. estimated €45bn/year on EU Common Agricultural Policy in 2012)*
  - Phase III; EU target of 20%+ emission reductions in 2020 and more auctioning. However, *EC impact assessment suggests target can be reached by other than ETS sector if EU energy efficiency & renewable strategy are implemented properly, let alone the use of the ‘global carbon market* (CEPS, *The Making of the EU ETS*, 2007)

Outcomes of existing Australian policy framework

- energy-related emissions +56% 1990–2010 (BAU + 66%)
- Considerable overall uncertainty
  - 2003 inventory +/-5%
  - 2010 emissions scenarios range 102-115% (Kyoto +108%)
- *Note that expected ETS impacts not included*

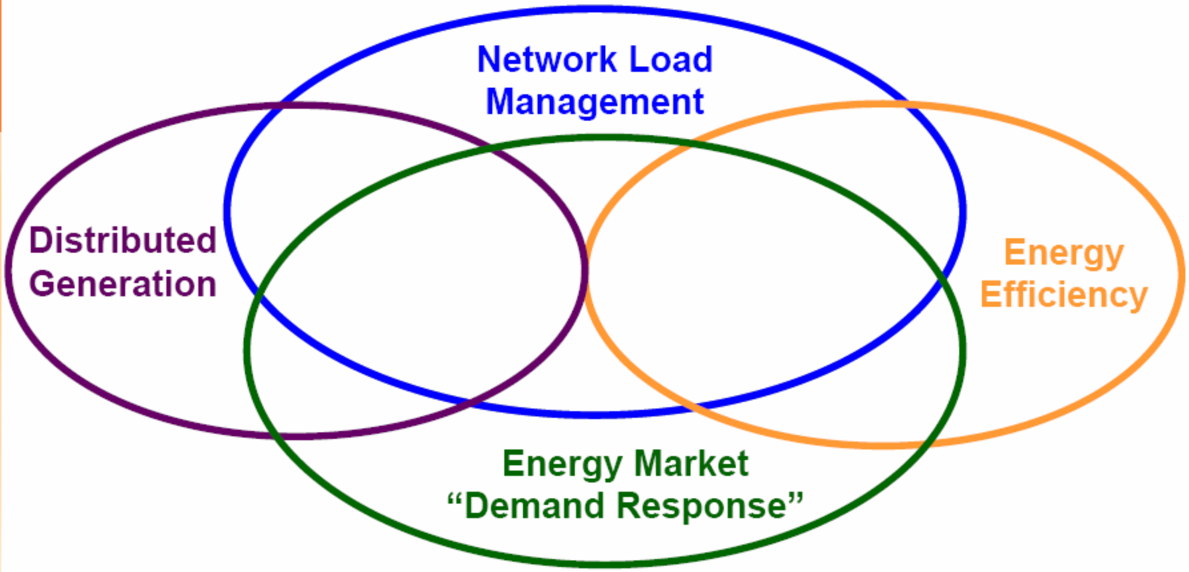


Federal Government policy development

- **Emission Trading System by 2010**. Detailed design finalised by end 2008.
- **Mandatory Renewables Target** of 20% by 2020, 45,000GWh. Scheme design finalised end 2008
- Demonstration and commercialisation funding
  - $500M **Renewable Energy Fund** intended to develop, commercialise and deploy renewable energy.
  - $500M under **National Clean Coal Fund** to finance deployment of clean coal technologies
- A wide range of Energy Efficiency policies and measures
  - Equipment and building energy and emission performance measuring, information and regulation
- Ongoing NEM restructuring

- *numerous diverse State Government policy efforts*

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

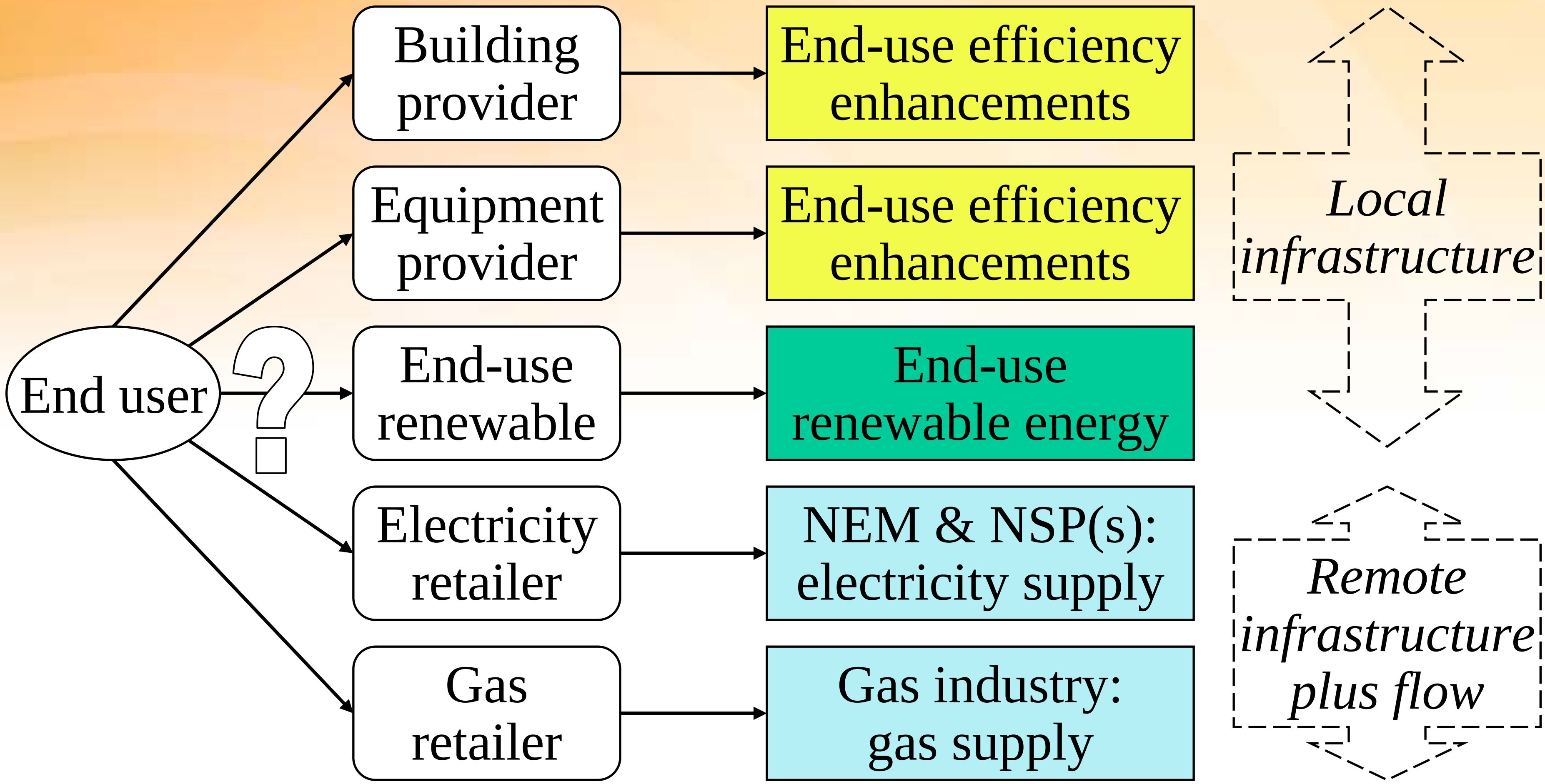
DE's complex yet promising characteristics

- Conceptual complexities
  - Demand side participation
    - … beyond consuming energy and paying bills
  - Controllable loads
    - … controlled with respect to evolving industry objectives
  - Energy efficiency
    - Difficult to define in useful ways
  - Generation, storage or demand
    - Can be technically near entirely fungible wrt overall industry operation
  - Decision makers
    - End-users, retailers or Network Service Providers
- Potentially valuable characteristics
  - Some highly cost-effective alternatives to centralised supply and associated network options
  - Environmental benefits from use of renewable energy resources or highly efficient fossil-fuel use (eg. Cogeneration)
  - Opportunities for greater end-user engagement in achieving desired energy services
- *However, generally limited role played to date in most electricity industries around the world*

Valuing EI related energy services requires…

- Energy value
  - Locational, time varying + contingency value on energy: *spot* + *forward*
  - Investment decisions determine most of this value
  - Value on Quality of Supply attributes
- Network value
  - Locational time varying + contingency value on network flows: *spot* + *forward*
  - Network investment decisions determine most of this value
- Environmental value
  - A range of adverse environmental impacts associated with different generation technologies, locations
  - Schemes that internalise externalities such as GHG emissions through Carbon Tax, Emissions Trading, niche market support (eg. MRET) can be used to 'capture' some of these values

Ideal decision making in the stationary energy sector: *led by the end-user*



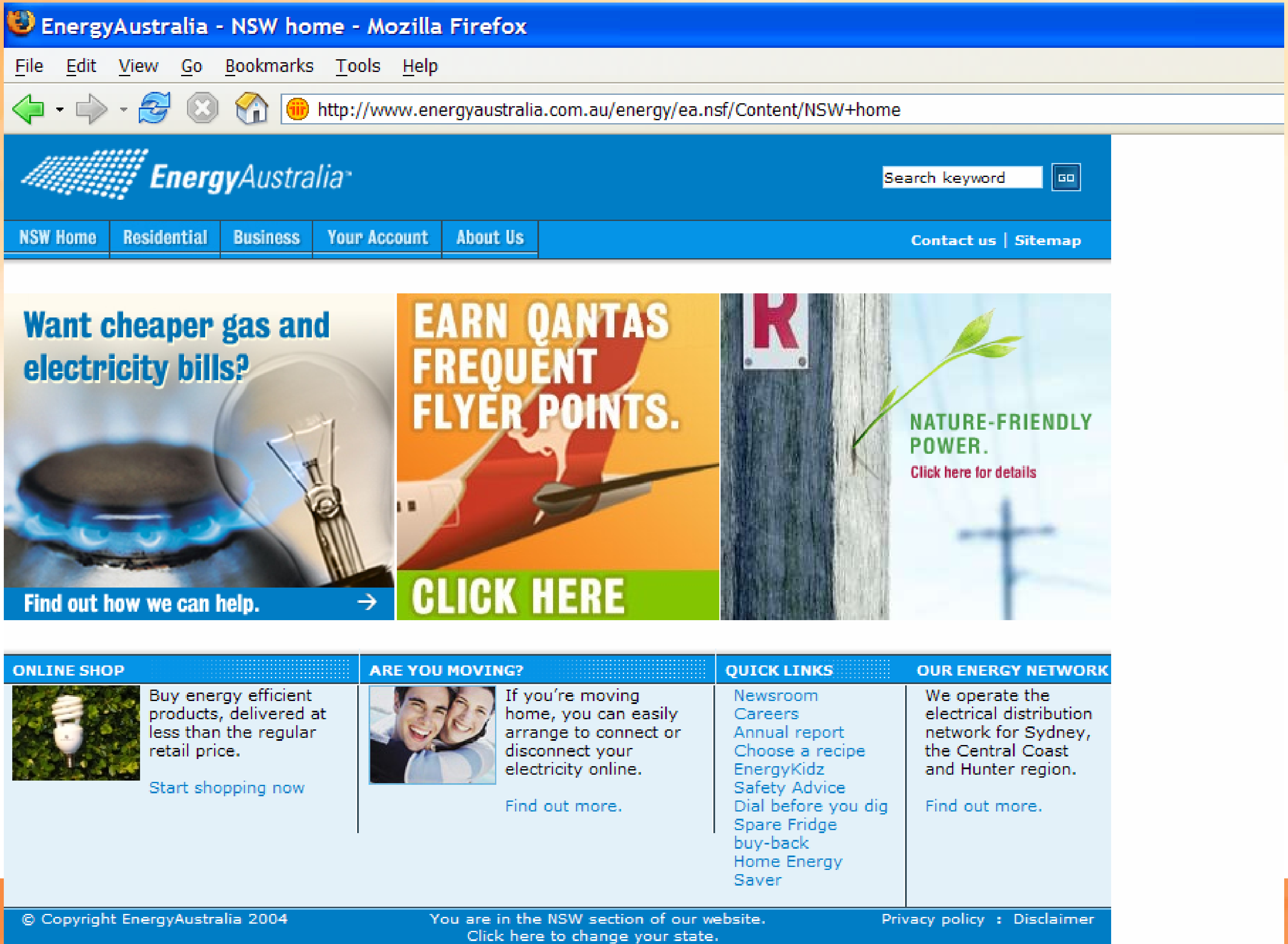
Barriers to good end-user decision-making

- Barriers for local infrastructure options:
  - Knowledge, cash flow, innovation & risk exposure
  - Limited influence over options (dependence on others eg. landlords)
  - Need for coordinated decision making to value diversity
- Barriers for remote infrastructure & flow options:
  - Limited knowledge & influence (dependence on others)
  - Revenue recovery retail tariffs (ex-post taxation)
  - Business as usual (status quo rather than innovation)
  - Regulators & system operators take key decisions:
    - To maintain availability & quality of energy flow
    - For which end-users bear most of the costs

Present retail market design in Australia

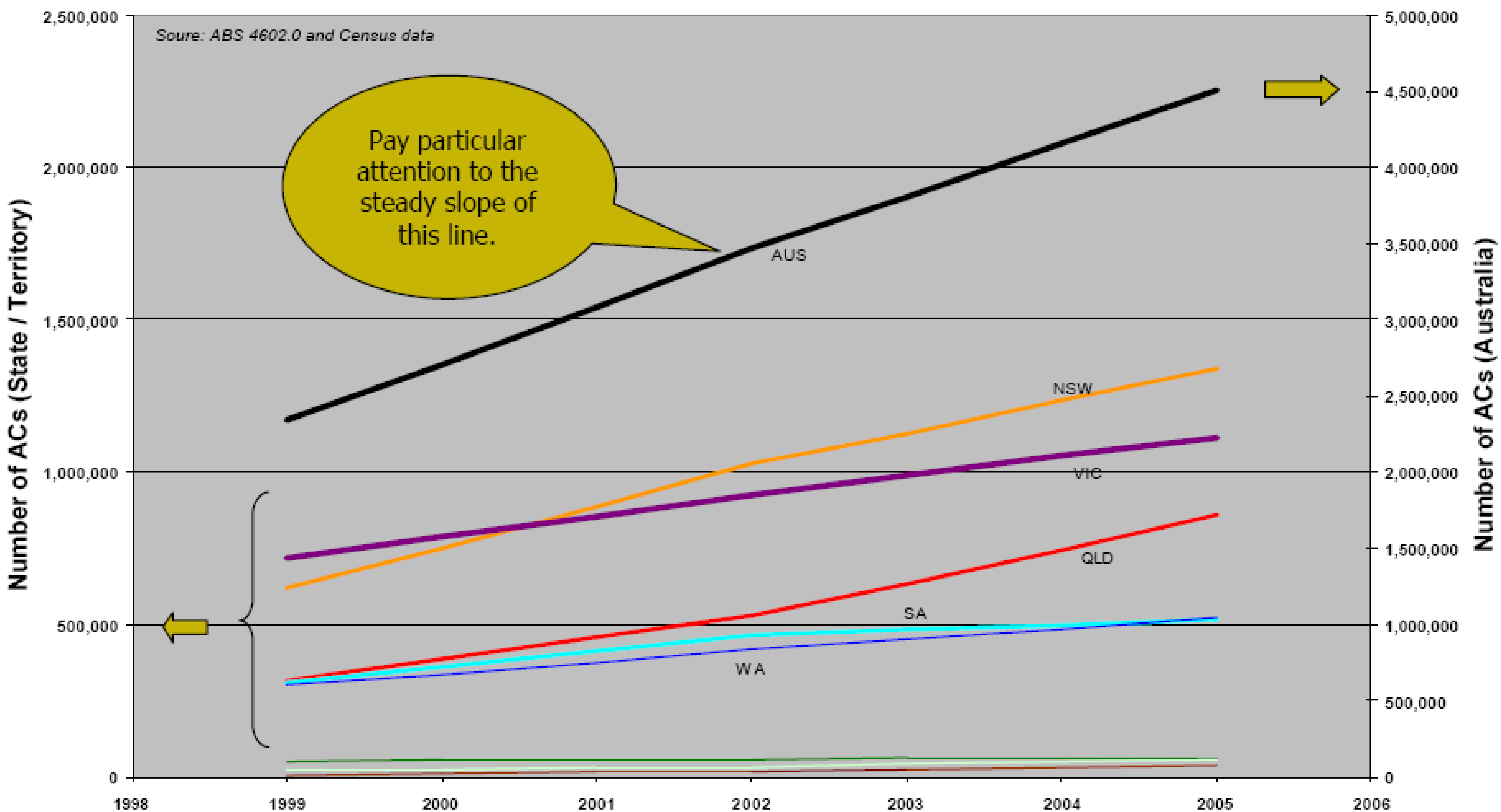
- Retail market design for large end-users:
  - Competitive retail market (not yet mature)
  - Regulated network pricing (not yet mature)
- Retail market design for small end-users:
  - Regulated or partially competitive retail market
  - Simplified tariff structure; immature metering; profiling
  - Network charges usually passed through retailer
  - Little support for informed end-user decision making
- Some social policy objectives internalised
- Some environmental objectives internalised
- Limited opportunities for embedded generation

Current Full Retail Competition limited

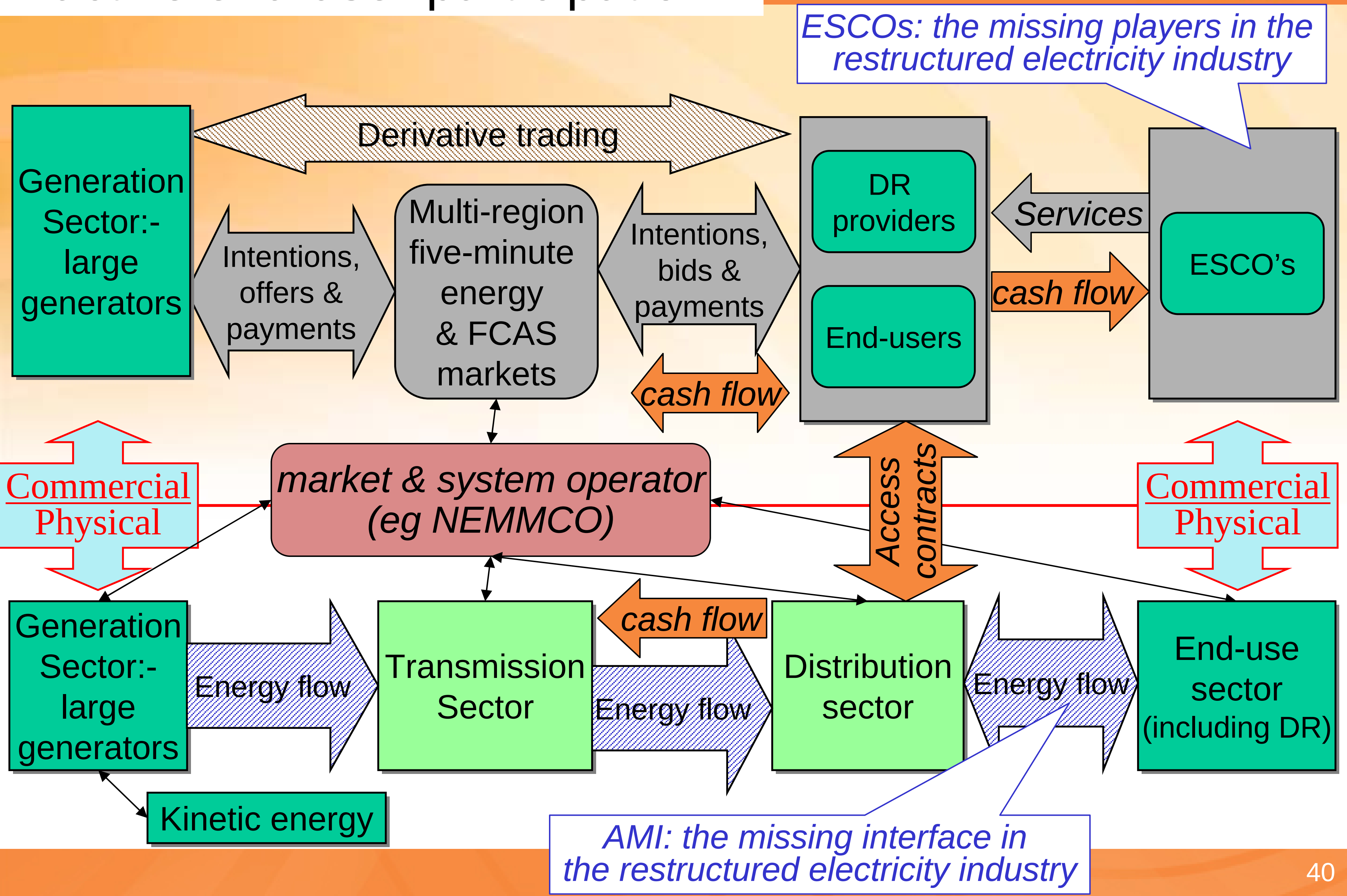


Meanwhile, decision making in the real world

(Washusen, 2005)



Enhanced NEM structure with active end-user participation



General principles to guide policy efforts

- What exists is possible
  - existing off-the-shelf energy efficiency, gas & renewables have demonstrated capabilities in reducing emissions & understood costs.
- What doesn't yet exist may or may not be possible
  - and while these options should be pursued, shouldn't be relied upon – eg. waiting for CCS or emerging renewables before taking action high risk
- It takes time to commercialise technologies
  - additional money can shorten but generally can't eliminate such delays
- It takes yet more time to develop industrial, infrastructure and institutional capacities
  - Key to taking technologies from niche applications to widespread deployment.
  - The Built Environment is one of the key infrastructures that needs to be transformed in order to achieve energy and environmental goals

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Thank you… and *questions*

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