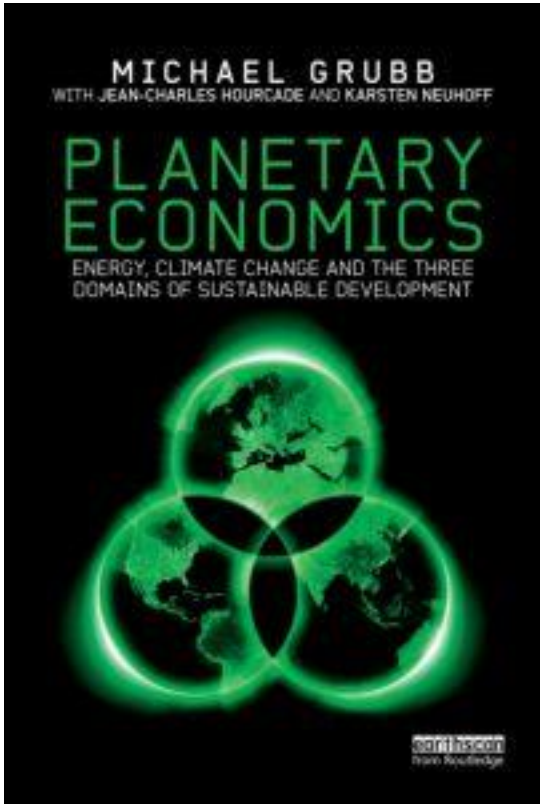
Navigating turbulent times

An integrating approach to energy-climate security and policy



Drawing on the book *Pla*

Michael Grubb

Prof. International Climate Change and Energy Policy, UCL

Editor-in-Chief, *Climate Policy* journal

Senior Advisor, Ofgem

With

Jean-Charles Hourcade and Karsten Neuhoff

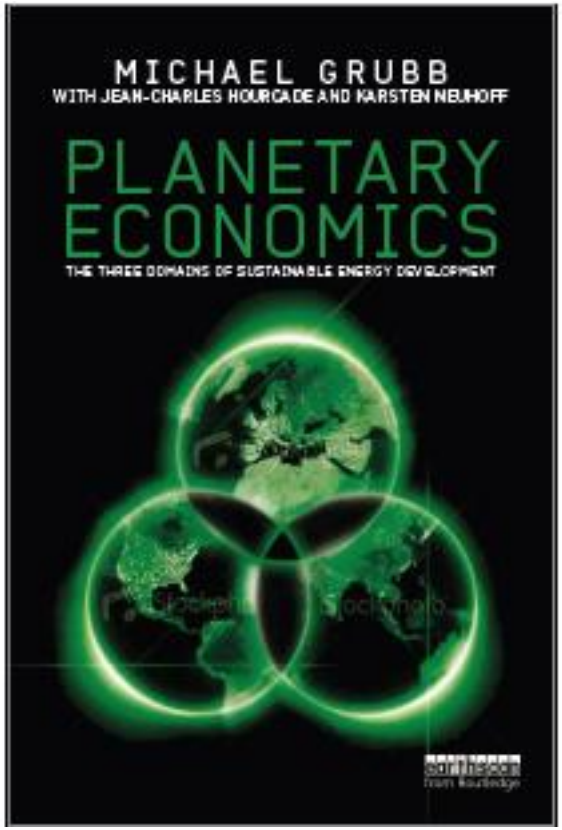
Presentation to BIEE, 25 June 2014

4CMR

ofgem Making a positive difference for energy consumers

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

An integrated approach to Energy Transition



- Nature of the energy-climate challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment
- Growth theory and macroeconomic linkages
- Policy Integration
- *A digression / illustration: electricity transitions and Capacity Mechanisms*
- Joint Benefits
- The Economics of Changing Course

4CMR

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

Turbulent times ..

- Security
- “Affordability”
- Resources & climate

ie. The “Trilemma”

Define boundaries more than trade-offs?

Climate change economics 101:

Severity & CBA debates have been largely about the *discounting, scope* & *risk aversion* in impacts analysis (Weitzman's Dismal Theorem)

		Which kind of impacts?		
		Market	Non-market	Multiple stresses and socially contingent
What kinds of climate changes?	Projection (trend)	Coastal protection; Dryland loss; Energy (heating and cooling)	Heat stress; Wetland loss; Ocean acidification; Ecosystem migration/ termination	Displacement from coastal zones; Regional systemic impacts
	Climate variability & (bounded) extremes	Agriculture; Water; Storms	Loss of life; Biodiversity; Environmental services	Cascading social effects; Environmental migration
	System changes & surprises	'Tipping point' effects on land, resources	Higher order social effect; Irreversible losses	Regional collapse; Famine; War

Figure 1.8 The risk matrix: an assessment framework for evaluating the social cost of climate change
Source: Developed by the author from Downing et al. (2007), Jones, R. and G. Yohe (2008), Downing and Dyszynski (2010).

Note: 'Socially contingent' costs may be understood as those that may be amplified by the inability of society to respond to impacts effectively, such as failures of governance , inability to act collectively, or the frictions associated with migration or deeper disturbances

Climate change – context

- A mega-problem of risk management under deep uncertainty
  - Not the primary science but the consequences
  - .. And how to value them, act, and coordinate response
- “The biggest market failure in history” (Stern)
- “The perfect moral storm”
- A “Super-Wicked” problem

And we have not been doing very well globally ...

- “Current trends are at the high end of levels that had been projected … growing on average at 2.2%/yr since 2000” [IPCC 2014]
- Energy debate in Europe dominated by bills and competitiveness
- Frontier energy investments concentrated on finding more Carbon …
- Developing countries largely following the existing model

Trade-offs in short term highlight need for *cost management*

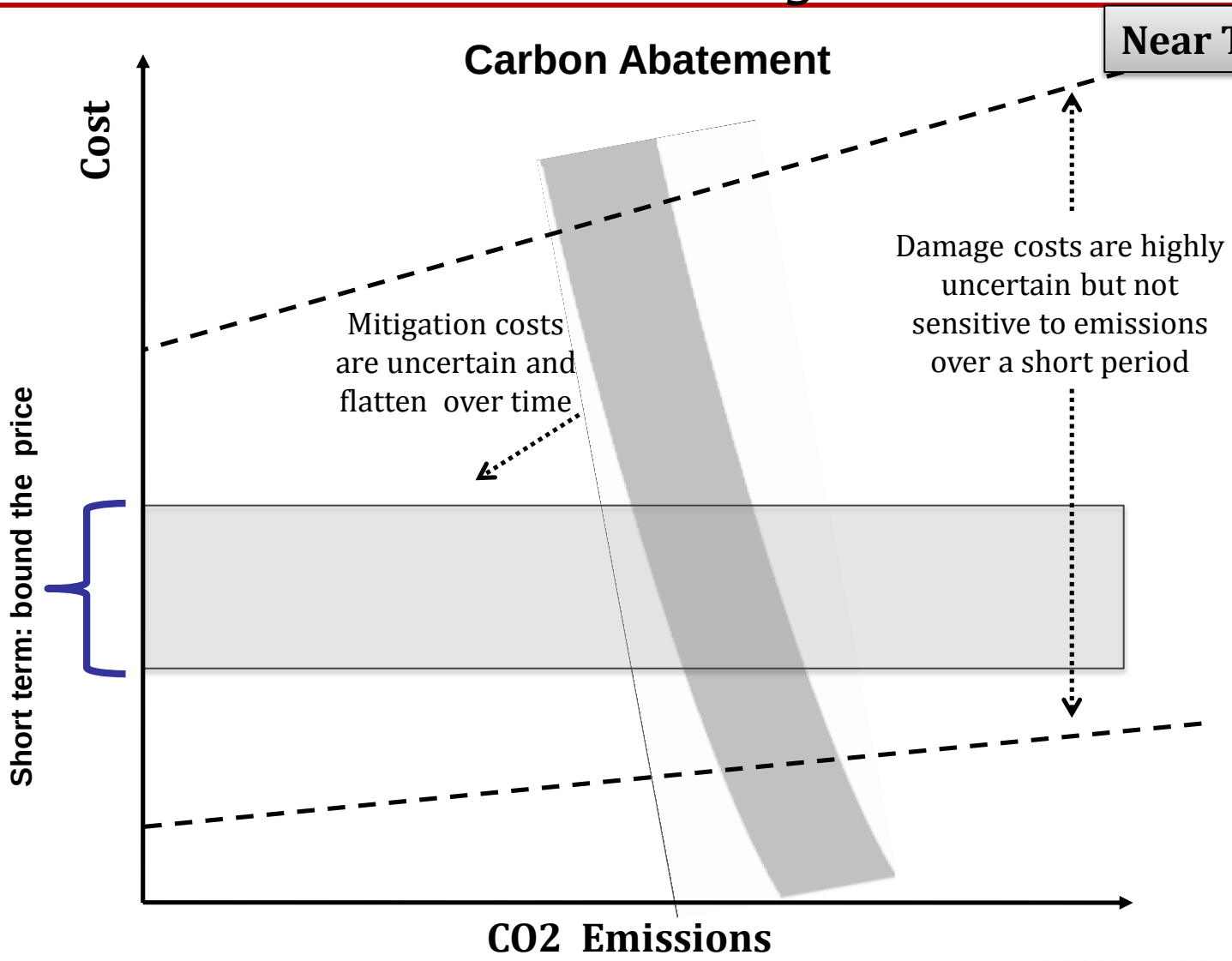


Figure 6-6 Stylised benefits and costs of cutting emissions: implications for 'tax or cap'?

Evidence of strong *long run* adjustment of costs…

National energy intensity approx inversely proportional to long-run prices

- across countries the % of GDP spent on energy is remarkably constant

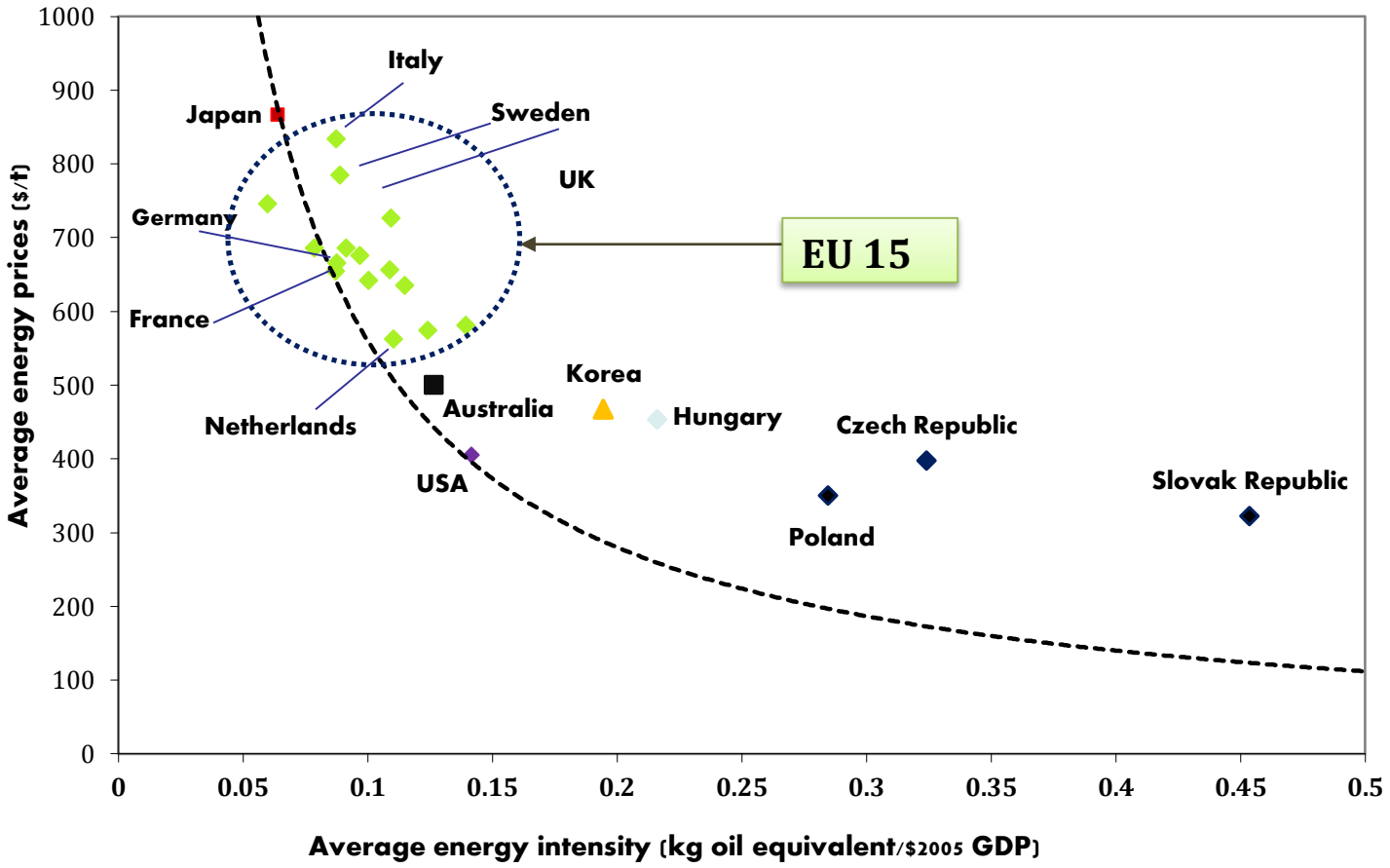


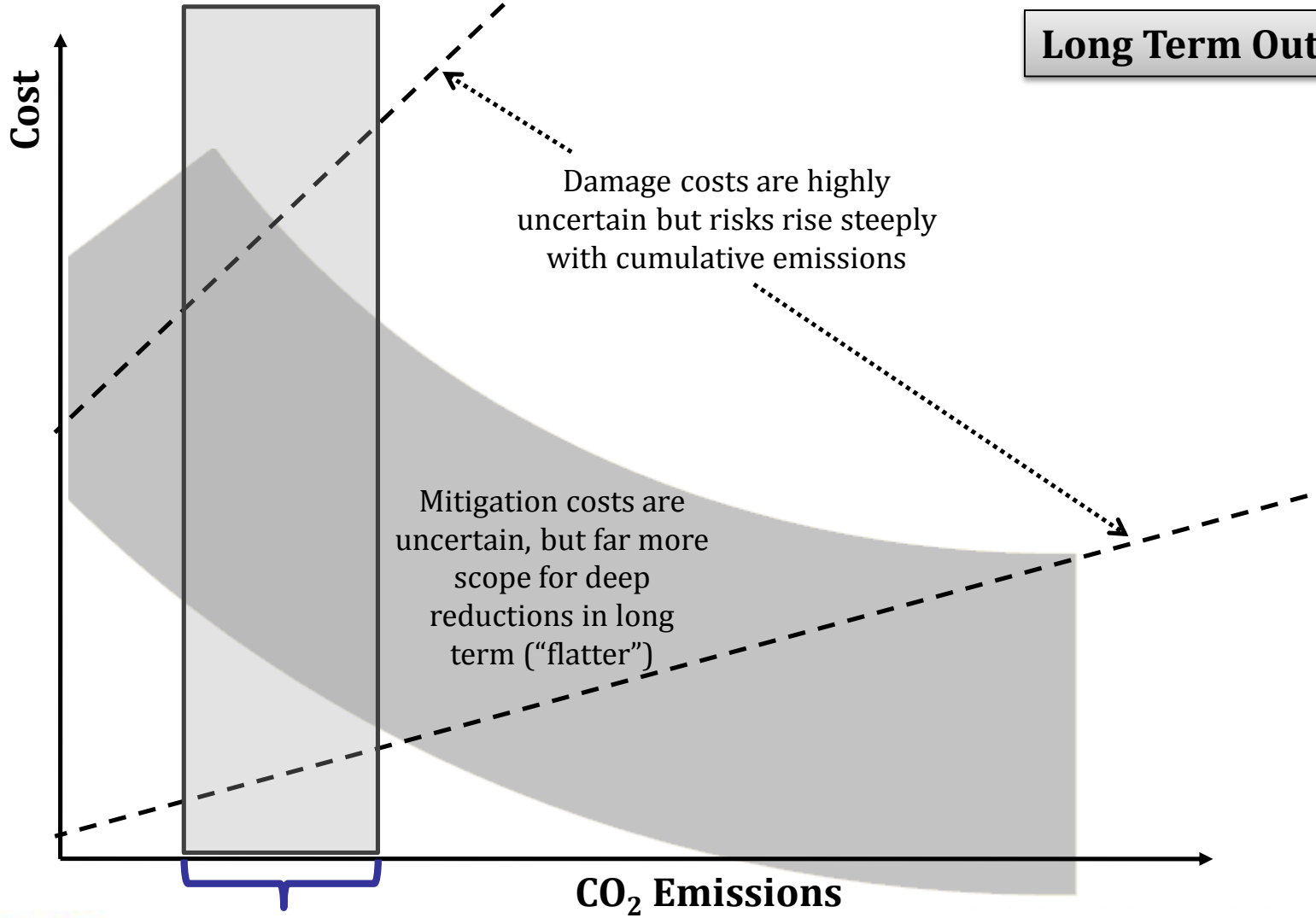
Figure 6-1 The most important diagram in energy economics

Note: The graph plots average energy intensity against average energy prices (1990-2005) for a range of prices. The dotted line shows the line of constant energy expenditure (intensity x price) per unit GDP over the period.

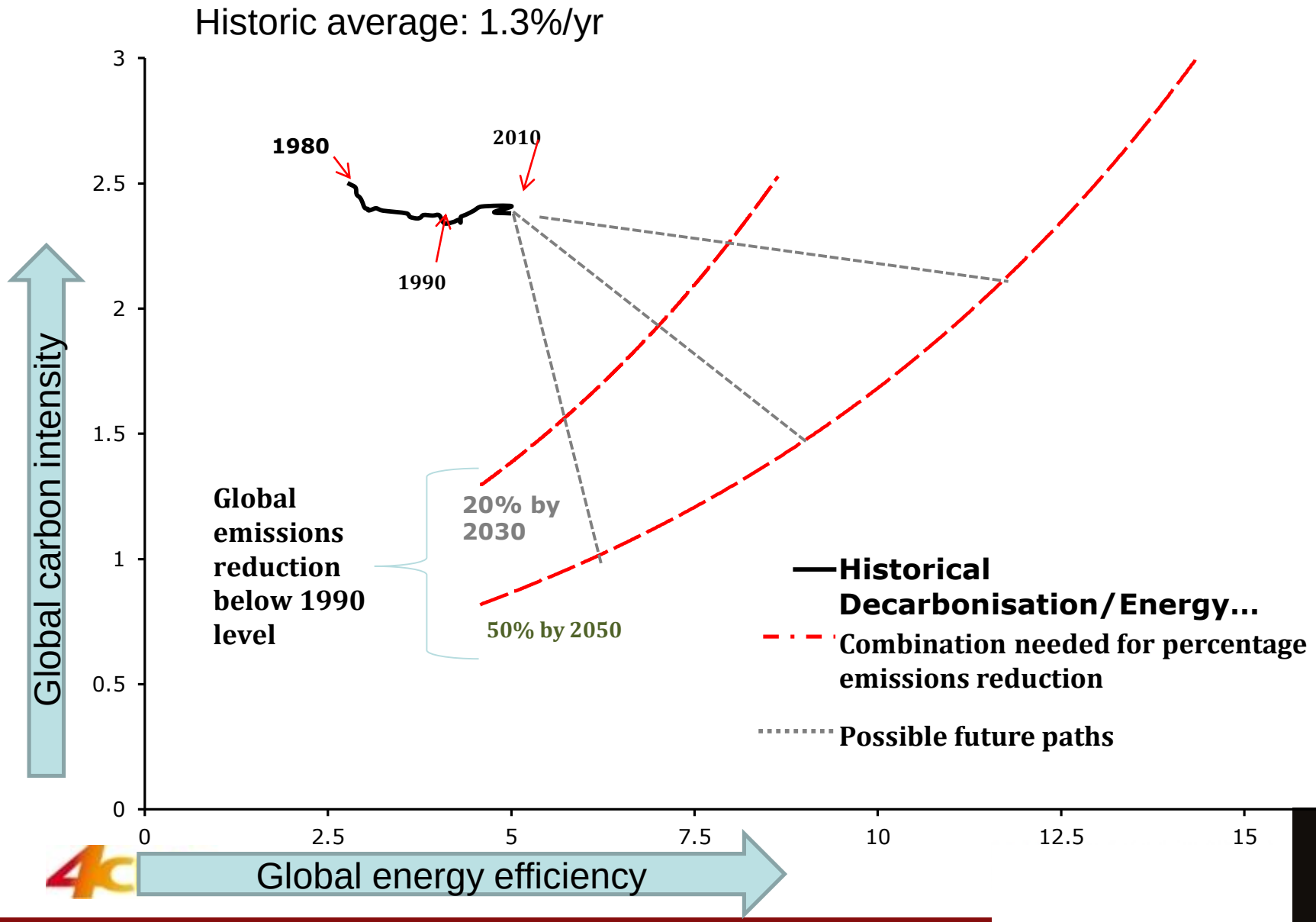
Source: After Newbery (2003), with updated data from International Energy Agency and EU KLEMS

Scope for adjustment in long term enables a security-oriented, goal driven approach to safe boundaries

(ii) in the long term, fix a safe quantity



The energy challenge of decarbonisation



Carbon & energy intensity has fallen but countries remain at widely varying levels

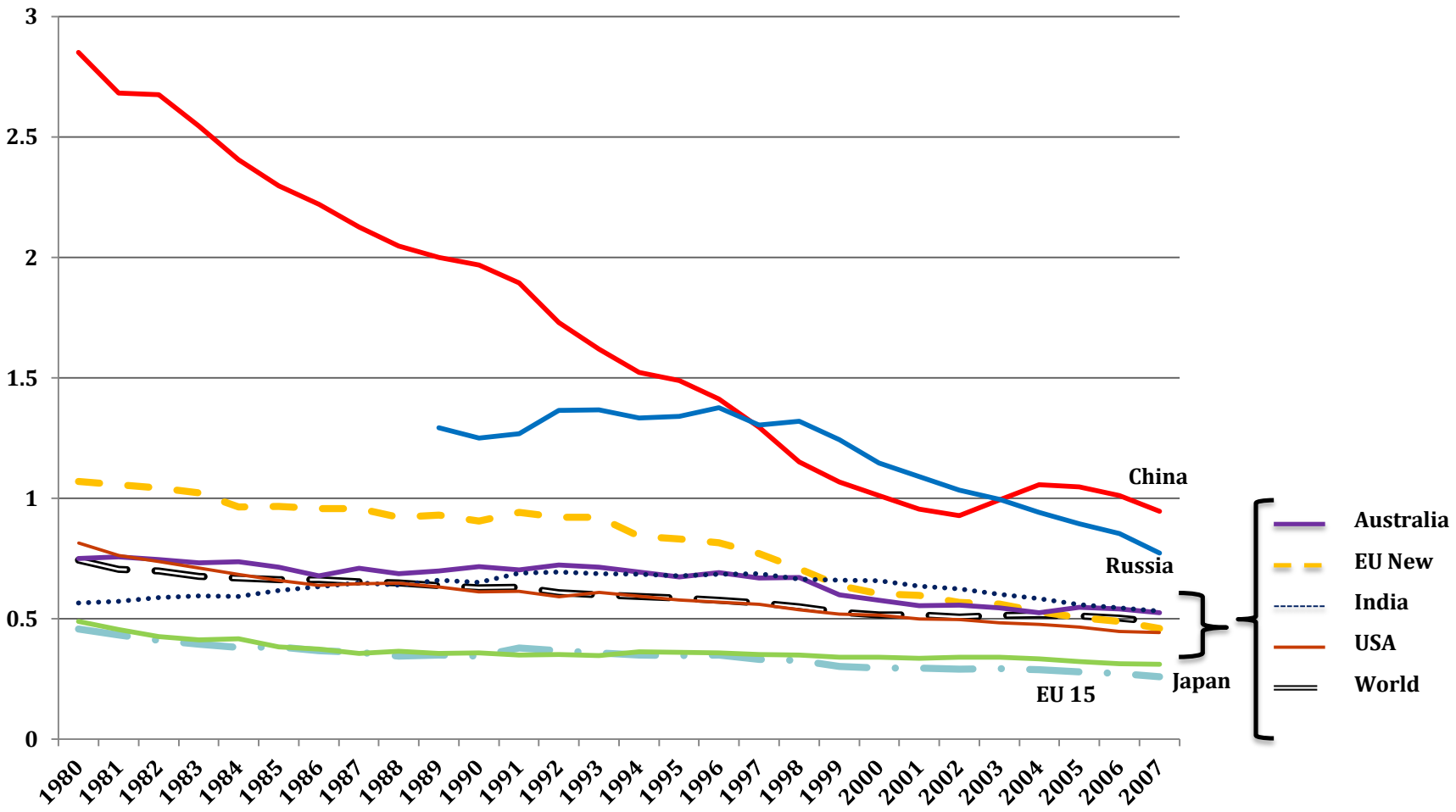


Figure 1.6 Trends in carbon intensity, by region and globally from 1980-2008

Source: Authors. Data from IEA (2010) and World Bank (2011)

… Over last few decades, largely stable per-capita emissions (recent declines) in industrialised countries with little sign of convergence

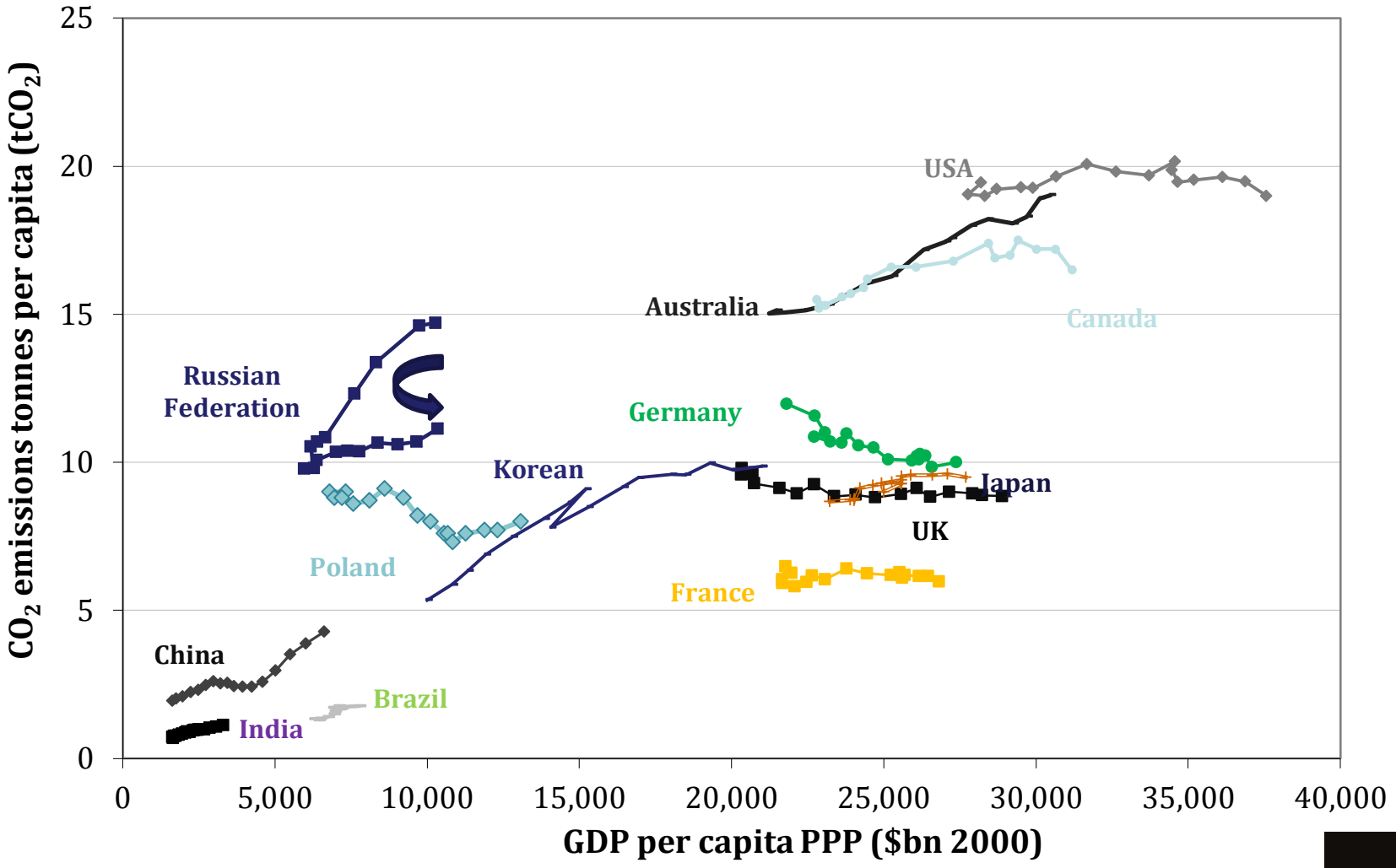


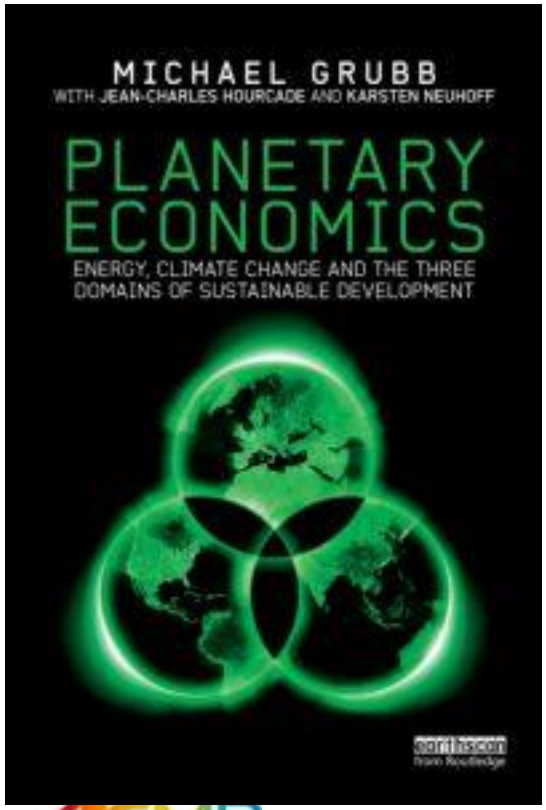
Figure 1.7 Per-capita CO2 emission trends *vs income* - trends of major countries
Source: Authors. Data from World Bank (2011) and IEA (2010)

An integrating approach to climate policy

Three Domains

and the

Three Pillars of Sustainable Development



- Nature of the challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment
- Policy Integration
- Joint Benefits
- The Economics of Changing course

Prelude: three levels of risk conception ..

Risk Conception	Basic Belief	Typical Strategy	Societal process	Time-scale of climate change
Indifferent or disempowered	Not proven, or "What you don't know can't hurt you"	"Ignorance is bliss"	NGO campaigns *vs* .resistance lobbying	First few decades of climate change
Tangible and attributed costs	Weigh up costs and benefits	Act at costs up to level of marginal benefits	Technocratic valuation and politics of pricing	As impacts rise above the noise – next few decades
Disruption and securitization	Personal or collective security at risk climate change as a "threat multiplier"	"Containment and defence"	Mitigate as much as practical and adapt to the rest	**Ultimately,** for all (systemic and global risk) **Most vulnerable**, sooner, with international spillover

The "Bashmakov-Newbery Constant"

- The proportion of national income spent on energy has remained surprisingly constant
  - for more than a century
  - for most countries
- *Despite* huge variations in energy prices (Bashmakov)

- This cannot be explained through the classical measures of in-country consumer price response (elasticities) but needs also to invoke:
  - **Energy efficiency** regulation and related policy responses
  - **Innovation** throughout energy supply and product chains

Three Domains – an Economic Interpretation

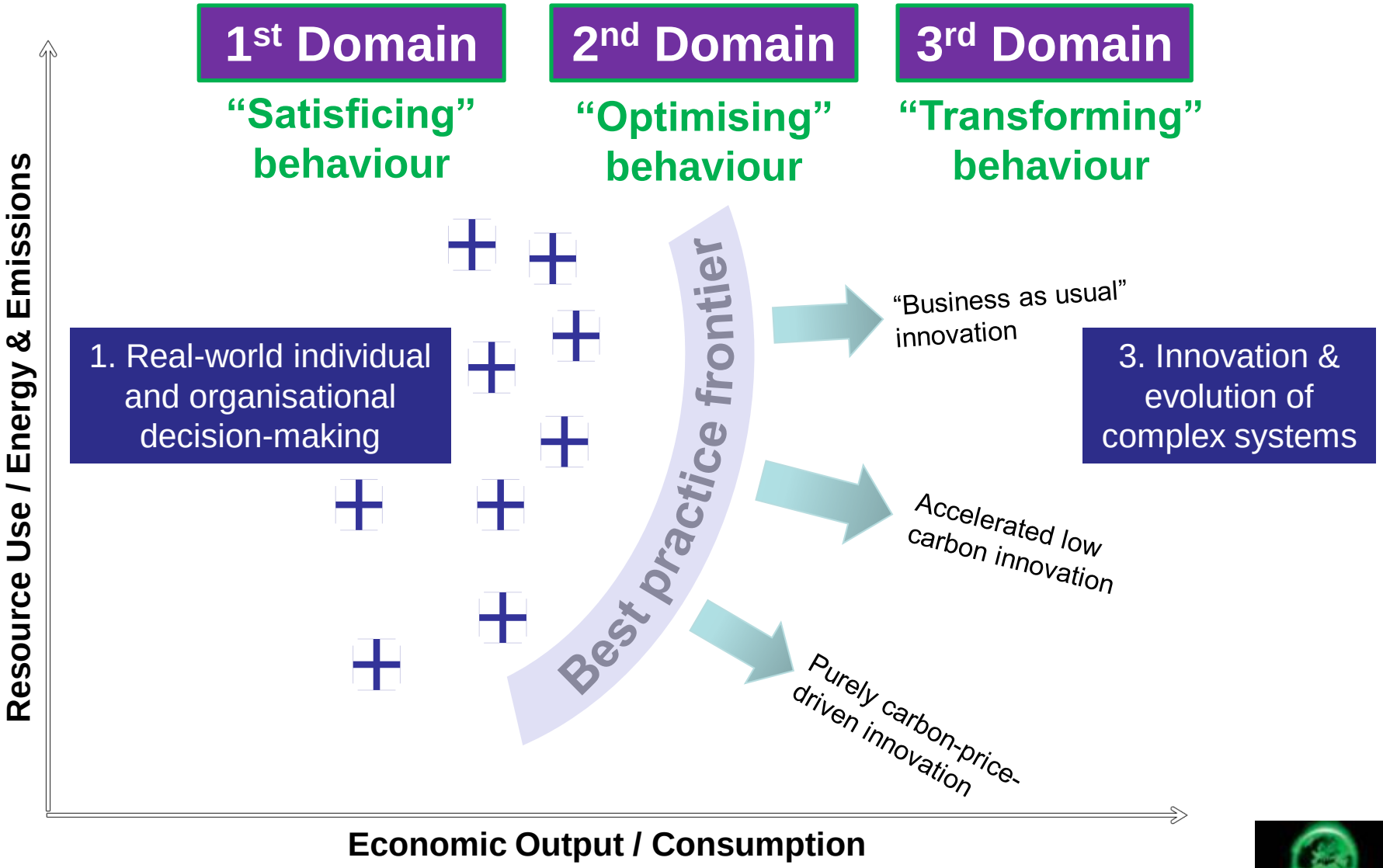


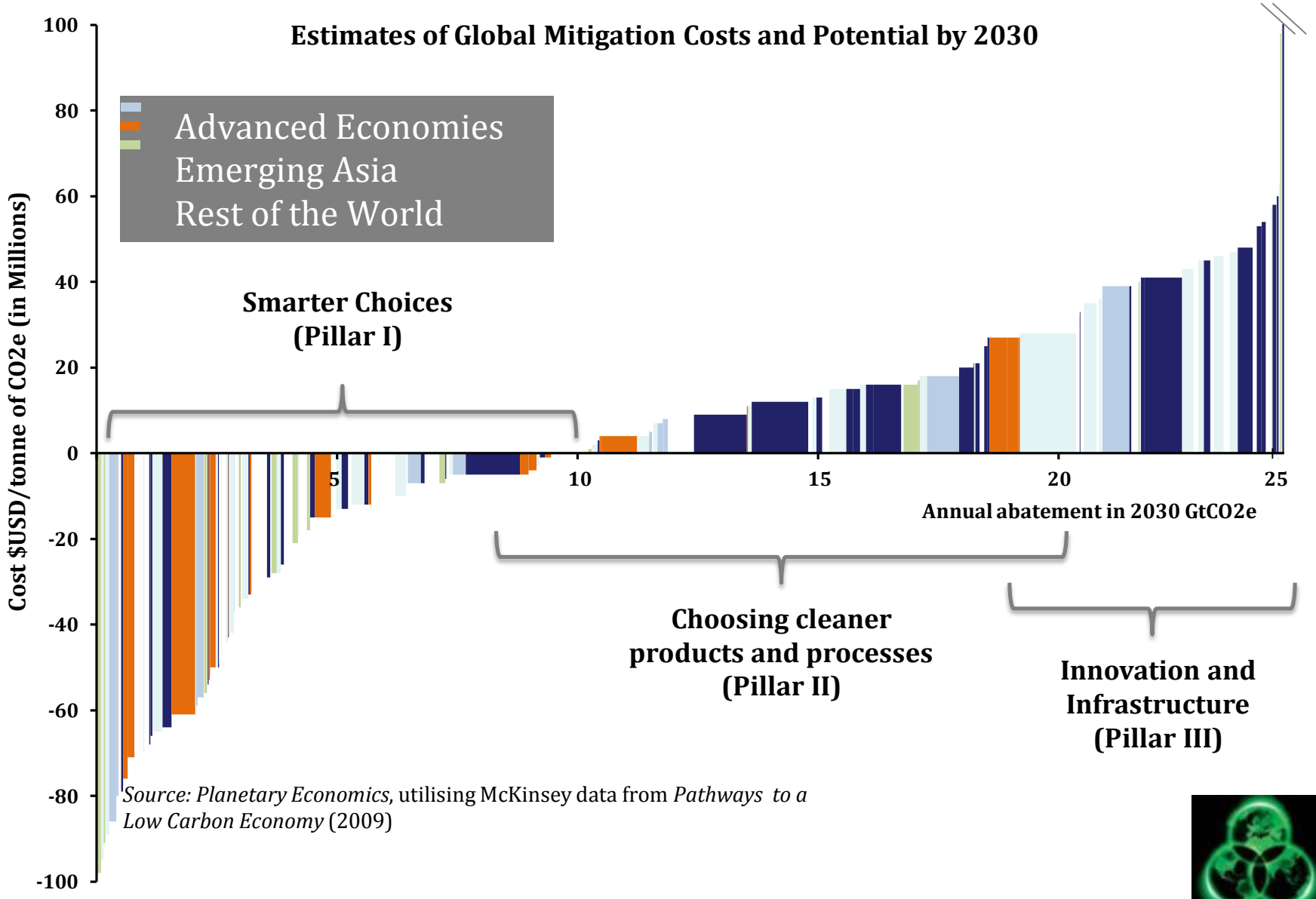
Fig. 2 -3 b Resource trade-offs with the other two domains

Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

The Three Domains rest on different fields of theory that apply at different scales

Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

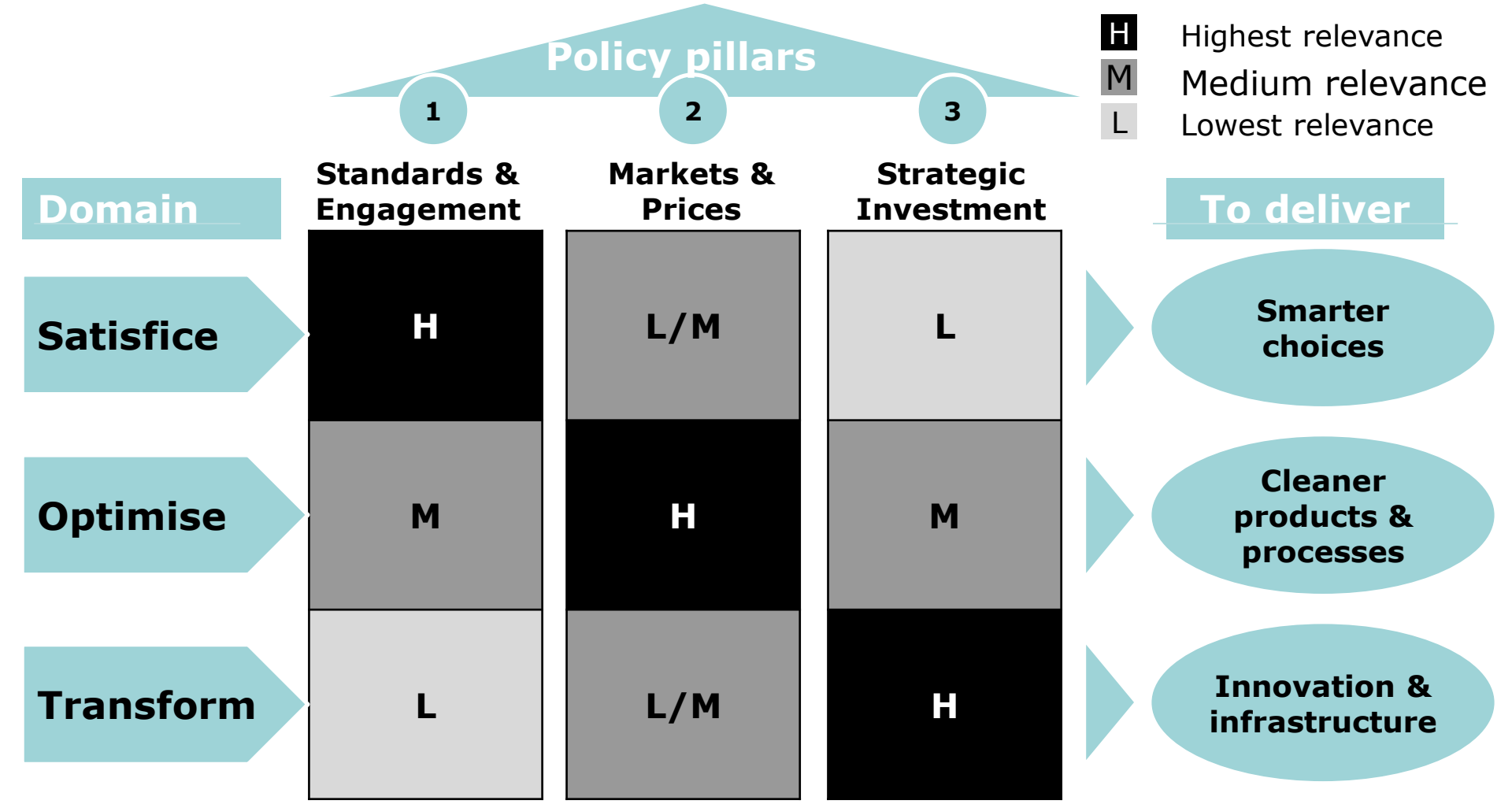
Three realms of abatement opportunities .. - [Global estimates for 2030 highlight first two ..]



Source: Planetary Economics, utilising McKinsey data from *Pathways to a Low Carbon Economy* (2009)

Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

Solutions need to harness corresponding policy pillars based on the three domains, to transform energy systems



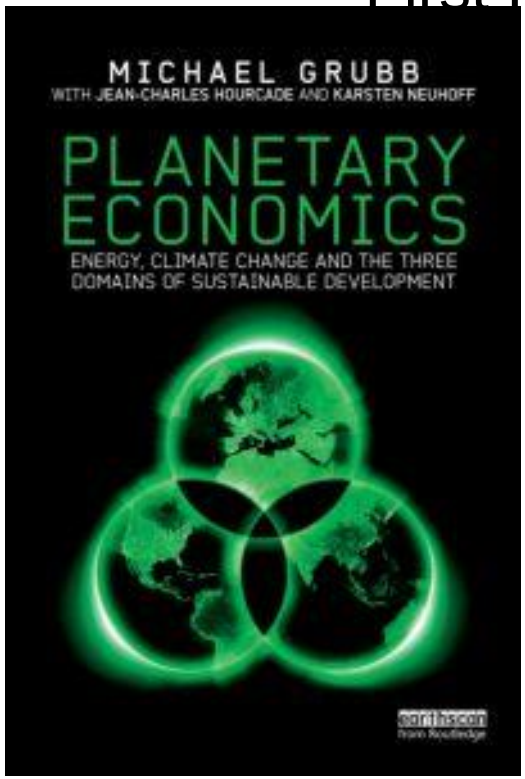
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

An integrating approach to climate policy

Three Domains

and the

First Pillar of Sustainable Development



- Nature of the challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment
- Policy Integration
- Joint Benefits
- The Economics of Changing course

4CMR

Energy and emission flows within the fossil fuel system

Note: The lower panel gives the numeric breakdown at each stage illustrated in the upper panel. Numbers at each step in the Chart (fuel, channel, end-use) independently add to 100%.[1]
All data from the International Energy Agency, accessed through ESDS.

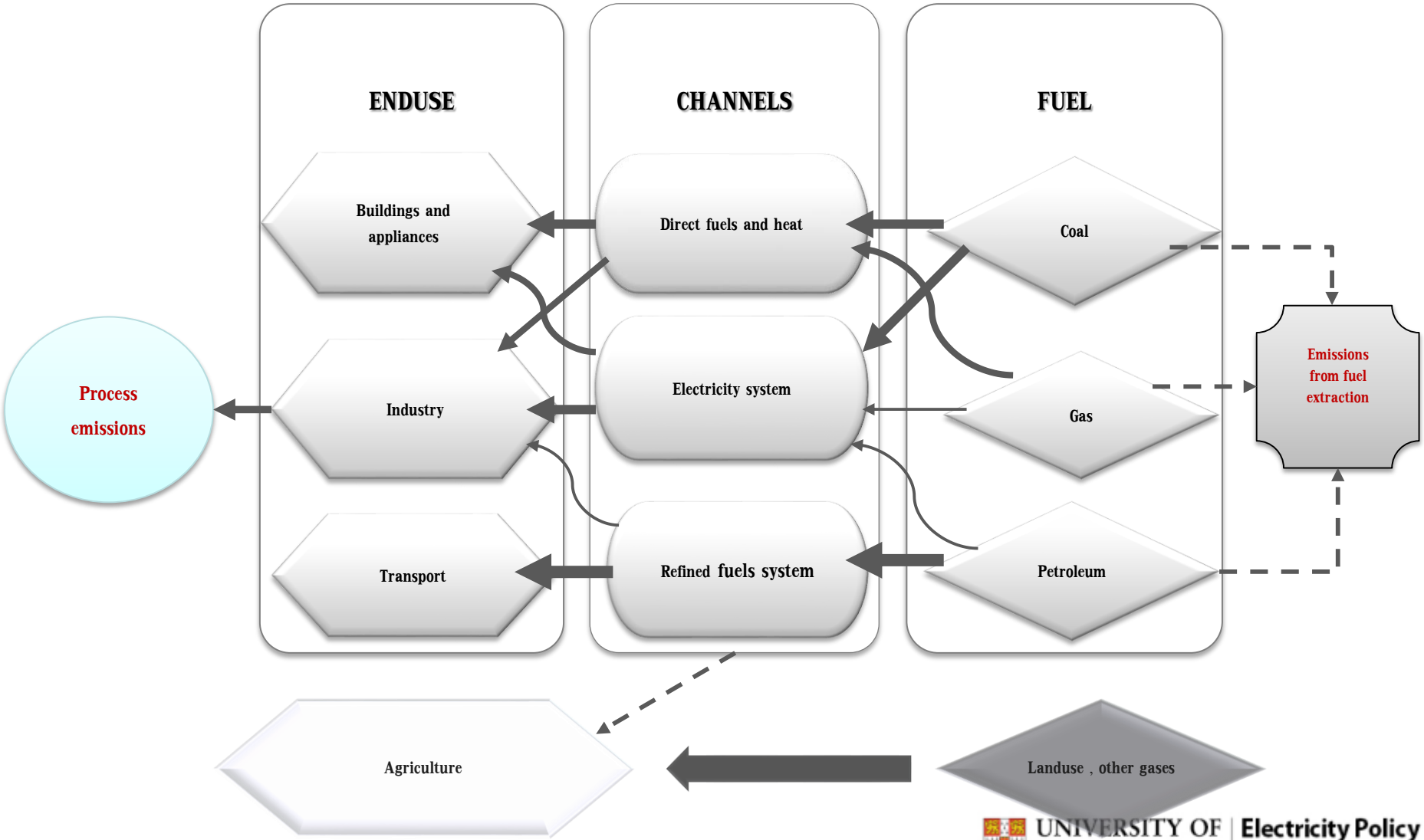


Fig. 3.1 a

In transforming energy systems globally, *all three domains are*

- … approximately ***equally important***
  - Cost curve data
  - Difference between in-country and international elasticities
  - Observed policies of the most successful countries
  - Suggestive evidence from economic Growth Accounting

  & individual pillar 'bottom up' evidence

- *.. and* ***interdependent***
  - *The pillars are complementary, not competing*
  - *"Any pillar on its own will fail"*

But the relative importance of different measures varies across sectors and nature of co-benefits are diverse

A key to Planetary Economics – and politics – lies in the *potential to align different levels of risk conception with the different pillars of response*

Risk conception / Domain	Dominant scale	Decision framework	Field of theory	Mitigation economic process	Realm of opportunity	Pillar of policy/ response
Ignore / Satisfice	Short term / local	Indifferent or disempowered	Behavioural & Organisational	Move closer to the 'best practice frontier''	'Smarter choices'	Standards and engagement (Pillar I)
Compensate/ Optimise	Medium term / regional	Costs / impacts are tangible and significant	Neoclassical & welfare economics	Make best trade-offs along the frontier	Substitute cleaner production & products	Markets and pricing (Pillar II)
Secure/ Transform	Long term / global	Transformational risks and opportunities	Evolutionary & Institutional	Evolve the frontier	Innovation & infrastructure	Strategic investment (Pillar III)

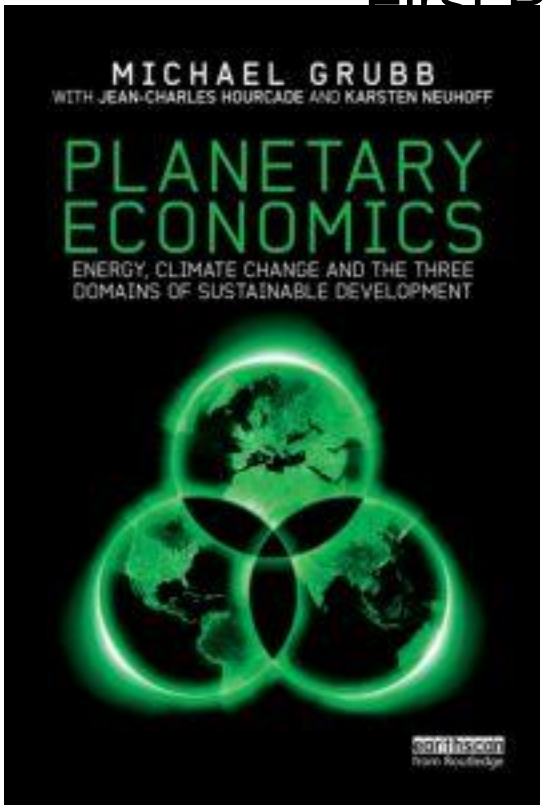
Figure 2-6 Alignments within each domain

An integrating approach to climate policy

Three Domains

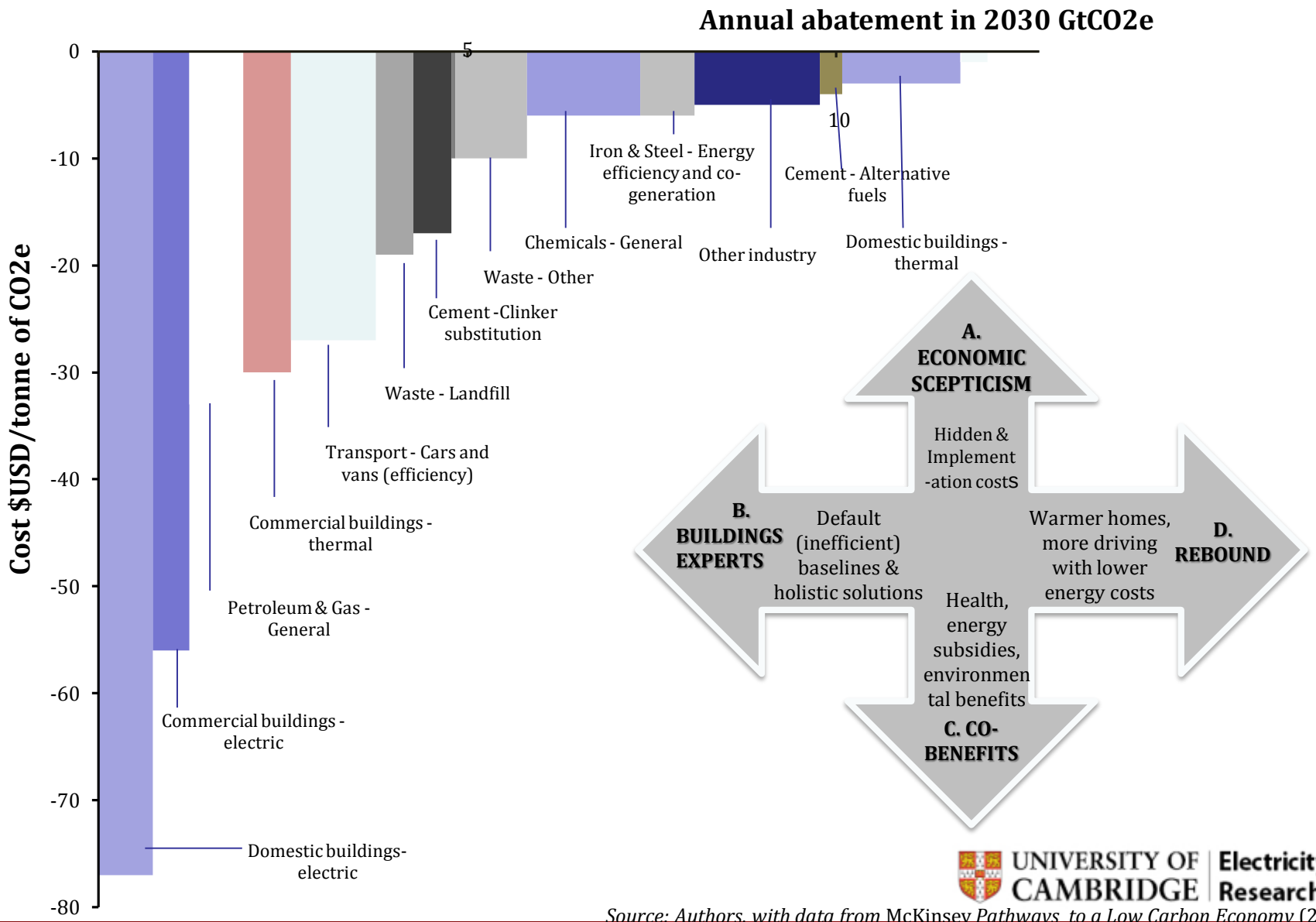
and the

First Pillar of Sustainable Development



- Nature of the challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement for Smarter Choices
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment
- Policy Integration
- Joint Benefits
- The Economics of Changing course

Evidence confirms potential exists across individuals and organisations and many sectors, and endless scope to argue about how 'big and real' it is …



Source: Authors, with data from McKinsey *Pathways to a Low Carbon Economy* (2009)

But in both buildings & vehicles, balance is moving towards embodied energy

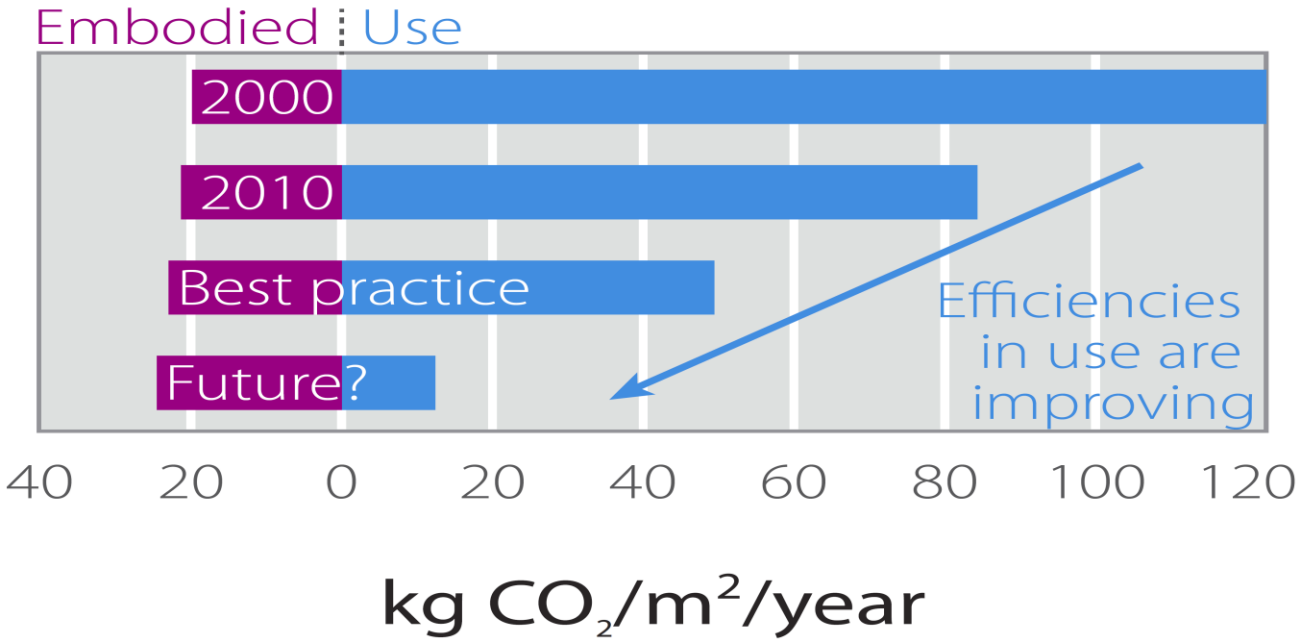


Figure 5-11 Embodied energy in buildings

Source: Allwood and Cullen (2012)

Taking energy / resource efficiency much further is likely to require digging into dimensions of use and embodied energy

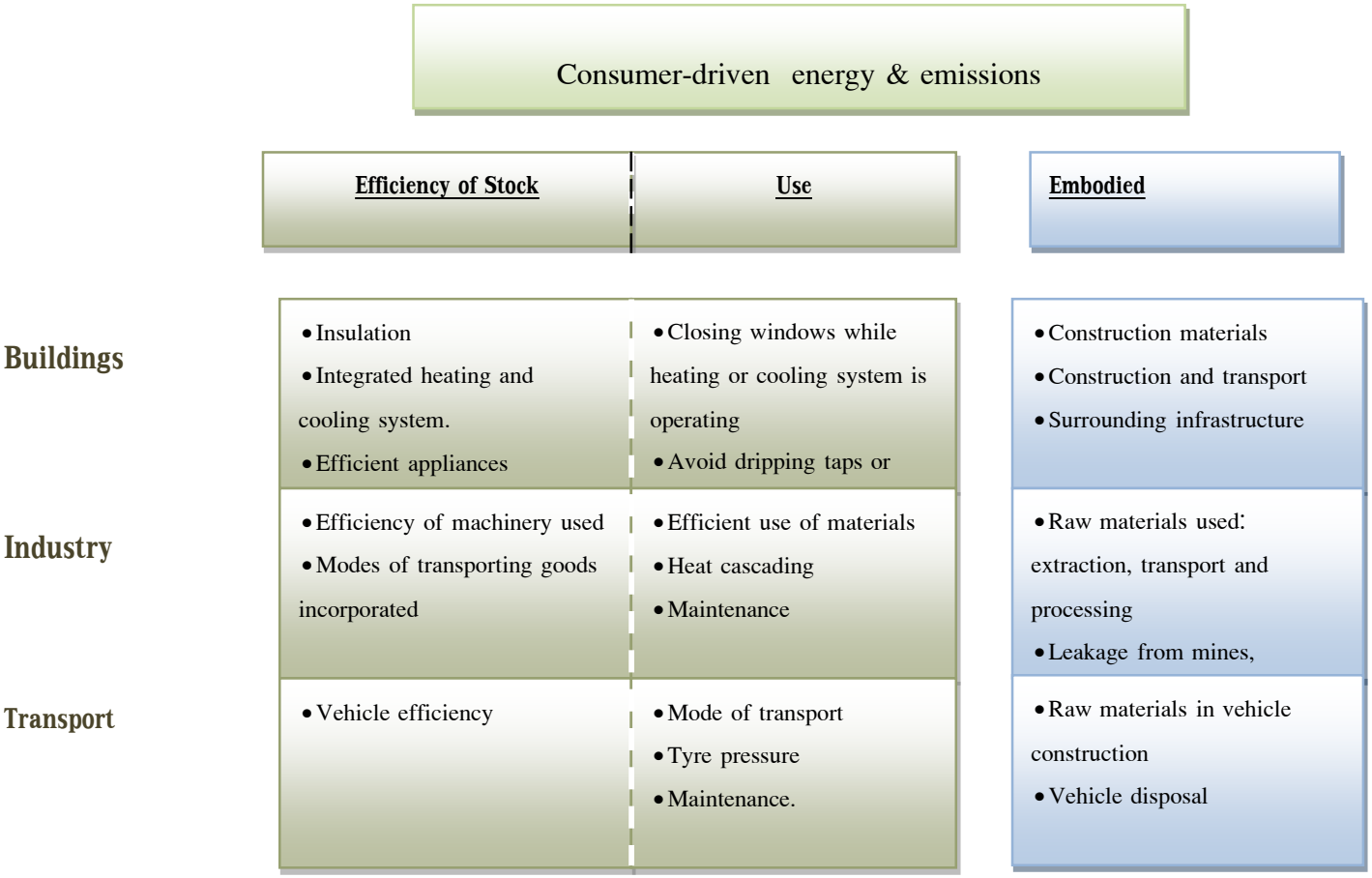


Figure 5-10 The scope of consumer-driven emissions

Note that these categorisations of the consumers' part are not entirely independent of one another. For example the emissions from the industrial process make up the embodied emissions of consumer goods and services.

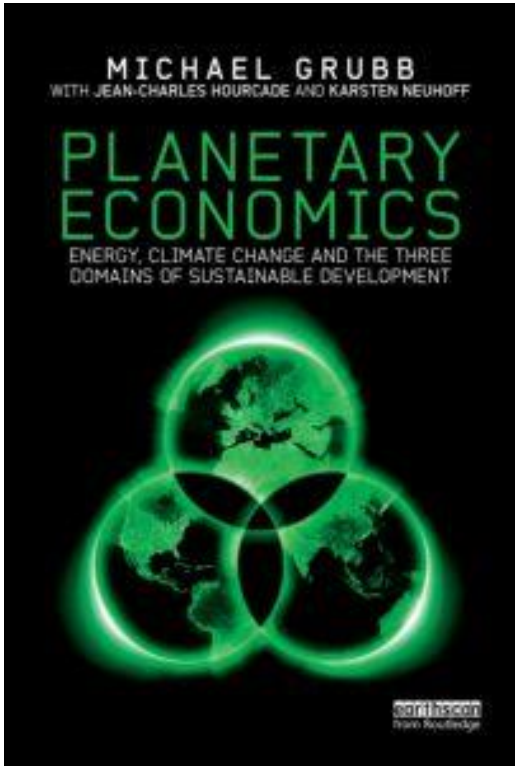
Source: Authors

An integrating approach to climate policy

Three Domains

and the

Second Pillar of Sustainable Development



- Nature of the challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing for cleaner products and processes
- Pillar III: Strategic investment
- Policy Integration
- Joint Benefits
- The Economics of Changing course

Price stabilisation mechanisms are essential for credibility – *and also for linkages to other domains*

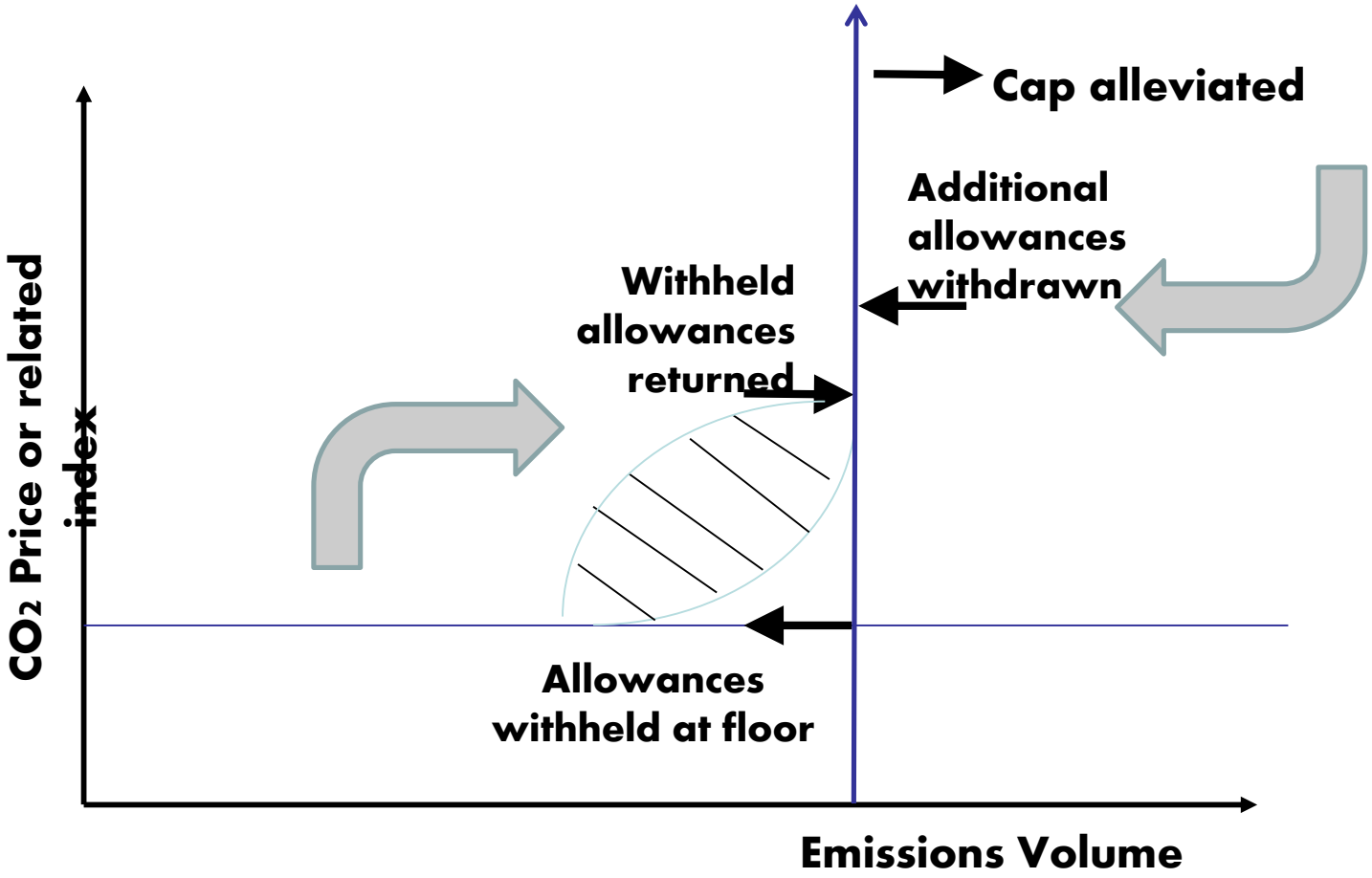


Figure 7-8 Steadying mechanisms for emissions trading systems

Note: The Figure illustrates mechanisms to help emissions cap-and-trade systems deal with deep uncertainties , so as to maintain a reasonable balance of price and quantity objectives. The mechanisms are most simply illustrated with respect to price floors and ceilings, in which case the shaded area indicates the likely region of price and quantity for a system with substantial surplus allowances. However the same principle could apply to other 'threshold' triggers, for example based on the level of cumulative surplus.

Source: Authors

But must address distributional concerns - Of both industry …

- c. half a dozen primary commodity sectors

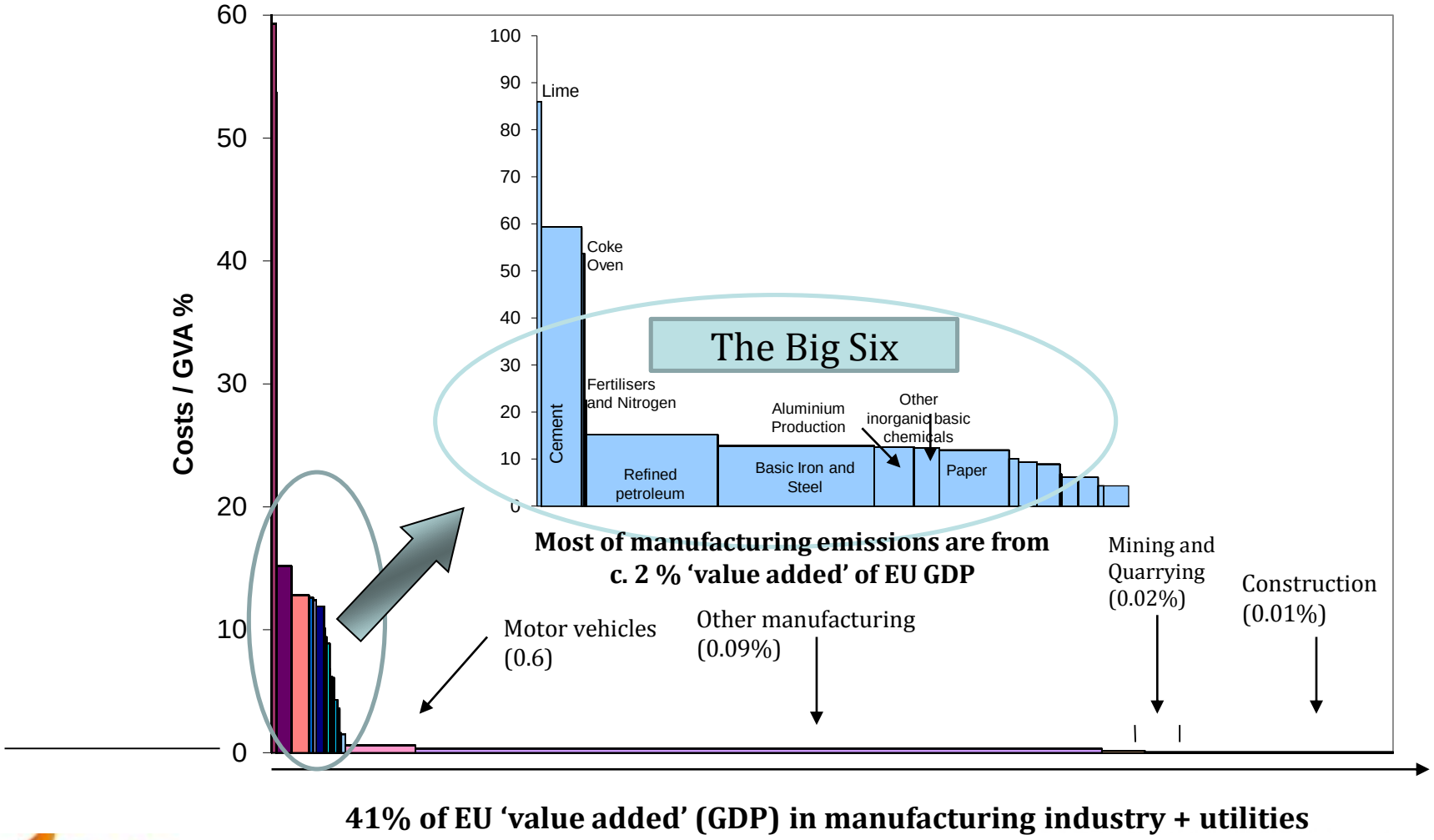
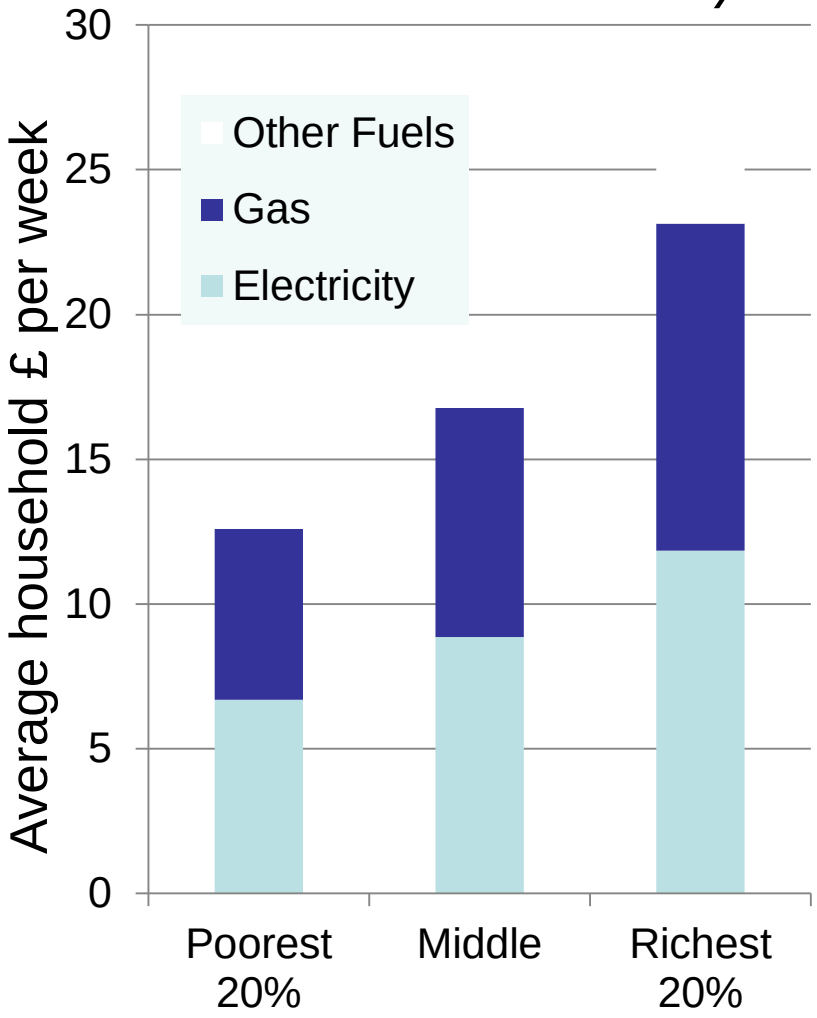


Figure 8-4 Impact of carbon pricing on EU industry sectors and their share of the EU economy

Data source: Eurostat and EU Commission

.. And domestic consumers.
downstream the *direct* impacts are 'all losers' and regressive:
'Bills constancy' hinges on the other Pillars



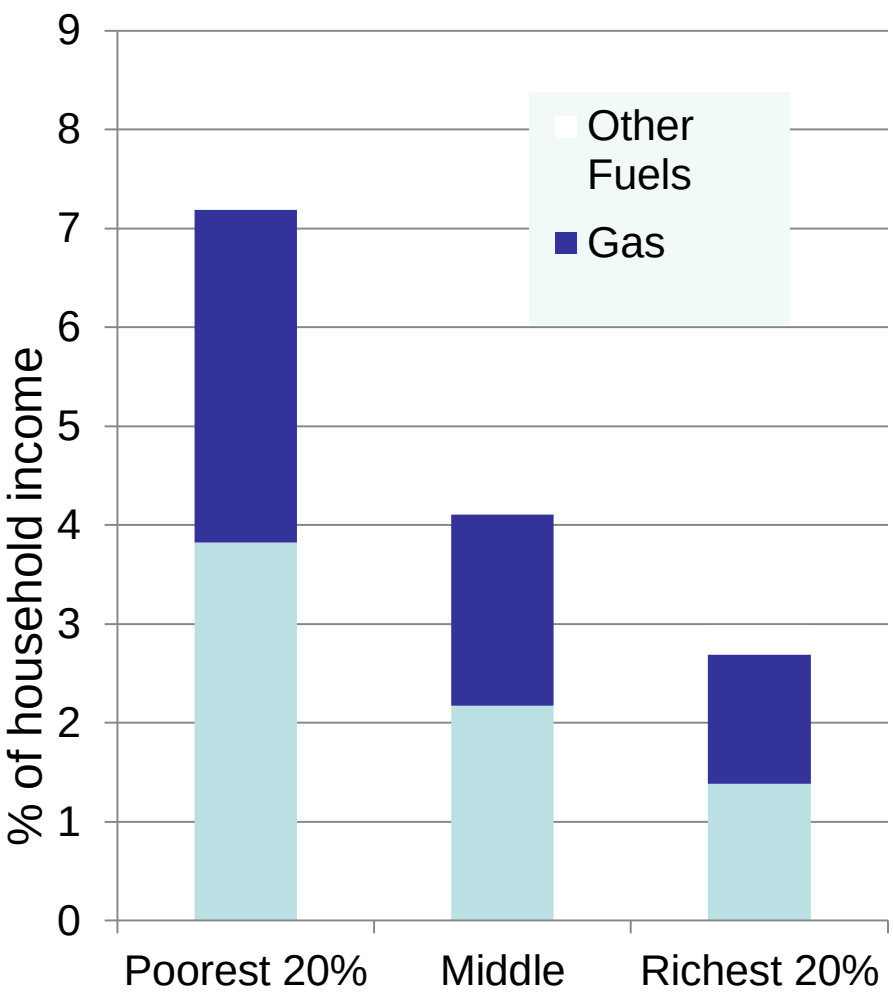


Figure 8-7 Household expenditure on energy UK 2008
Source: Office of National Statistics 2009.

Pillar II Conclusions

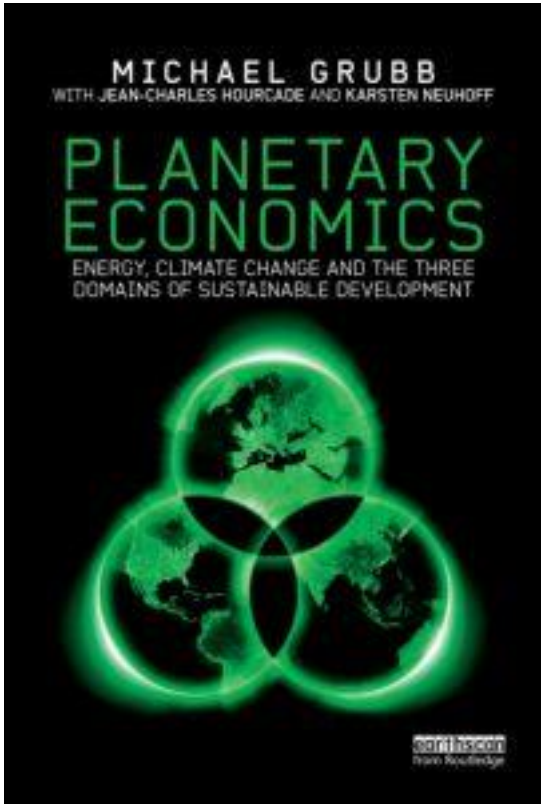
- Too much ‘looking under the lamppost’
- The *economics* of carbon pricing are as much about design and strategic credibility than level
- The *politics* of carbon pricing are driven by distributional impacts *and the lack of clearly articulated positive narrative* for either industry or consumers
- Links to the other two domains are central to any ‘tangible’ positive narrative, drawing on ‘Bashmakov’s Constant of Energy Expenditure’

An integrating approach to climate policy

Three Domains

and the

Third Pillar of Sustainable Development



- Nature of the challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment for Innovation and Infrastructure
- Policy Integration
- Joint Benefits
- The Economics of Changing course

From II to III: Clean tech innovation and benefits

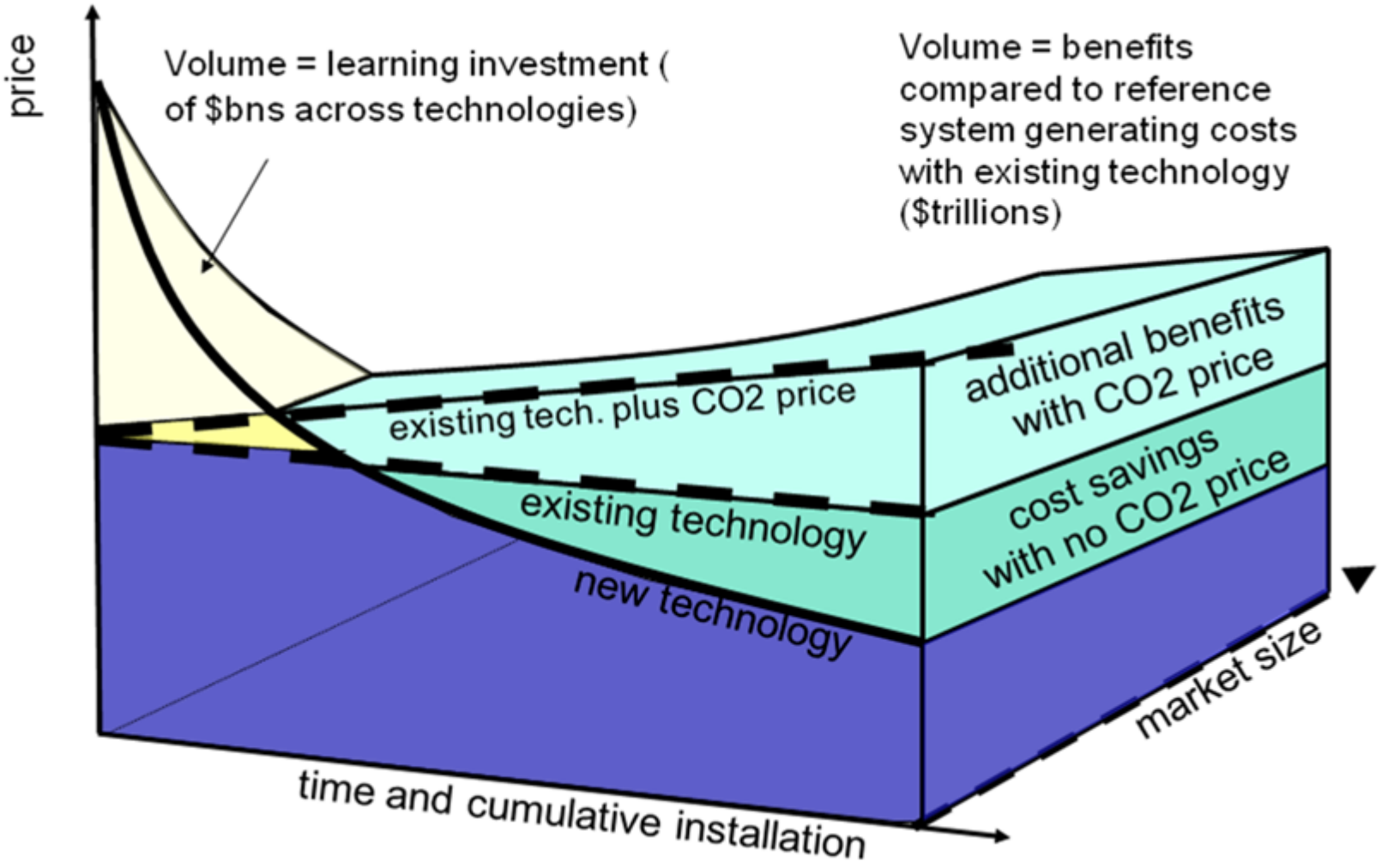


Fig.9.1 Immediate costs and future benefits of low carbon technology

We are seeking radical innovation in some of the least innovative sectors of our economies

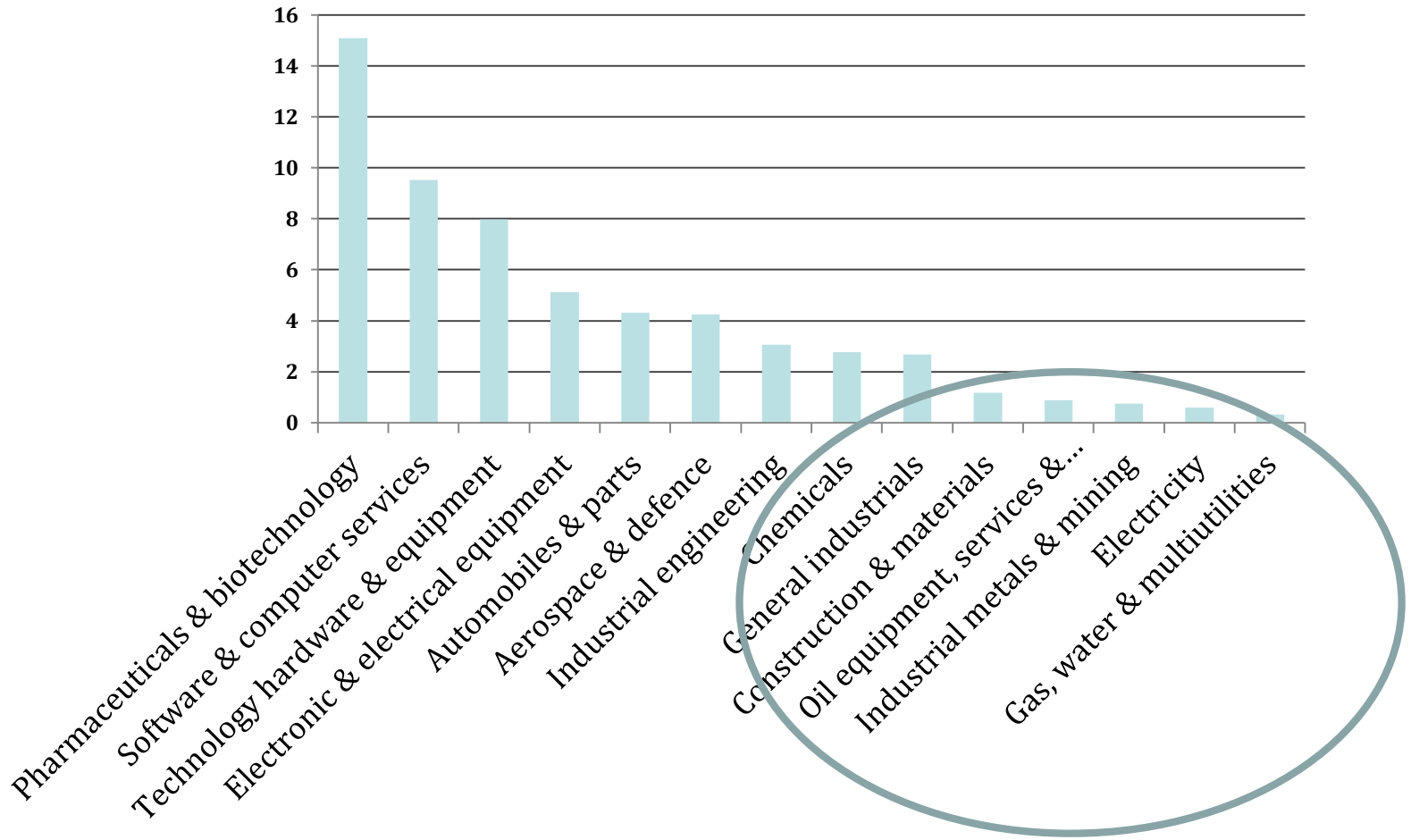


Fig.9.3 R&D expenditure by top companies in different sectors as % of sales, 2011

Data source: EU Joint Research Centre on Industrial Investment and Innovation, R&D Scoreboard 2012, http://iri.jrc.europa.eu/scoreboard12.html

Technologies have to traverse a long, expensive and risky chain of innovation to get from idea to market

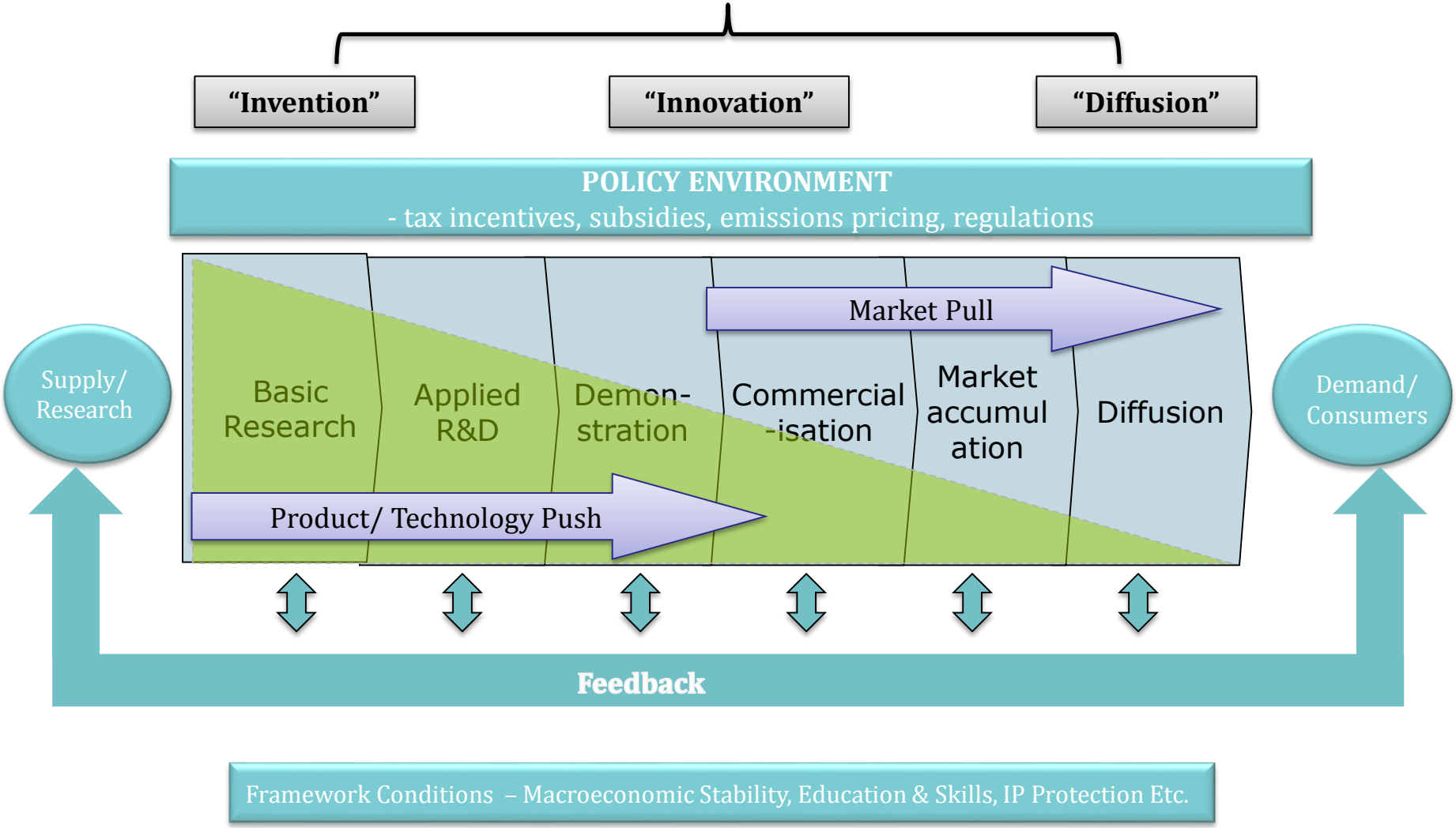


Fig.9.5 The Innovation Chain

Source: Author

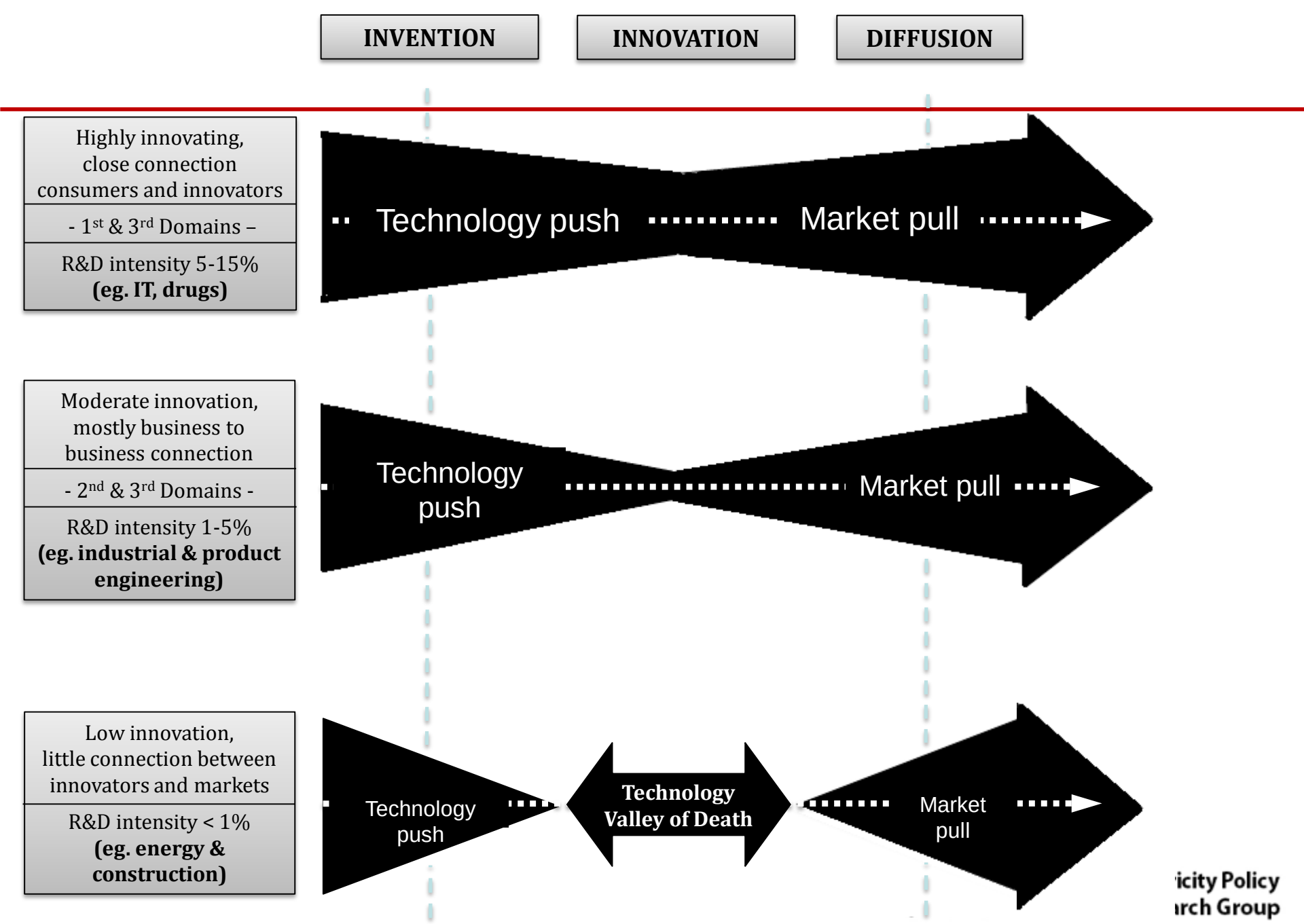


Figure 9.7. Innovation intensity and the broken chain
Source: Authors

Energy & related sectors are 'complex sociotechnical systems', with big evolutionary & lock-in characteristics

- Progress in clean energy industries impressive, but heavily dependent on public policy
- .. and so far outweighed by 'carbon entanglement'
- Consider response to oil price rises
- .. and study the policy implications of evolutionary economics:
  - Niche accumulation
  - Hybridisation strategies
- Industrial strategy is unavoidable
- … with the potential positive side being macroeconomic version of "Porter's kick"

Macro modelling : Global GDP in mid Century has little or nothing to do with global mitigation …

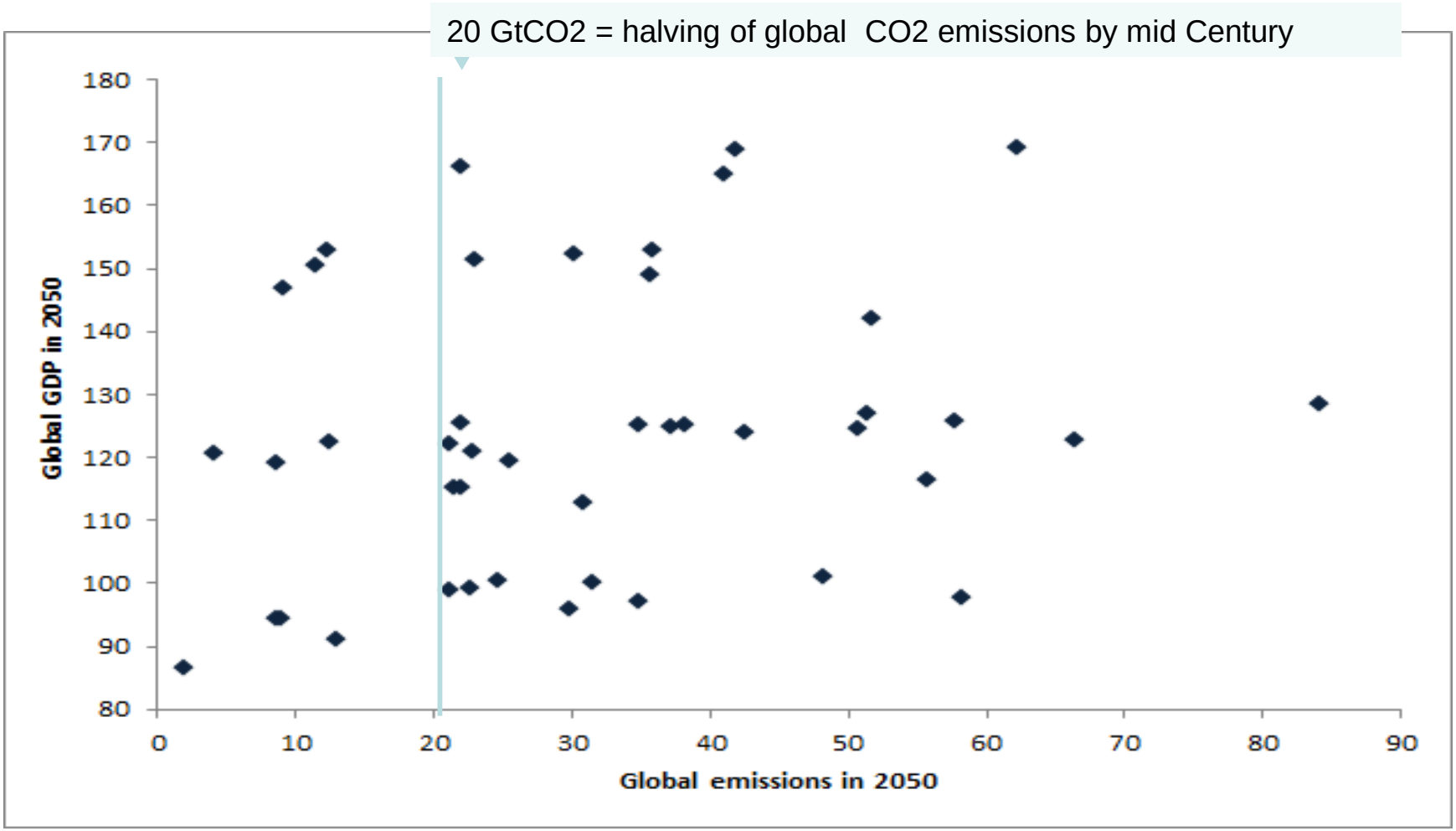
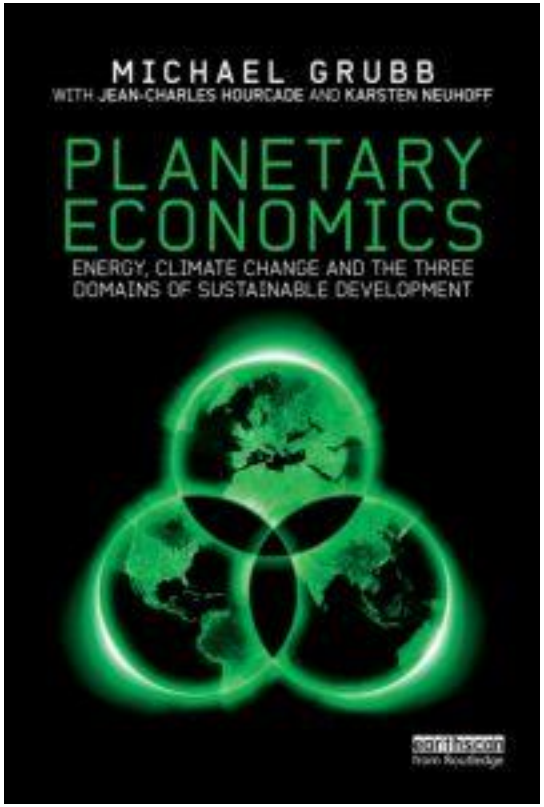


Figure 11.4 Gross World Product in 2050 (excluding environmental benefits) from a wide range of models

Source: Energy Modelling Forum (**2009). MF22 Database: Climate Change Control Scenarios. Available from:** http://emf.stanford.edu/events/emf_briefing_on_climate_policy_scenarios_us_domestic_and_international_policy_architectures/

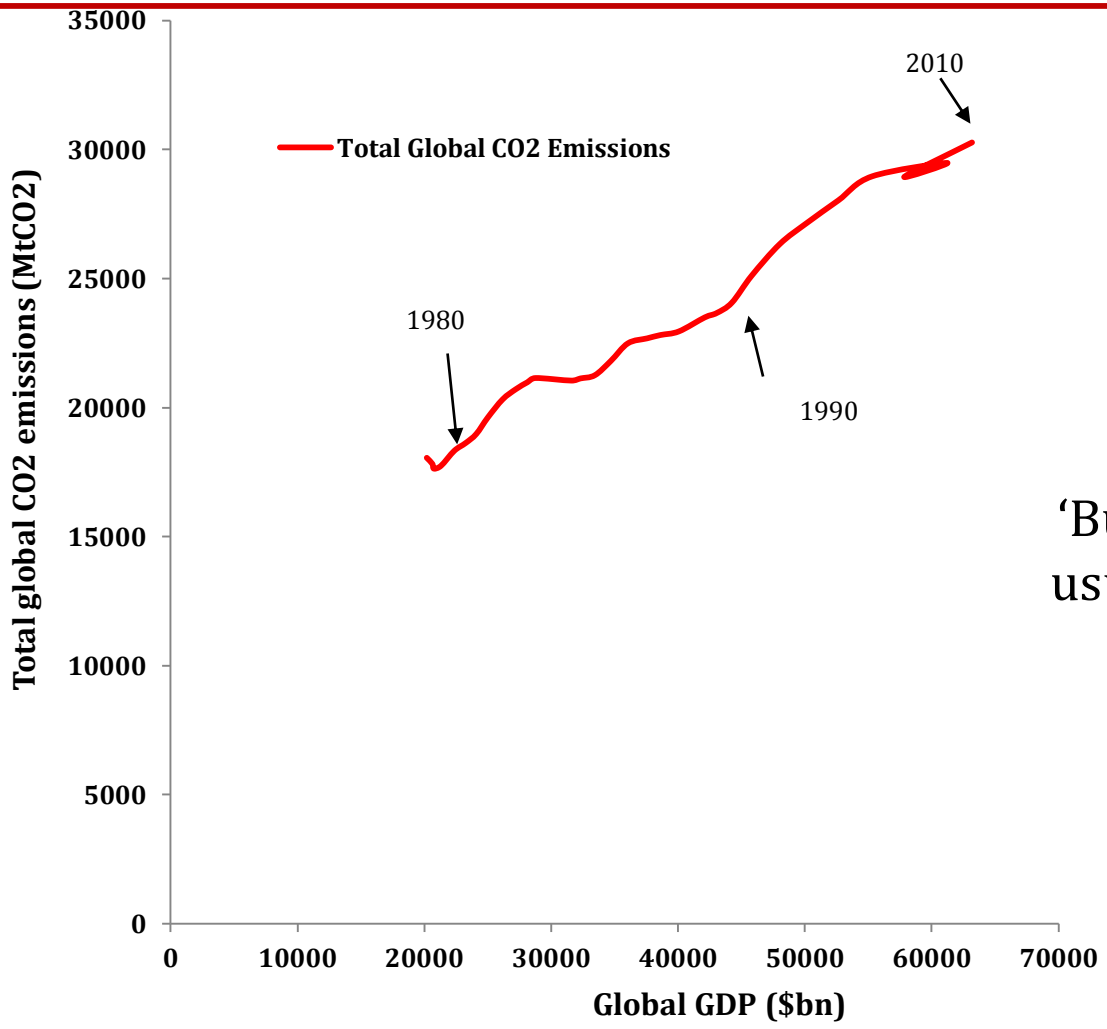
Planetary Economics

An integrating approach to climate policy

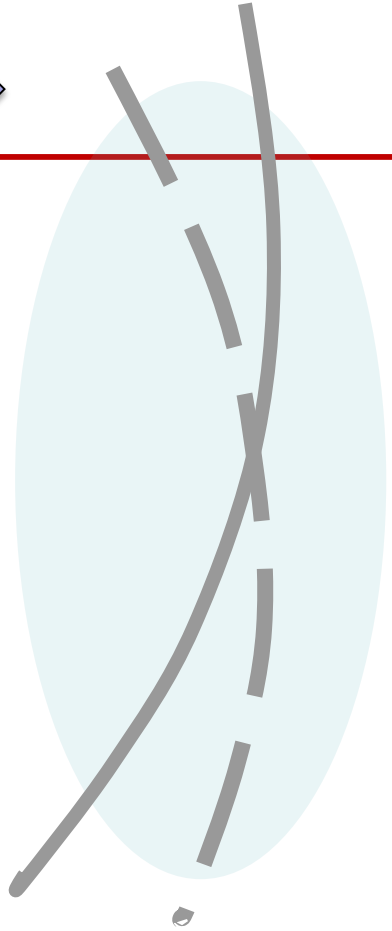


- Nature of the challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment
- Policy Integration
- Joint Benefits
- The Economics of Changing course

By mid-century, there is a huge range of possible emissions, all with similar level of global economic development



'Business–as-usual' frontier in 2050



Efficiency and low carbon innovation frontier in 2050

Projected economic growth without climate damages

(Frontiers not to scale)

Figure 12-1 Global trends: default and potential trajectories

Different pillars have different structures of returns, and involve different actors in economies and society

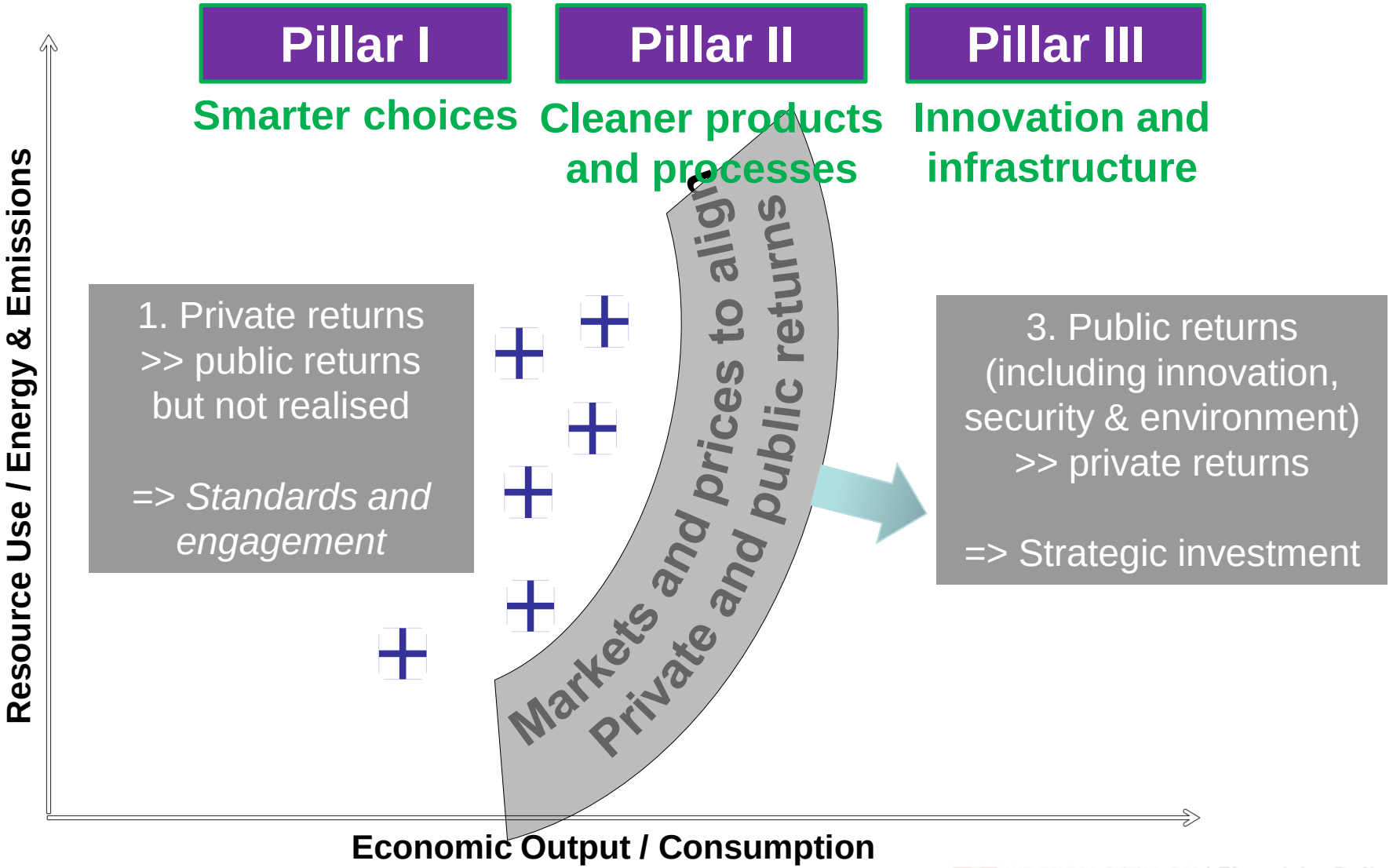


Fig. 12.3 ***Public and private returns in the 3 domains***

Experience and theoretical reasoning on each pillar shows …

- There are multiple lines of evidence that in context of transforming the global energy system over a few decades, **all three domains are of comparable importance**
- Only approaches that integrate across all three domains have potential to generate ‘Green Growth’
- The dominant neoclassical ‘Second Domain’ theories emphasise instrument (pricing) that maximises political opposition unless it is nested in the complementary triad
- First and Third pillar policies can (and have) delivered multiple benefits, but ….

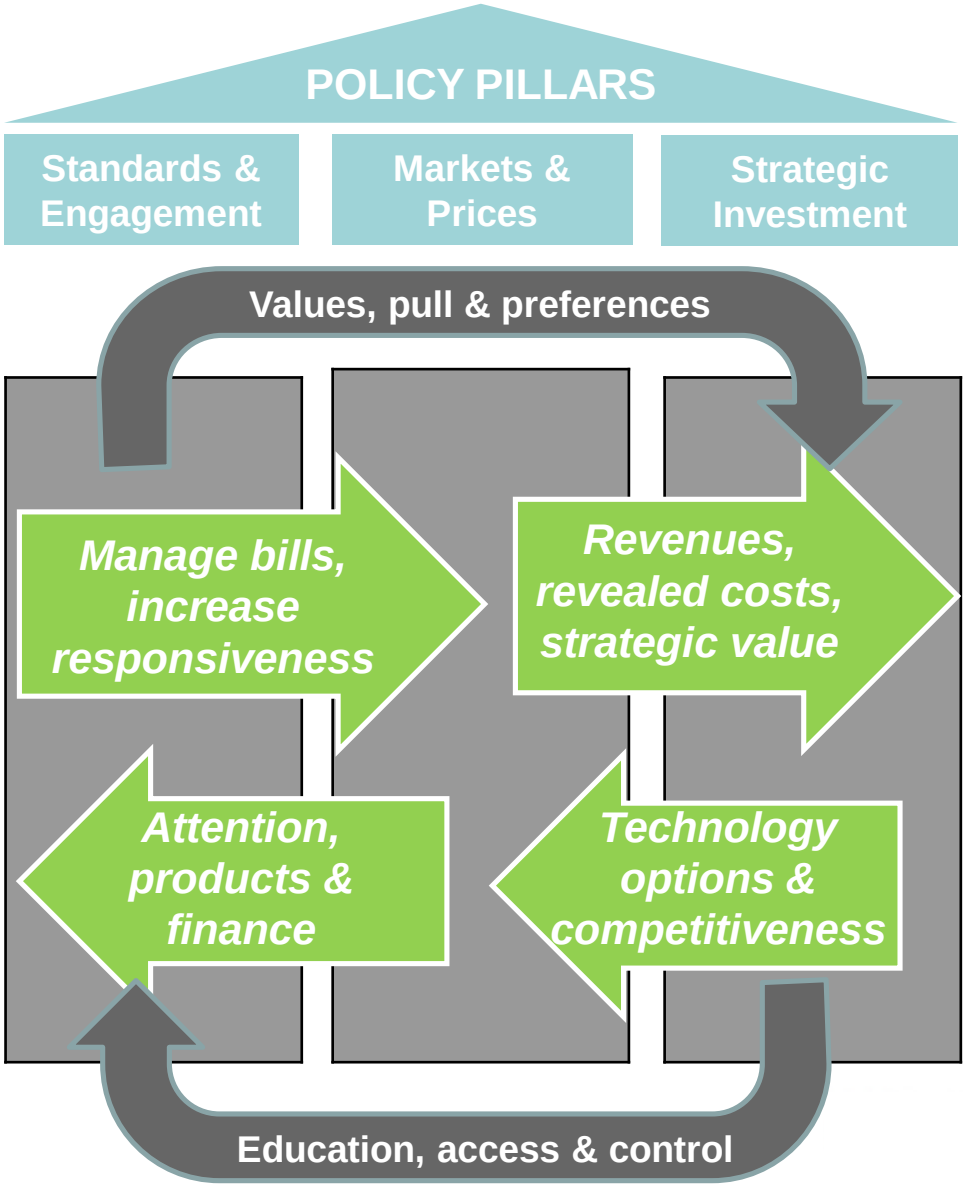
But no pillar on its own can credibly solve the problem – *nor offers a politically stable basis for policy*

- Energy efficiency policy on its own limited by:
  - Scale of intervention required
  - Growing scale satisficing behaviour
  - …. Leading to large Rebound effects

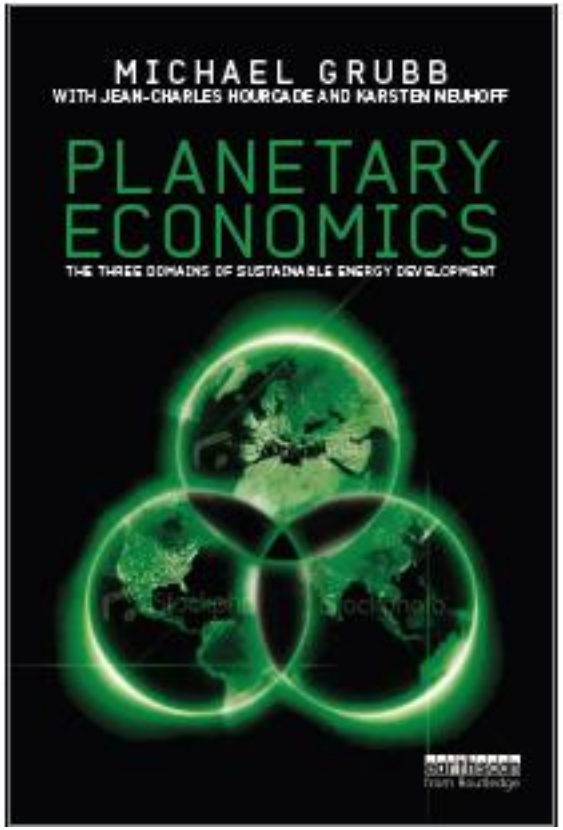
- Pricing on its own limited by:
  - Blunt nature of impacts First and Third Domain impacts
  - Rising political resistance to rising fuel bills
  - .. and competiveness concerns

- Innovation on its own limited by:
  - Lack of demand pull incentives
  - Scale & risks of investment costs
  - Political failures in absence of rising market feedbacks

Changing course requires a sustained package - the key is to integrate and synergise across all three domains



An integrated approach to Energy Transition



- Nature of the energy challenge
- The Three Domains and Three Pillars of Policy
- System key components
- Pillar I: Standards and Engagement
- Pillar II: Markets and Pricing
- Pillar III: Strategic investment
- Growth theory and macroeconomic linkages
- Policy Integration
- Joint Benefits
- A digression / illustrat*ion: electricity transitions and Capacity Mechanisms*
- The Economics of Changing Climate

4CMR

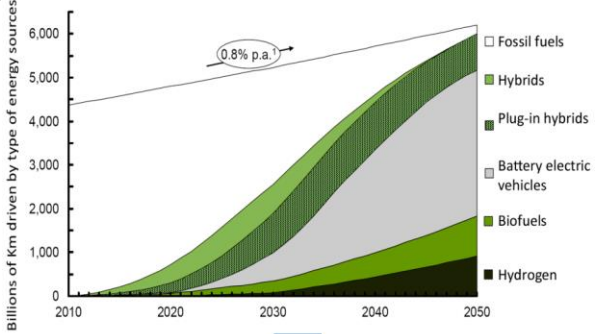
UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

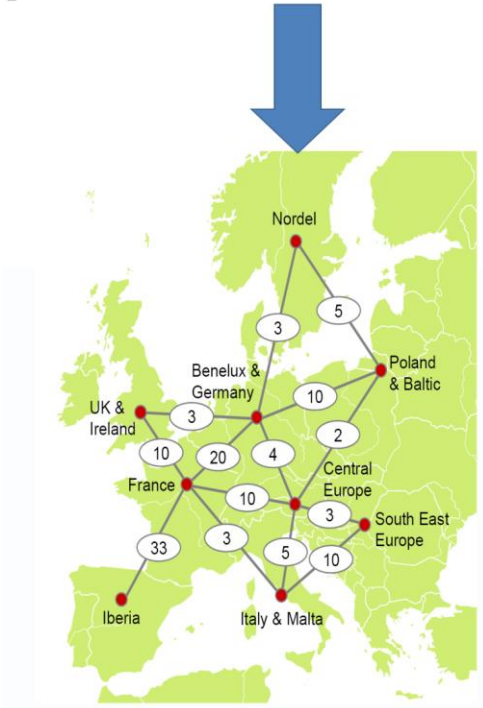
Transformation involves not just technologies but sectors – is possible, but complex

Three key "case studies"

- Transport in the Americas
- Electricity in Europe
- Urbanisation in Asia

The systems themselves also become more integrated





Decarbonising transport through electricity

More electricity demand and regulating capacity

Need for stronger transcontinental transmission network

Not marginal+ but structural and systemic change

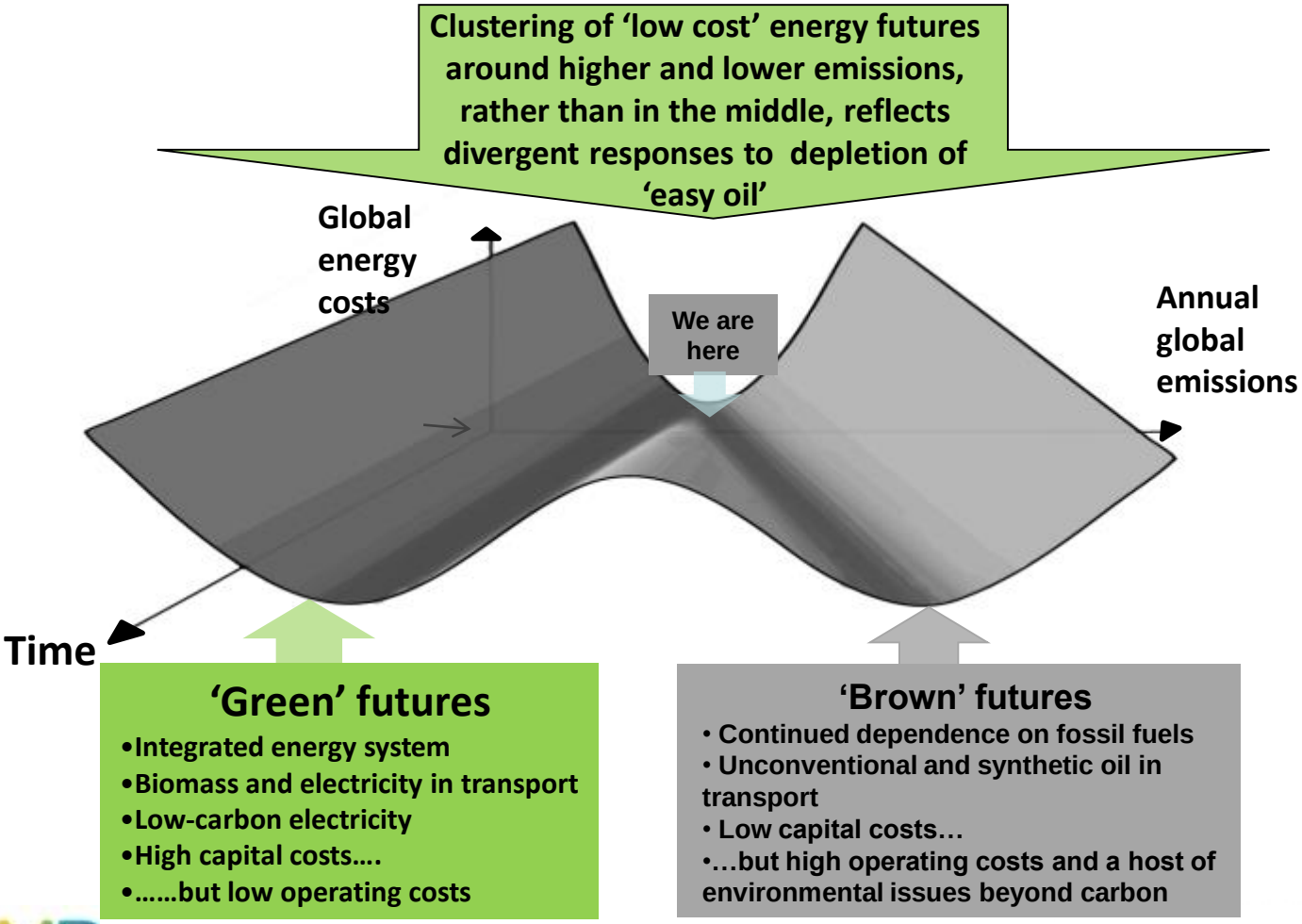


Figure 10-6: Two kinds of energy future – the carbon divide
Source: **Upper panel: Gritsevskyi and Nakićenović (2000); lower panel: authors**

Integrated view of elec system 'Mechanisms'

- Instruments for Capital Intensive – eg. CfD-FiTs
- ? Instruments for (grid) infrastructure *including interconnectors ?*
- Balancing & capacity adequacy
  - Energy efficiency may be forestalling need for new plant – see latest UK & European elec data
  - The Capacity challenge may be increasingly:
    - *Keeping the better existing plant (potentially for lower load factors) available*
    - *Economically & environmentally efficient dispatch & short-run balancing*
    - *Rewarding DSR and storage, including household level storage through rising electric vehicle use, as available Capacity?*

4CMR

The underpinning evidence and theory of Planetary Economics suggests several routes to 'co-benefits'

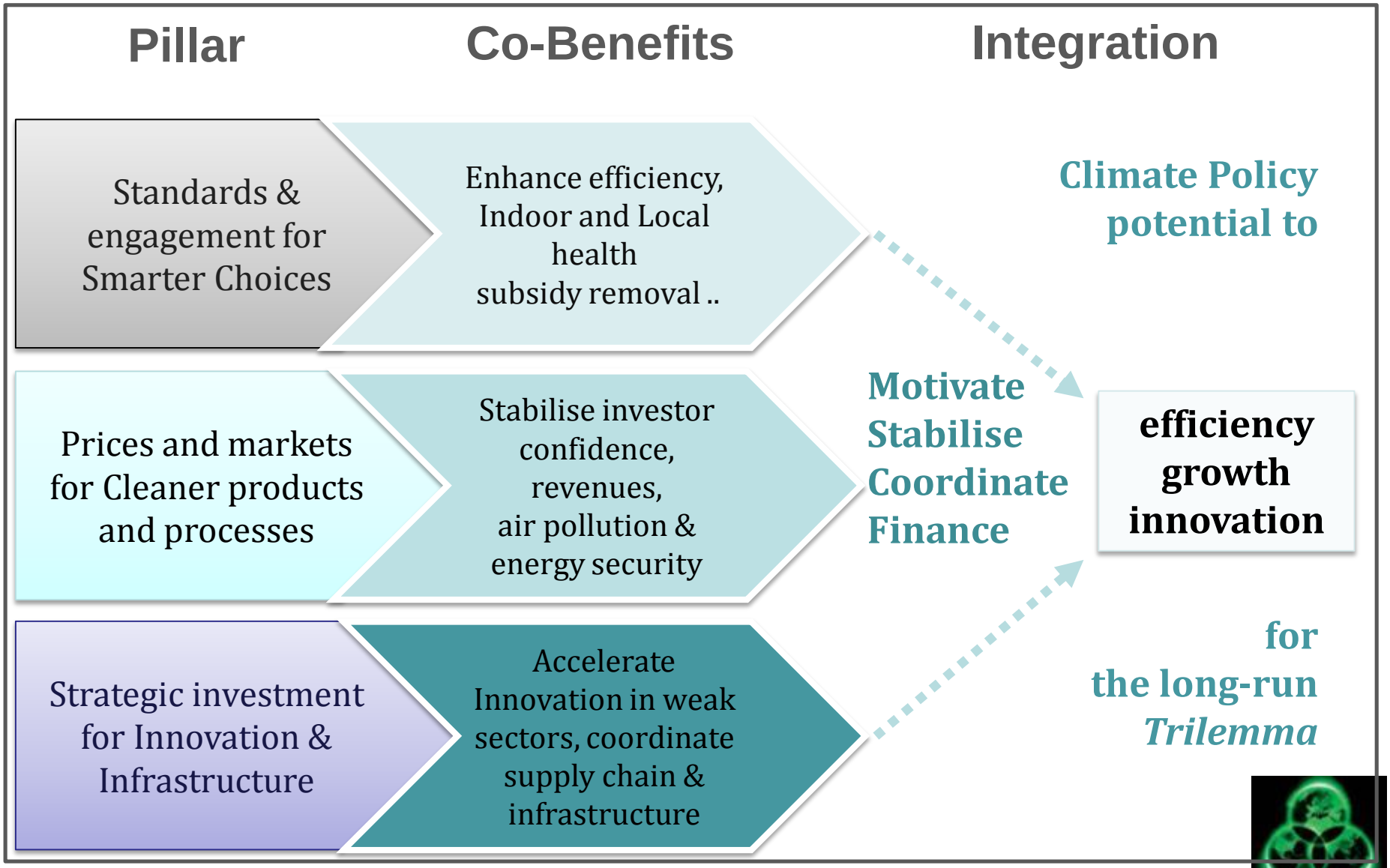


Figure 12-4 Potential joint benefits in energy and climate policy

Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

Economic modelling is proving a double-edged sword

- Economic models are mostly based on “Second Domain” assumptions and assume a cost function in relation to the degree of abatement from ‘reference projection’ at time t, ie.
  - have no history eg. DICE equations
  - assume separability
  - have no finance sector, so missing crucial practical issues

In contrast,

- Most First Pillar gains do not reverse and deliver on multiple objectives through regulatory or behavioural innovation
- Most Third Pillar gains do not reverse: infrastructure endures and innovation generally also delivers multiple benefits
- Issues of finance, risk and policy uncertainty are at the heart of the issues

An Annex to book explores modelling with transitional costs but enduring benefits; can generate very different profiles

Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

Key implications of numerical & macro analysis

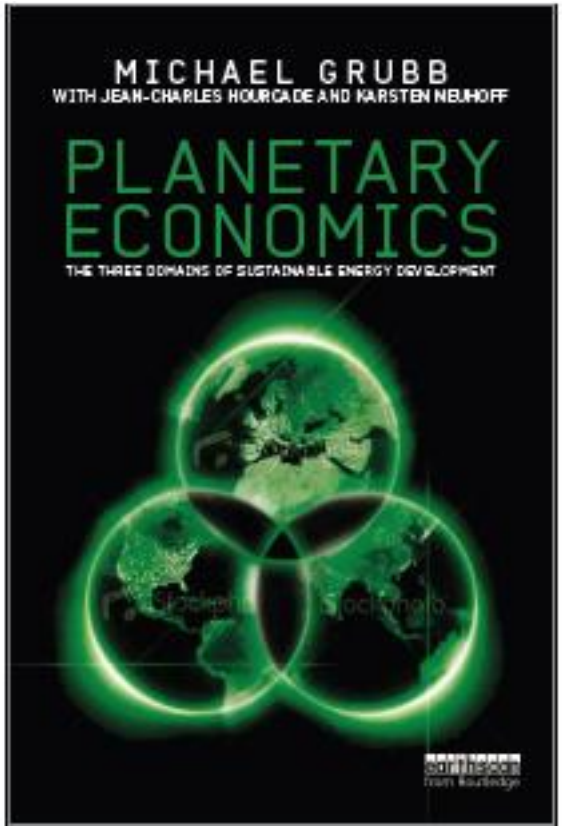
- The value of measures which *adjust the pathway* is *several times* that of measures which just save CO2
- Useful to think of a 'base' carbon price as that which can be implemented today to reflect the assumed damage of CO2 emissions
- Measures in the First and Third Domains may well justify a "cost of carbon" well above this base carbon price
- A rising base carbon price can also enhance in particular strategic investments & leverage *long term institutional* finance

Extending Instruments – some concluding questions

- Pillar 1: Energy efficiency and …
  - Standards – towards “embodied carbon”?
  - Engagement – is Green Deal a dead end or an important precursor .. ?
- Pillar 2: Carbon pricing and ...
  - Credibility – is the ‘Stabilisation mechanism’ salvation, sclerosis, or a window of opportunity for development?
  - Can we talk about revenues, please?
- Pillar 3: Infrastructure, Innovation and ..
  - Governance for interconnection and cost-sharing in Eurosceptic times?
  - Closing the loop by bringing in consumers - can we get energy to look more like IT?

Planetary Economics:

Energy, Climate Change and the Three Domains of Sustainable Development



1. **Introduction: Trapped?**
2. **The Three Domains**

Pillar 1

- **Standards and engagement *for* smarter choice**
- 3: Energy and Emissions – Technologies and Systems
- 4: Why so wasteful?
- 5: Tried and Tested – Four Decades of Energy Efficiency Policy

Pillar II

- **Markets and pricing *for* cleaner products and processes**
- 6: Pricing Pollution – of Truth and Taxes
- 7: Cap-and-trade & offsets: from idea to practice
- 8: Who's hit? Handling the distributional impacts of carbon pricing

Pillar III

- **Investment and incentives for innovation and infrastructure**
- 9: Pushing further, pulling deeper
- 10: Transforming systems
- 11: The dark matter of economic growth

12. **Conclusions: Changing Course**

4CMR

Seminar: The policy implications & EU 2030
British Institute of Energy Economics, London, 25th June 2014

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

www.climatestrategies.org/events/2014-events/book.html for information and maintained register of related events.