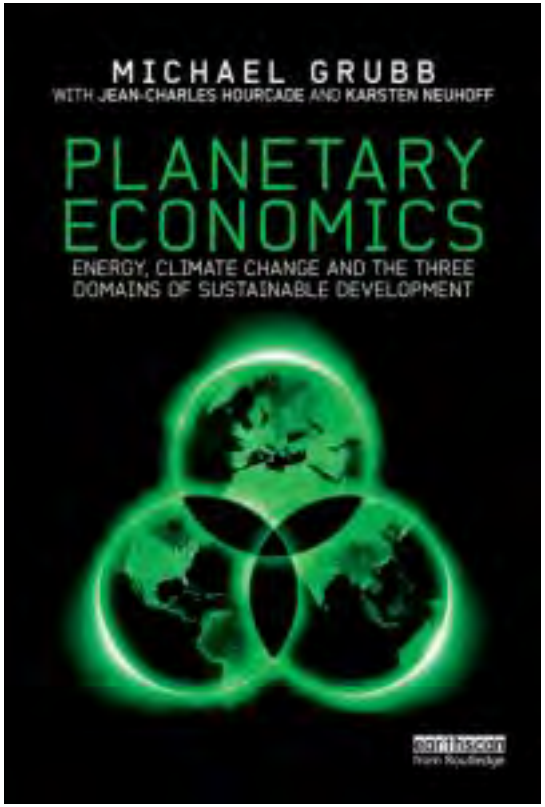
Planetary Economics

- The role of energy efficiency & urban development



Michael Grubb

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Global Conference on Energy Efficiency in Cities,
Mexico, 17-18 June 2014

4CMR

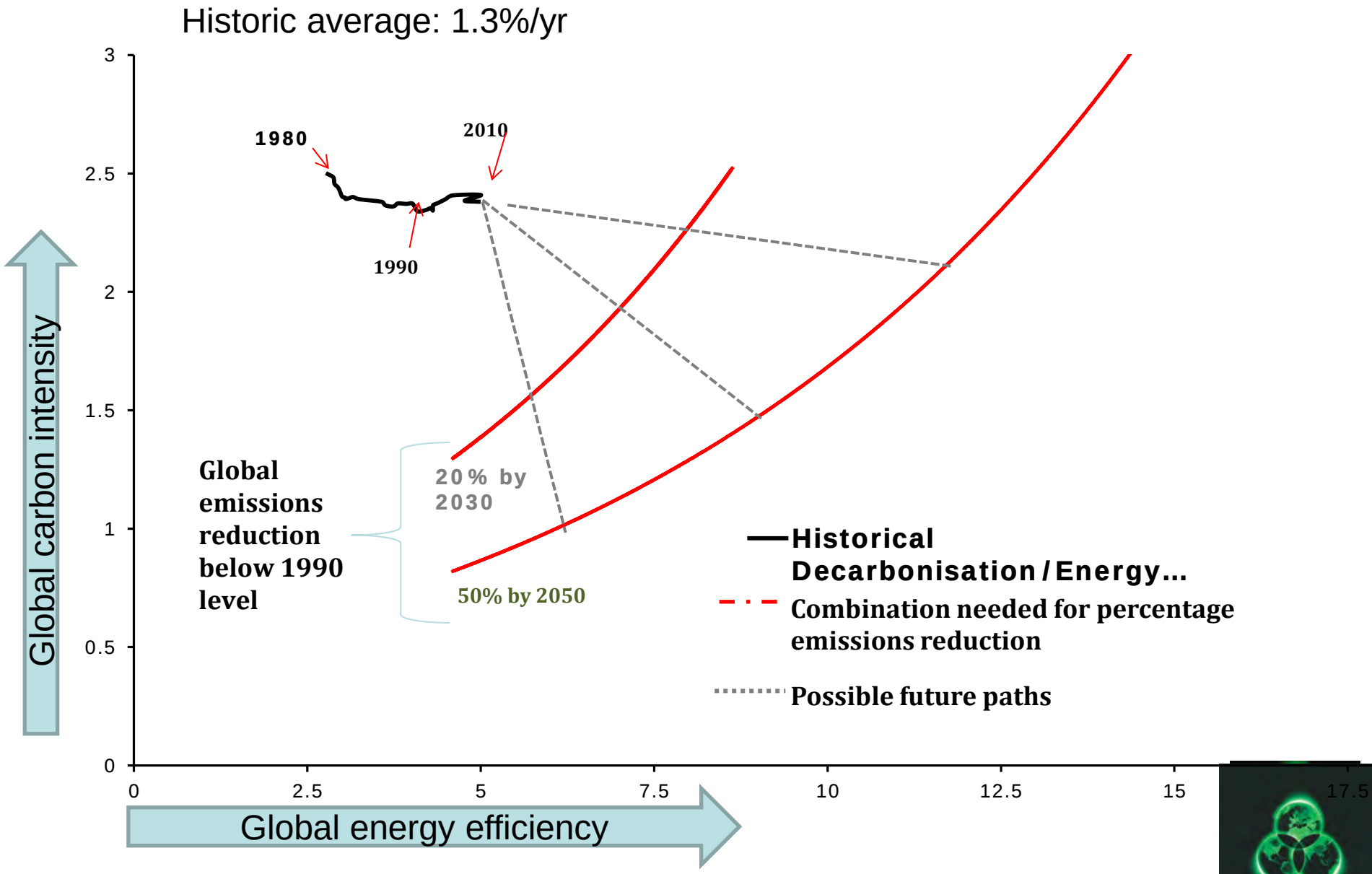
ofgem Making a positive difference for energy consumers

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

An integrated approach to Energy Transition

- Nature of the energy 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
- The Economics of Changing course

The energy challenge of decarbonisation



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

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

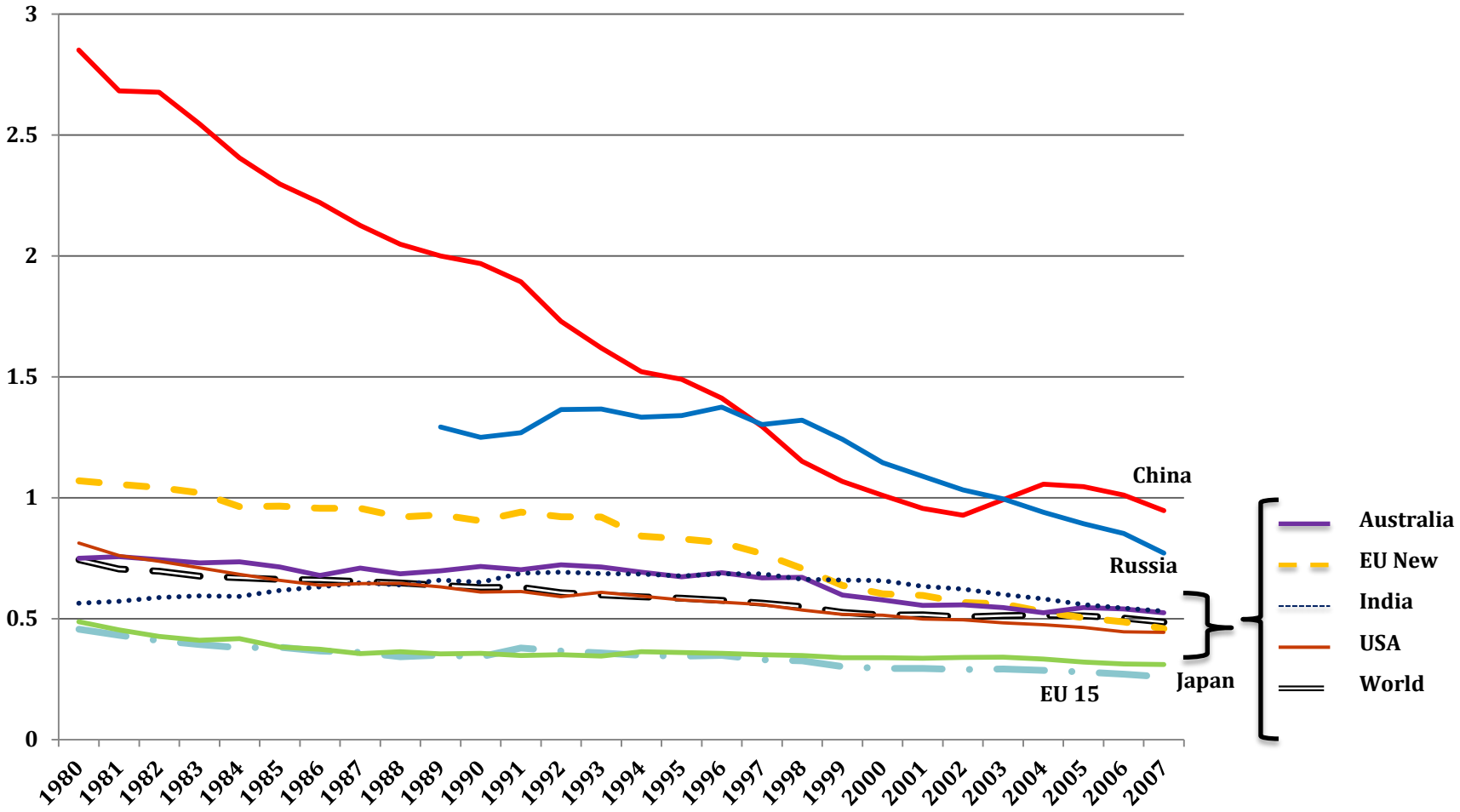


Figure 1.6 Trends in carbon intensity, by region and globally from 1980-2008

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

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

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

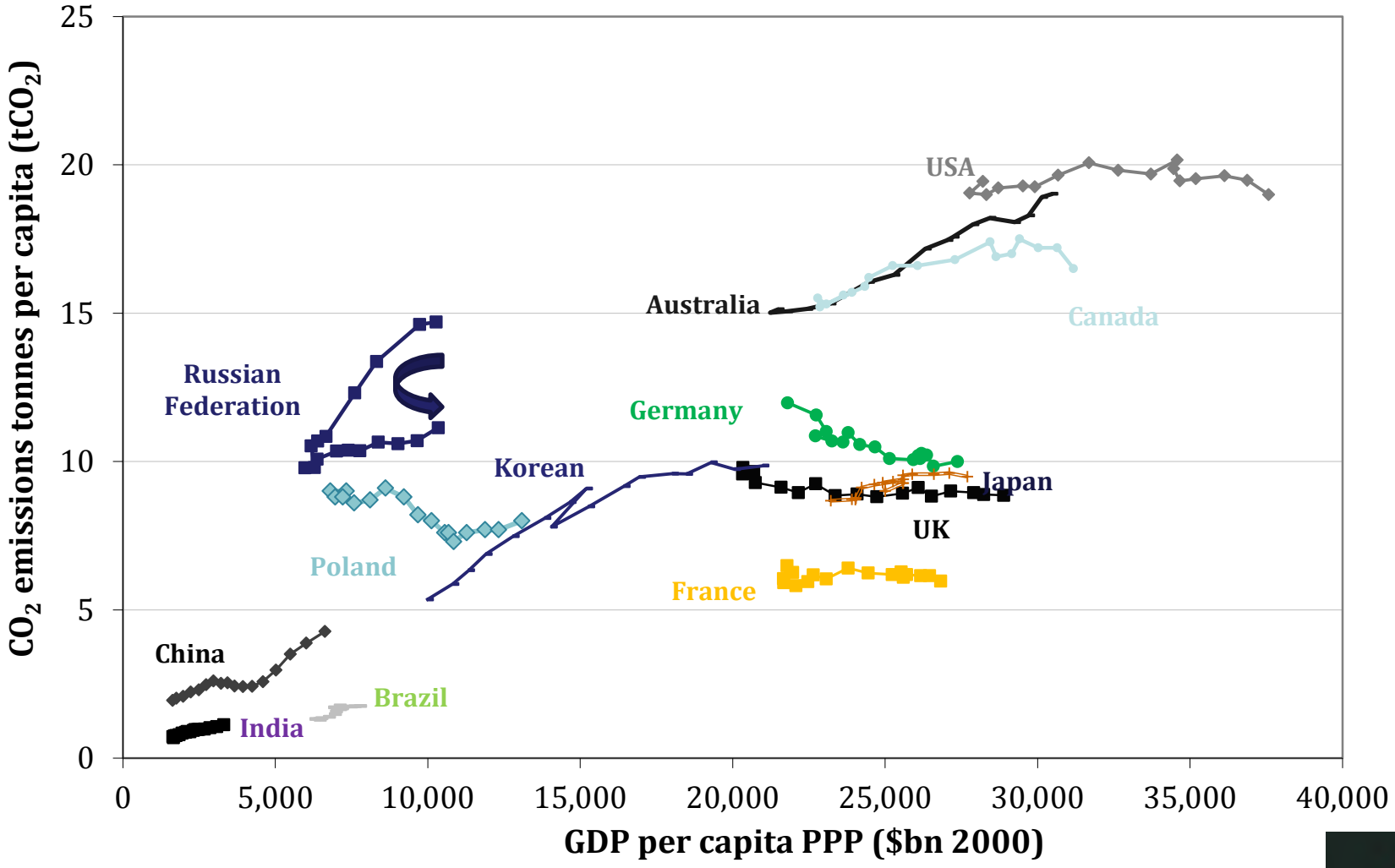


Figure 1.7 Per-capita CO2 emission trends *vs income* - trends of major countries
Source: Authors. Data from World Bank (2011) and IEA (2010)

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

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

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

City development likely the single biggest determinant of future energy needs – a challenge, and opportunity

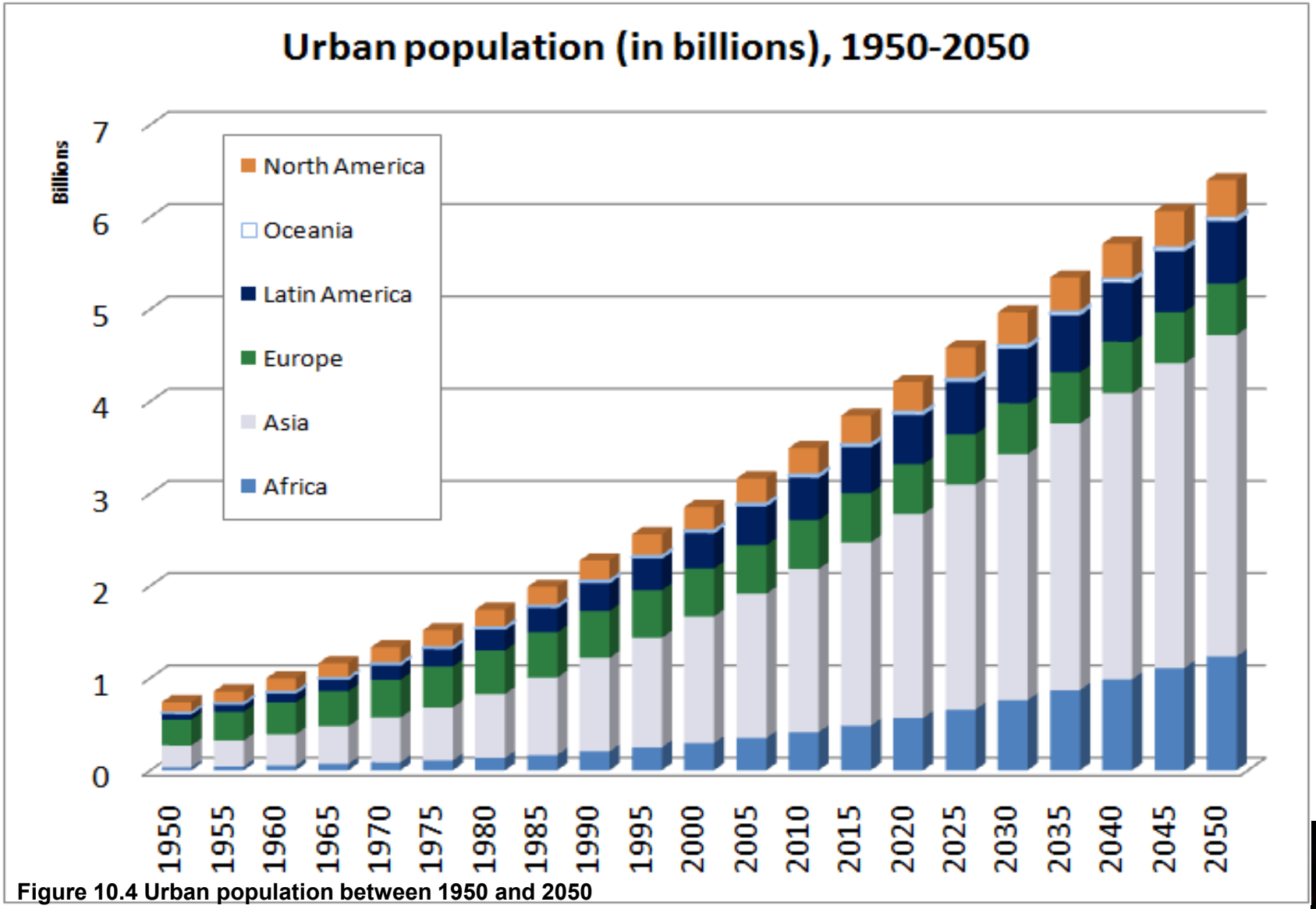


Figure 10.4 Urban population between 1950 and 2050
(Source: UNDESA, 2007)

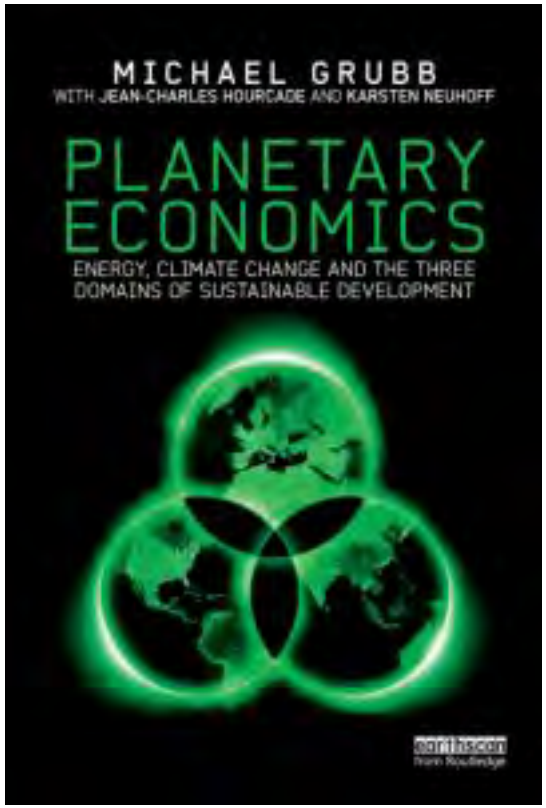
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

An integrating approach to climate policy

Three Domains

and the

Three Pillars of Sustainable Development



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

Three Domains – an Economic Interpretation

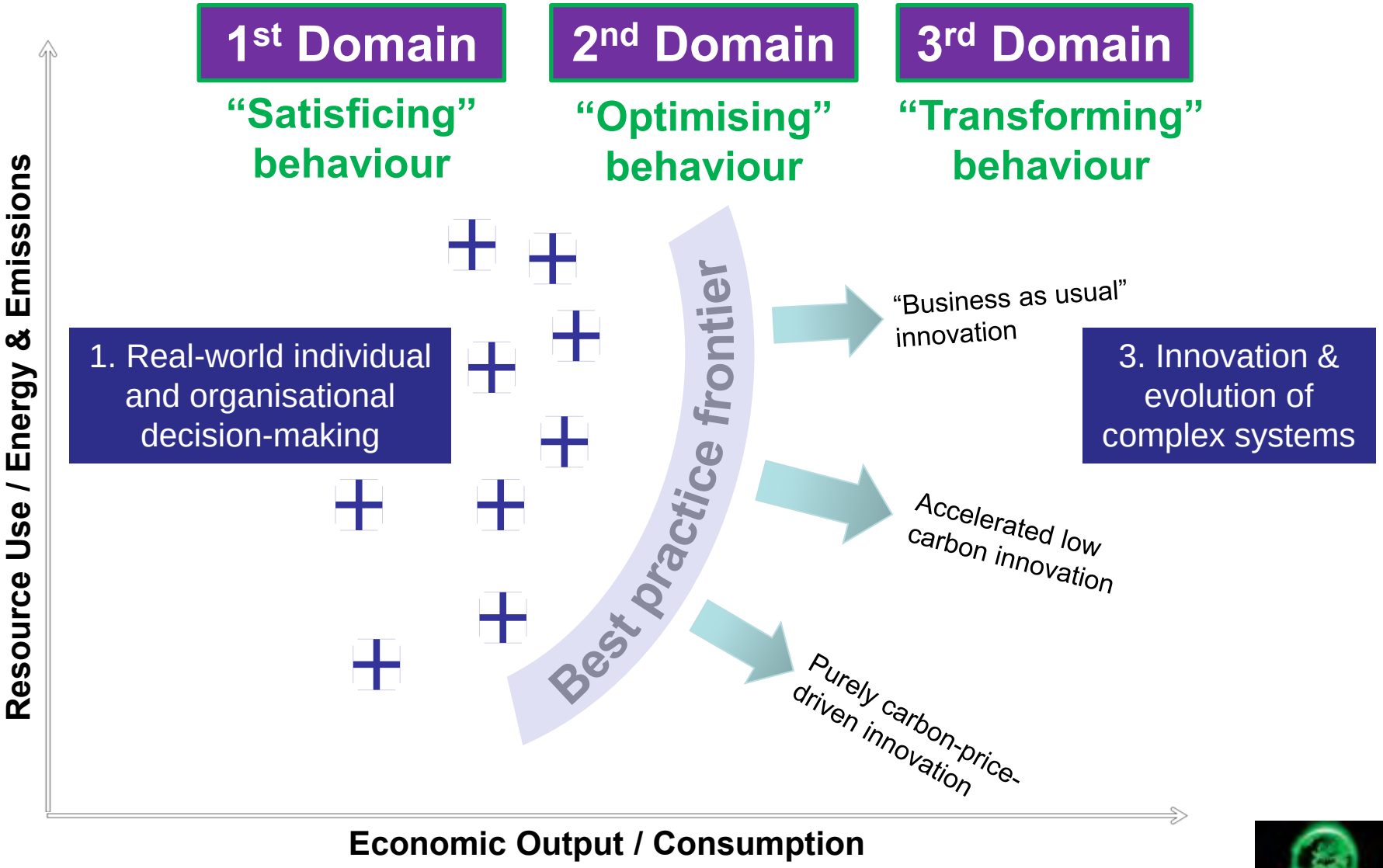


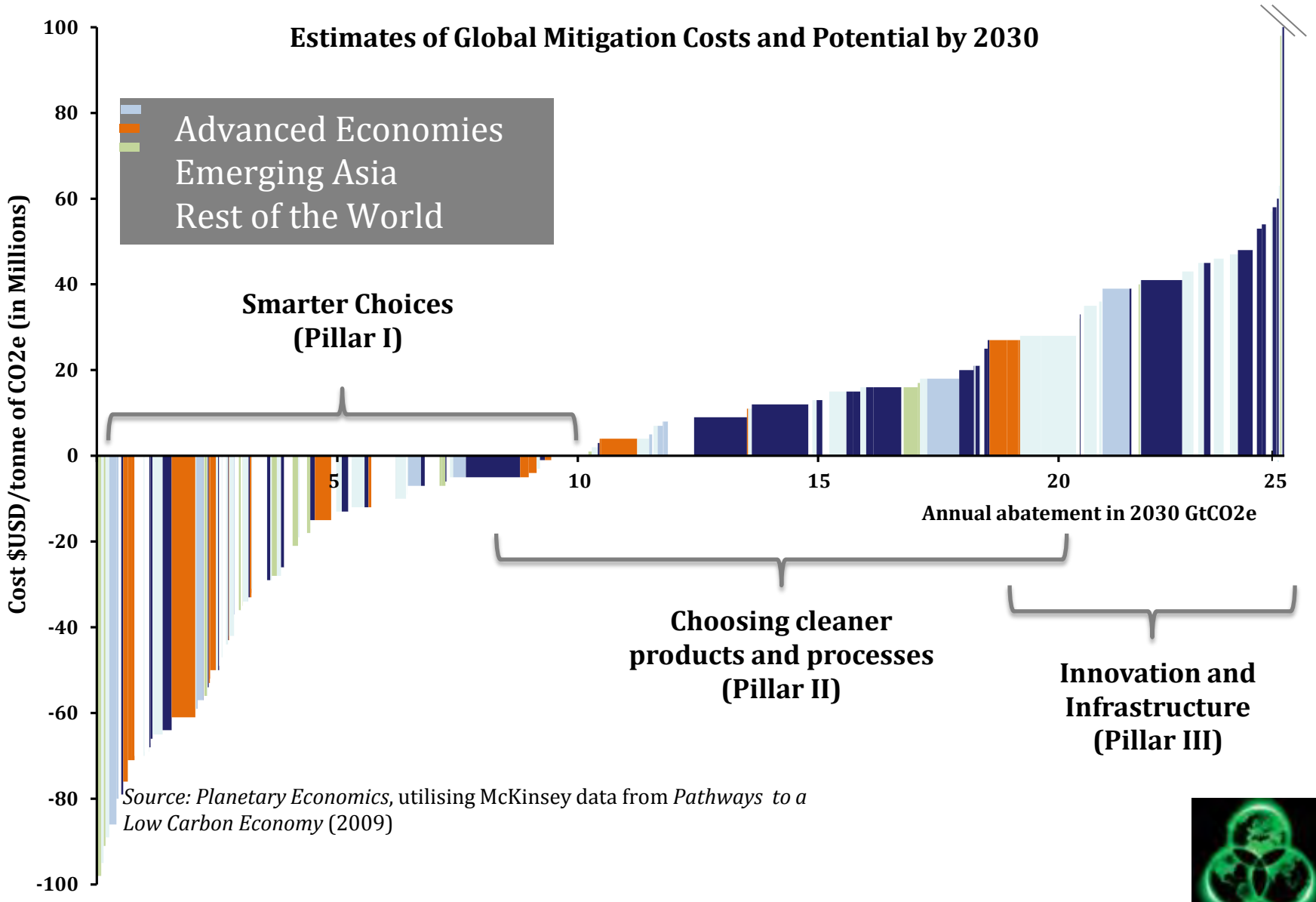
Fig. 2 -3 b Resource trade-offs with the other two domains

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

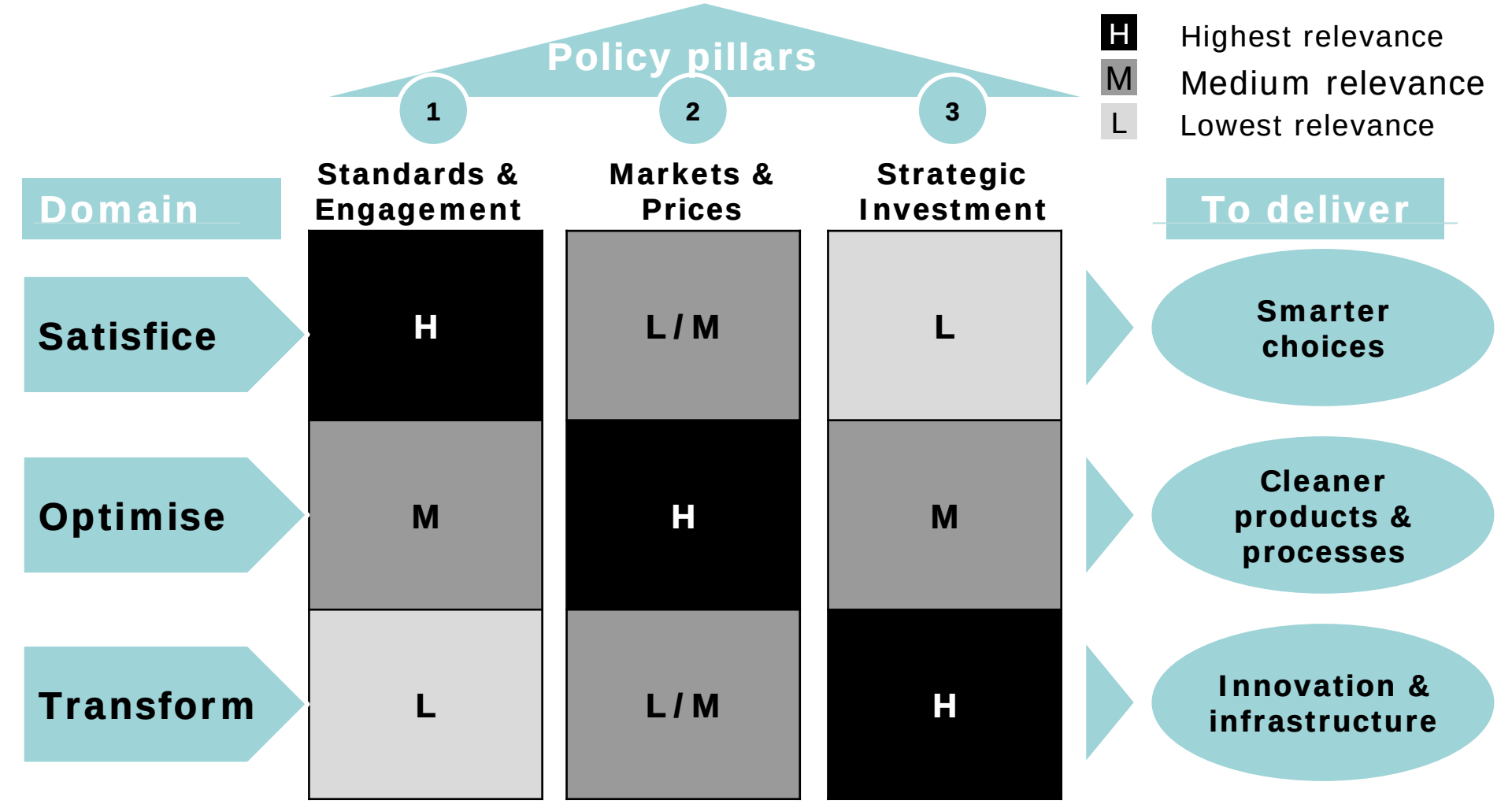
Three realms of abatement opportunities ..
- [Global estimates for 2030 highlight first two ..]



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

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

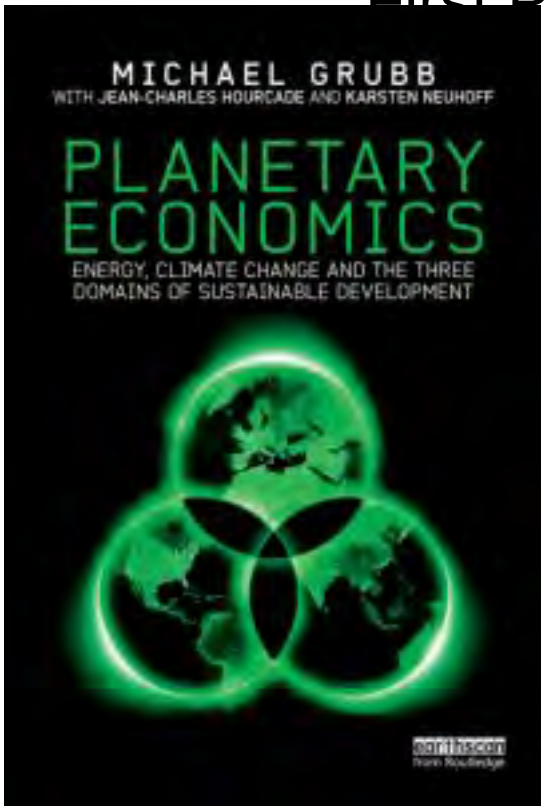
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

An integrating approach to climate policy

Three Domains

and the

First Pillar of Sustainable Development



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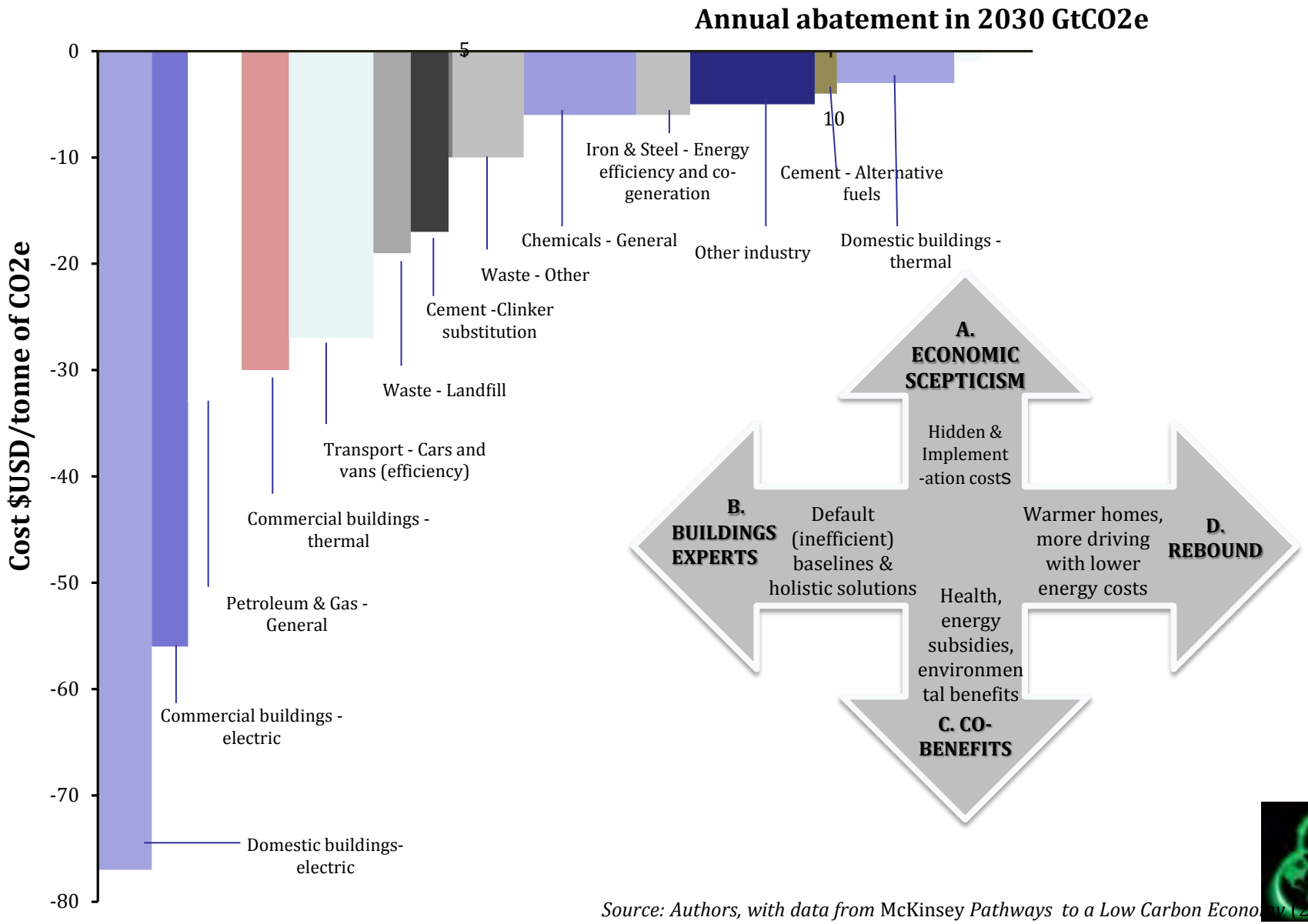
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

Engineering evidence confirms potential exists across individuals & 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)

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

The potential remains huge …
even for corporate energy use

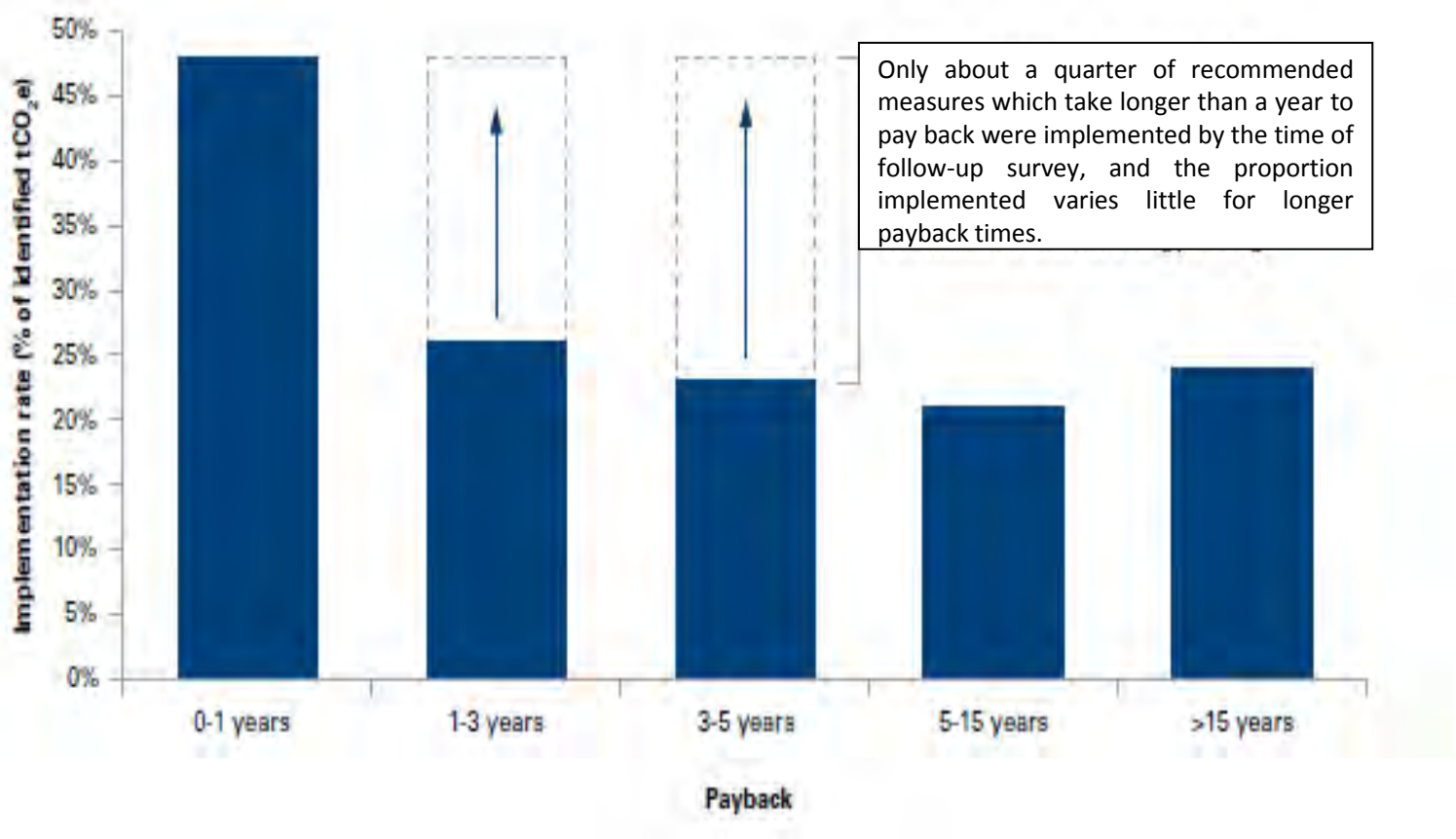


Figure 4-4 Proportion of Carbon Trust recommendations to UK business implemented: dependence on pay-back period

Note: The graph shows combined responses of public, services, retail and chemical sector regarding recommendations identified in 2006-2007.

Source: Source: Carbon Trust, based on Carbon Management/Energy Efficiency Advice Close-out database (personal communication)

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

The classical discourse is around *barriers* – useful also to think how these match against *drivers* – with each in four categories

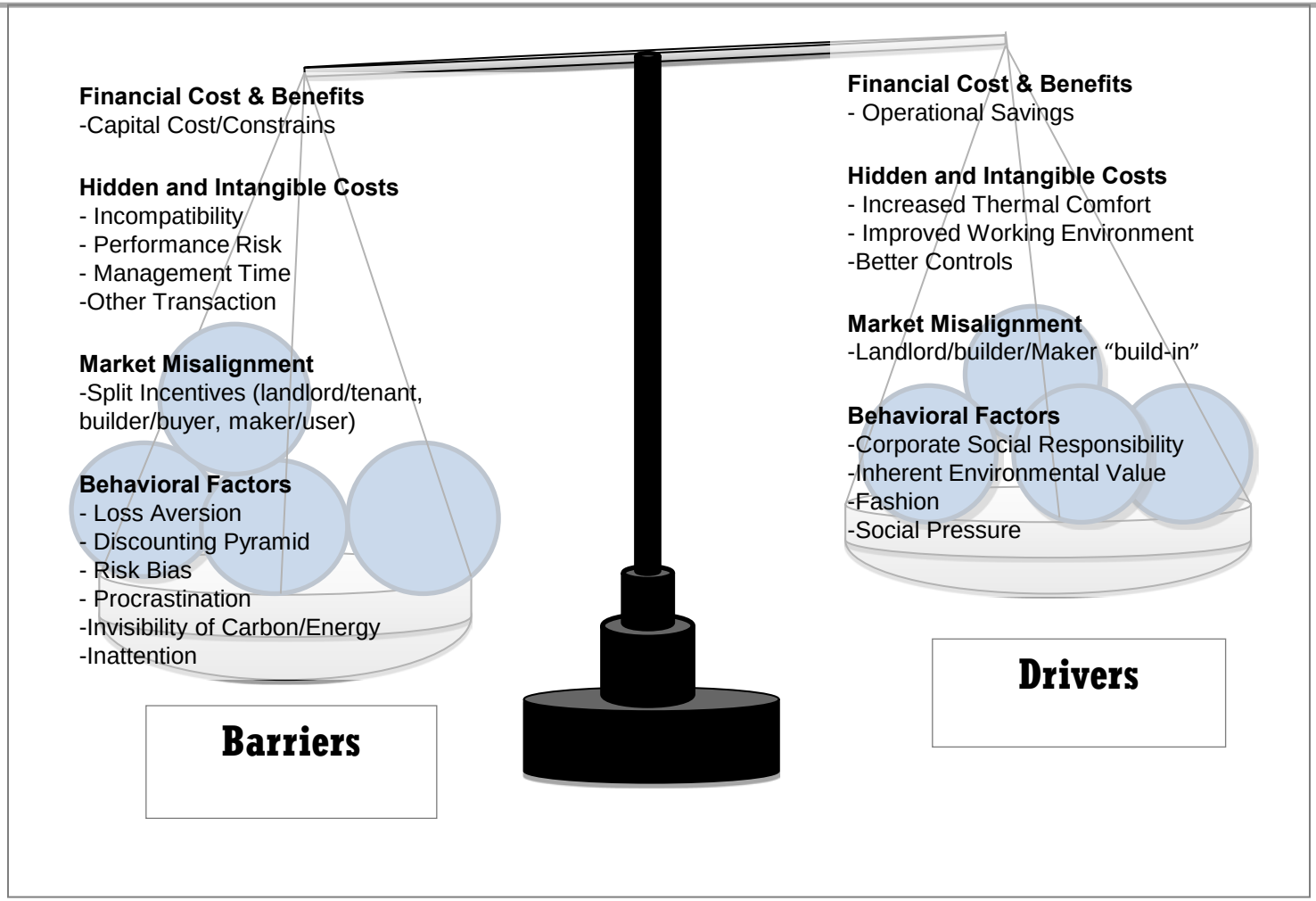


Figure 4-3 Energy Efficiency Barriers and Drivers

Note: The Figure shows the four classes of barriers that impede energy efficiency, set alongside the drivers that can offset thes[e] with some of the most common examples from the literature. At present, there is a clear imbalance between barriers and drivers tha[t] explains the persistent observed gap between the potential for and take-up of cost-effective energy efficiency options. Things t[hat] increase motivation to address these barriers or otherwise increase efficiency – to balance the diagram - have a good chance of being economically beneficial as well.

Source: Author, developed from classifications in Carbon Trust (2005) and UNEP (2009), Buildings and climate change, UNEP SBCI,

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

Useful to also set in context of theories of what actually determines actions ..

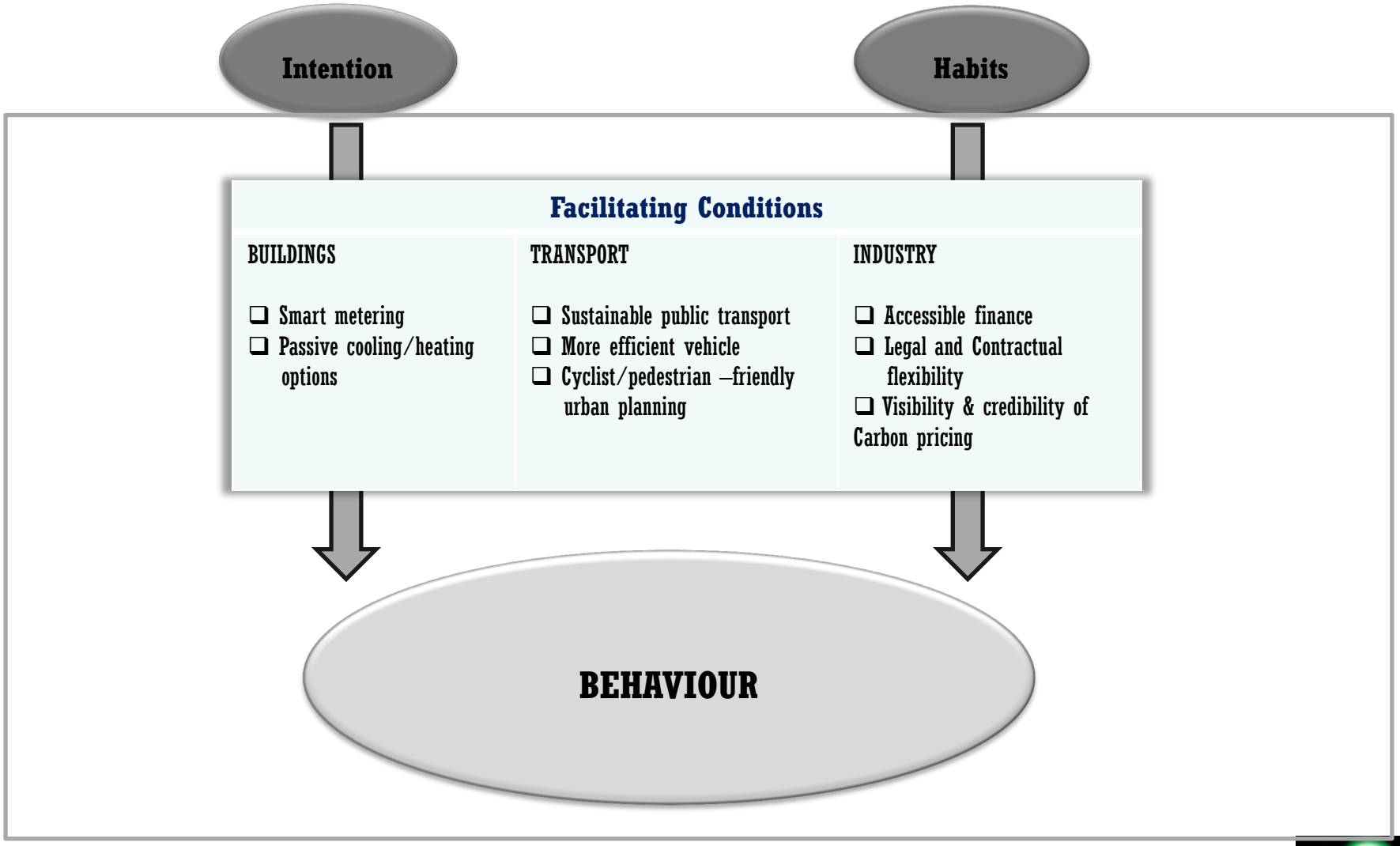


Fig. 4.5 Behavioural dependence on intention, habits and facilitating conditions
Source: Author's adaptation from DECC (2011)

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

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

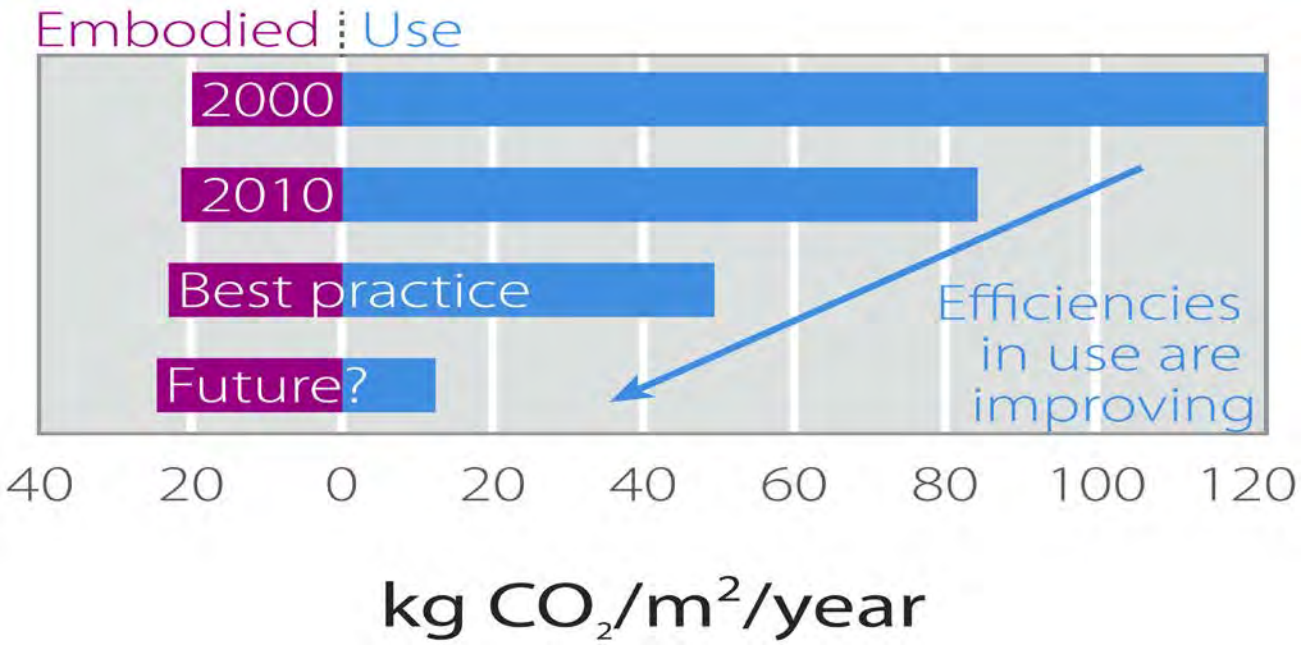


Figure 5-11 Embodied energy in buildings

Source: Allwood and Cullen (2012)

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

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

Consumer-driven energy & emissions

	Efficiency of Stock	Use	Embodied
Buildings	•Insulation •Integrated heating and cooling system. •Efficient appliances	•Closing windows while heating or cooling system is operating	•Construction materials •Construction and transport
Industry	•Efficiency of machinery used •Modes of transporting goods	•Efficient use of materials •Heat cascading •Maintenance	•Raw materials used: extraction, transport and processing •Leakage from
Transport	•Vehicle efficiency	•Mode of transport •Tyre pressure •Maintenance.	•Raw materials in vehicle construction •Vehicle disposal

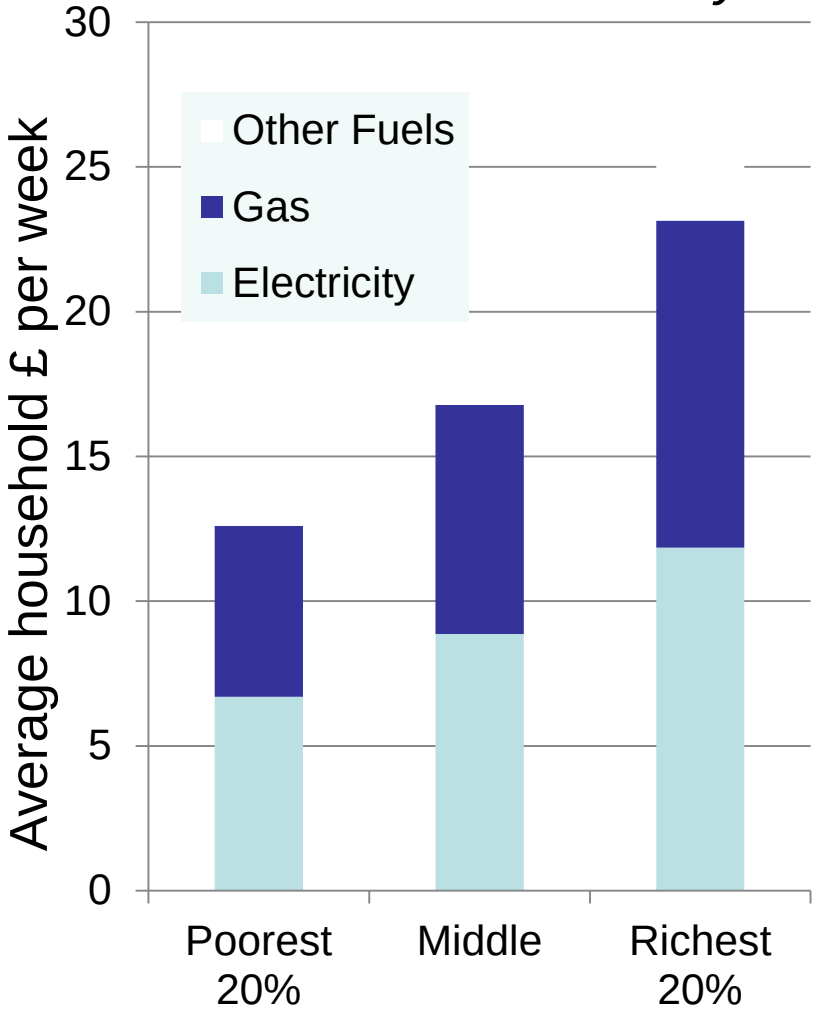
Figure 5-10 The scope of consumer-driven emissions

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

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

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



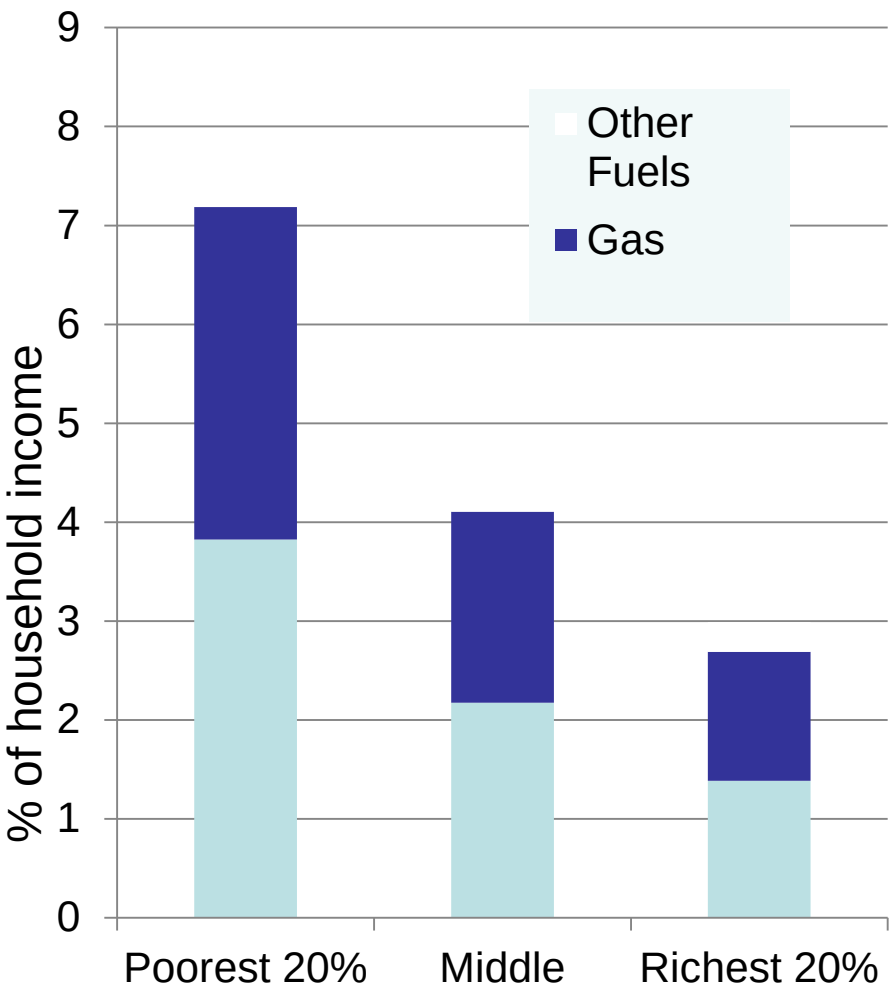


Figure 8-7 Household expenditure on energy UK 2008
Source: Office of National Statistics 2009.

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

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’

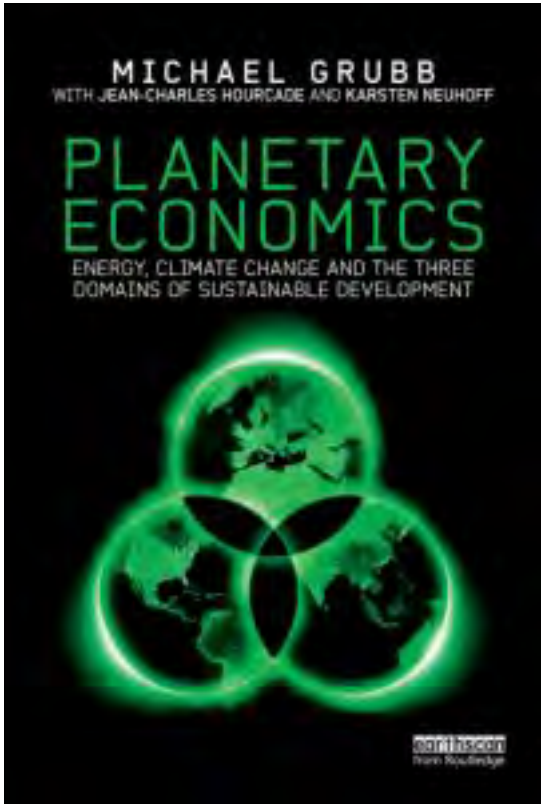
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

An integrating approach to climate policy

Three Domains

and the

Third Pillar of Sustainable Development



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

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 & tech diffusion unavoidable
- … with the potential positive side being macroeconomic version of “Porter’s kick”

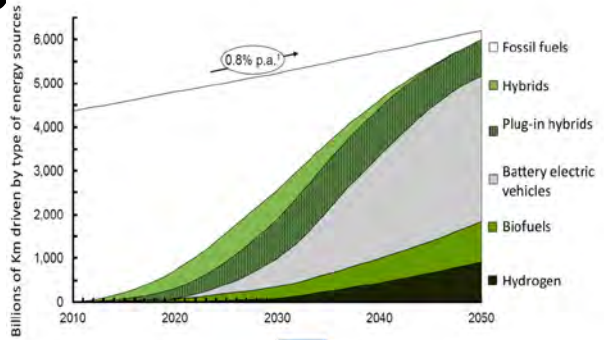
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

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

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

Urban choices have huge enduring implications..

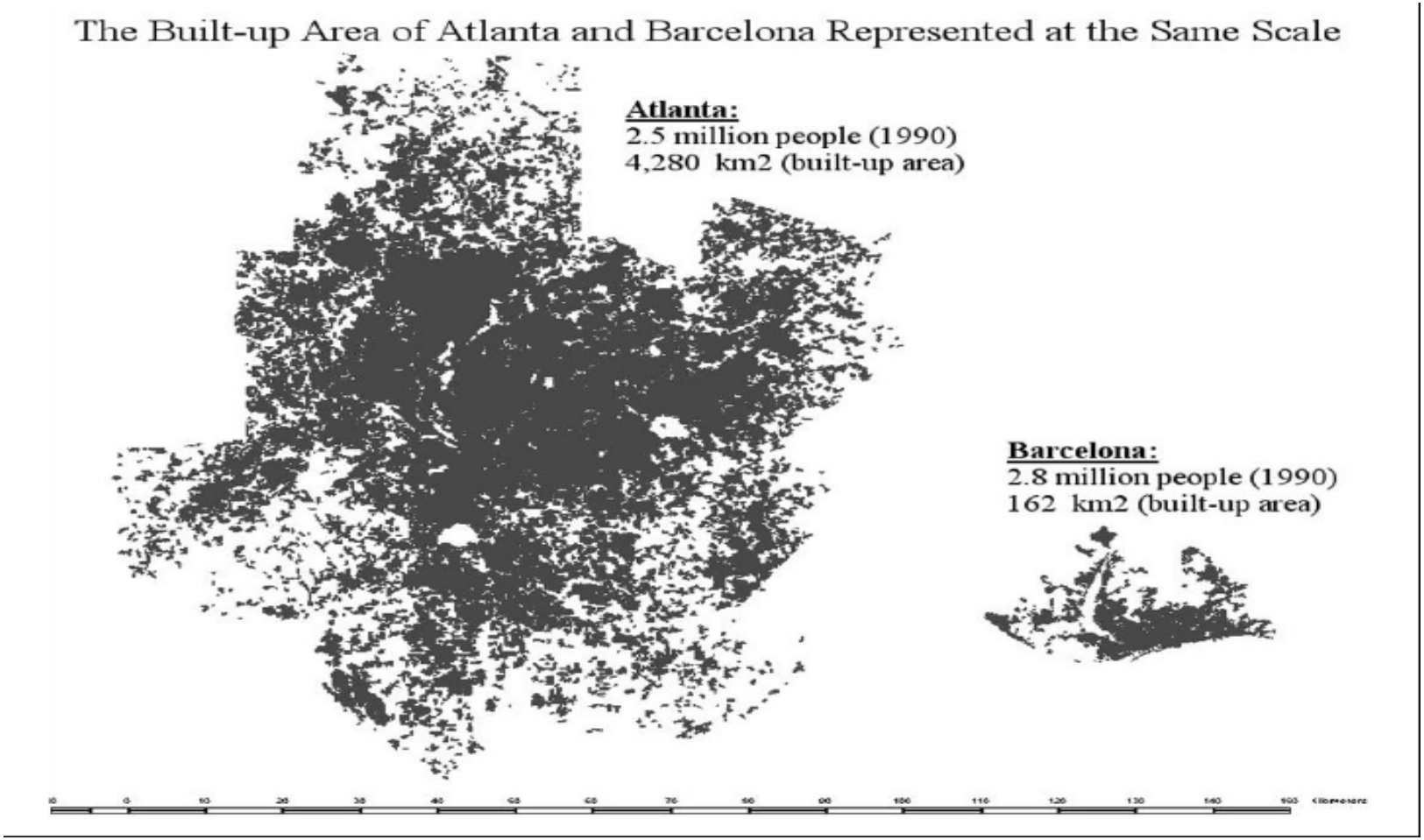
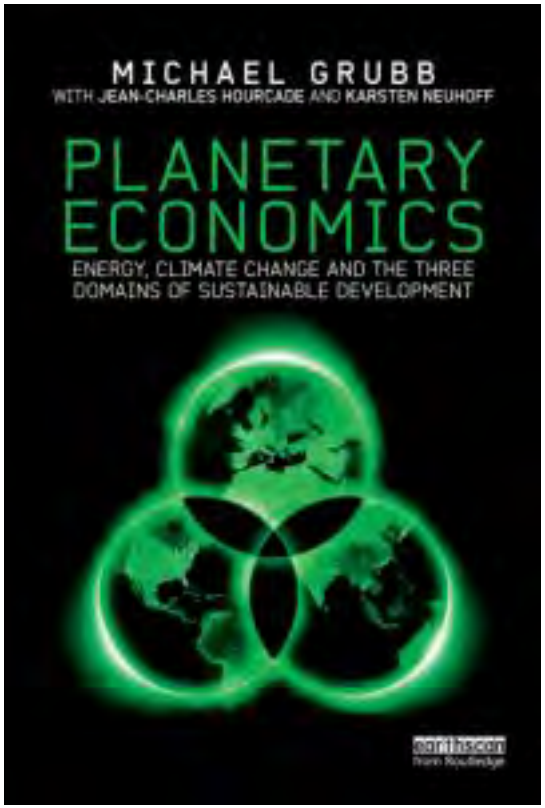


Fig.10.5 A comparison of the built-up area of Atlanta and Barcelona.
Source: Bertaud and Richardson (2004).

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

Planetary Economics

An integrating approach to climate policy



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

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

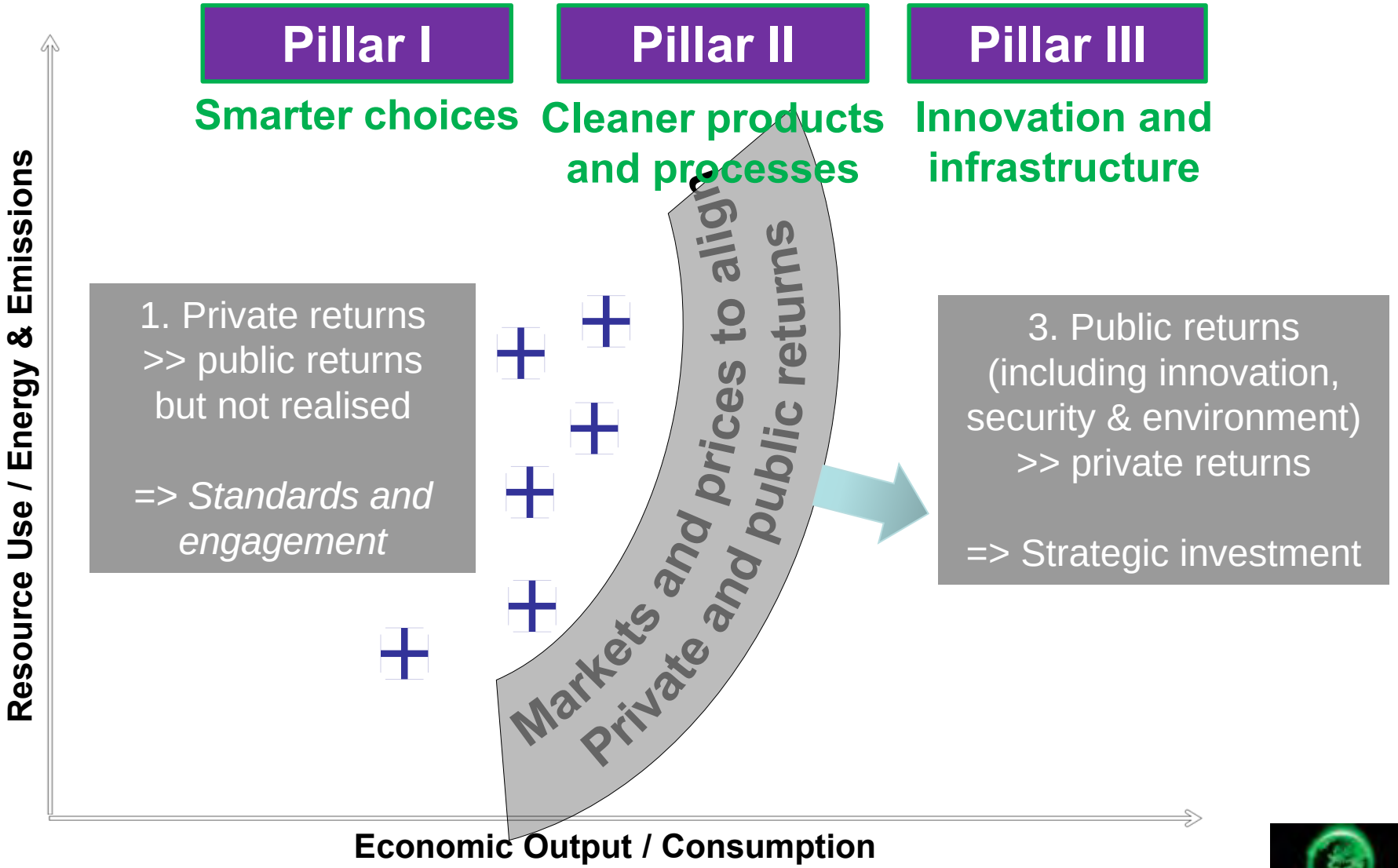


Fig. 12.3 ***Public and private returns in the 3 domains***

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

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

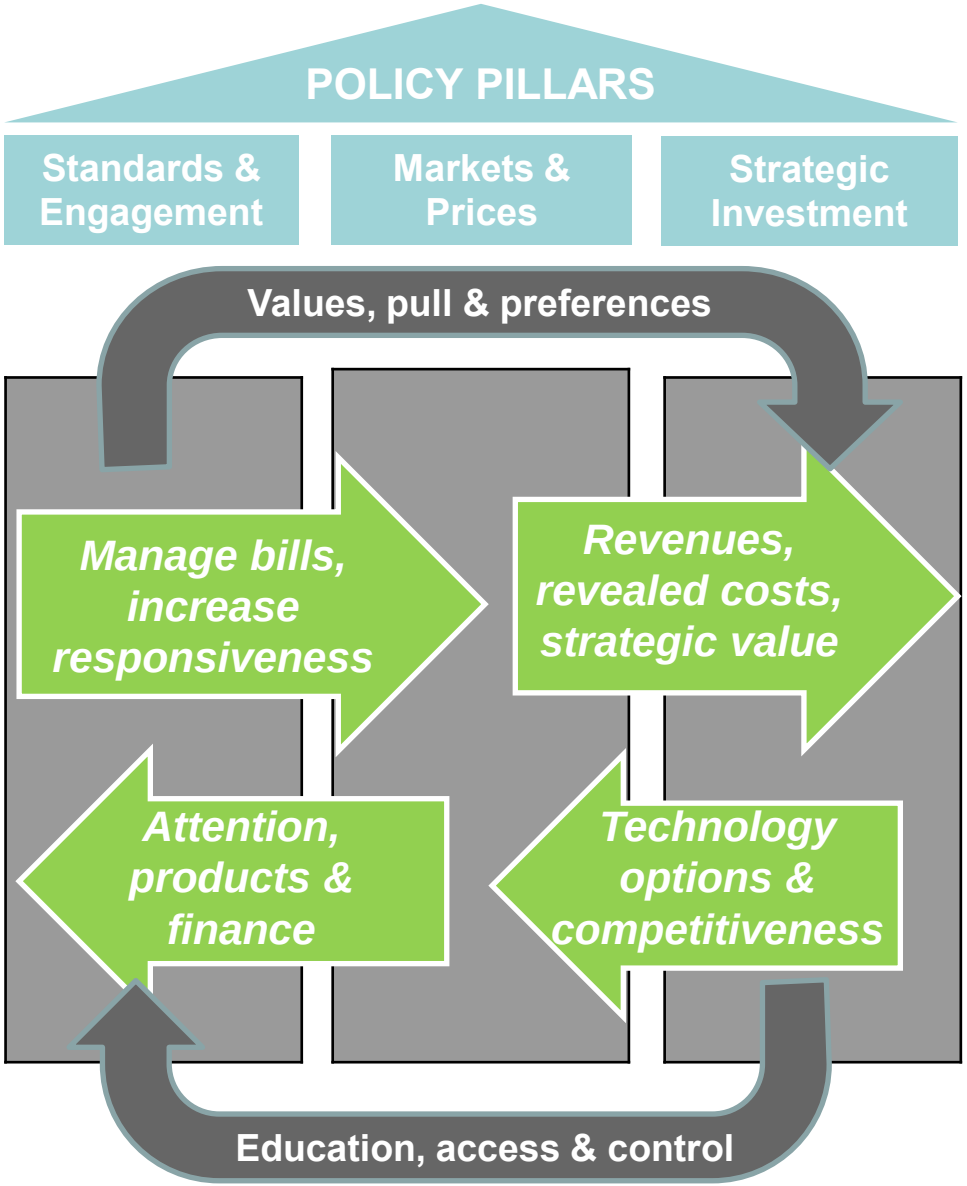
- Energy efficiency policy on its own limited by:
  - Scale of intervention required
  - Growing scale satisficing behaviour
  - …. Leading to large Rebound effects

- 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

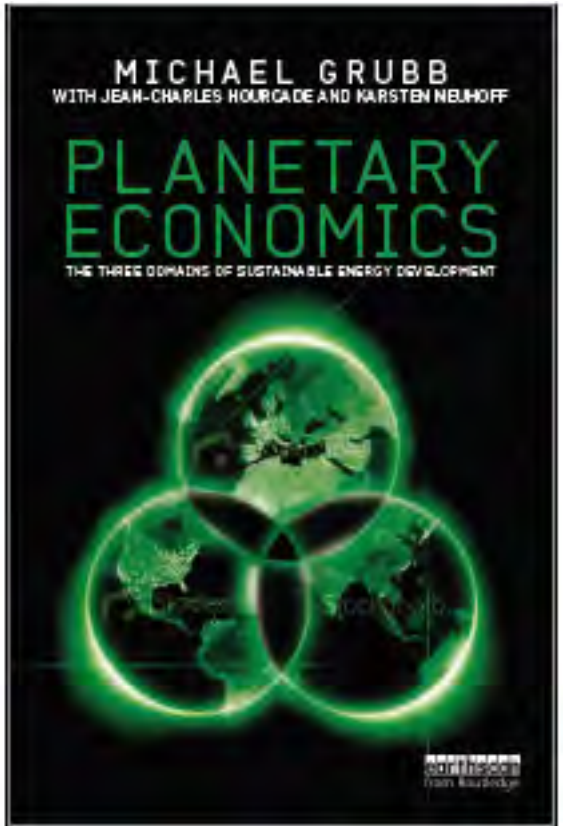
Source: Grubb, Hourcade, and Neuhoff. (2014): *Planetary Economics: energy, climate change and the three domains of sustainable development.* Routledge

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



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

An integrated approach to Energy Transition



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Not marginal+ but structural and systemic change

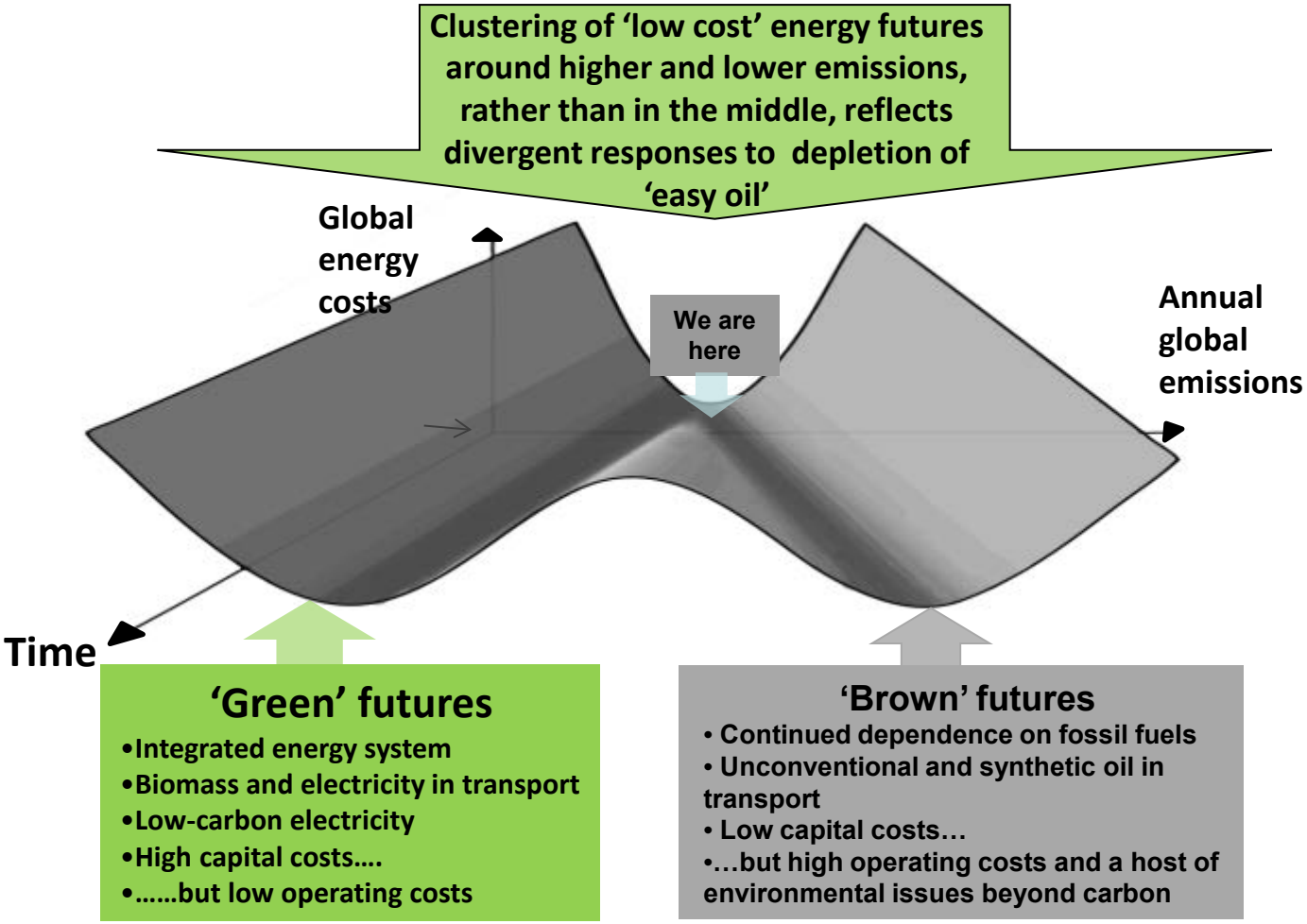

Figure 10-6: Two kinds of energy future – the carbon divide
Source: **Upper panel: Gritsevskyi and Nakićenović (2000); lower panel: authors**

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

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

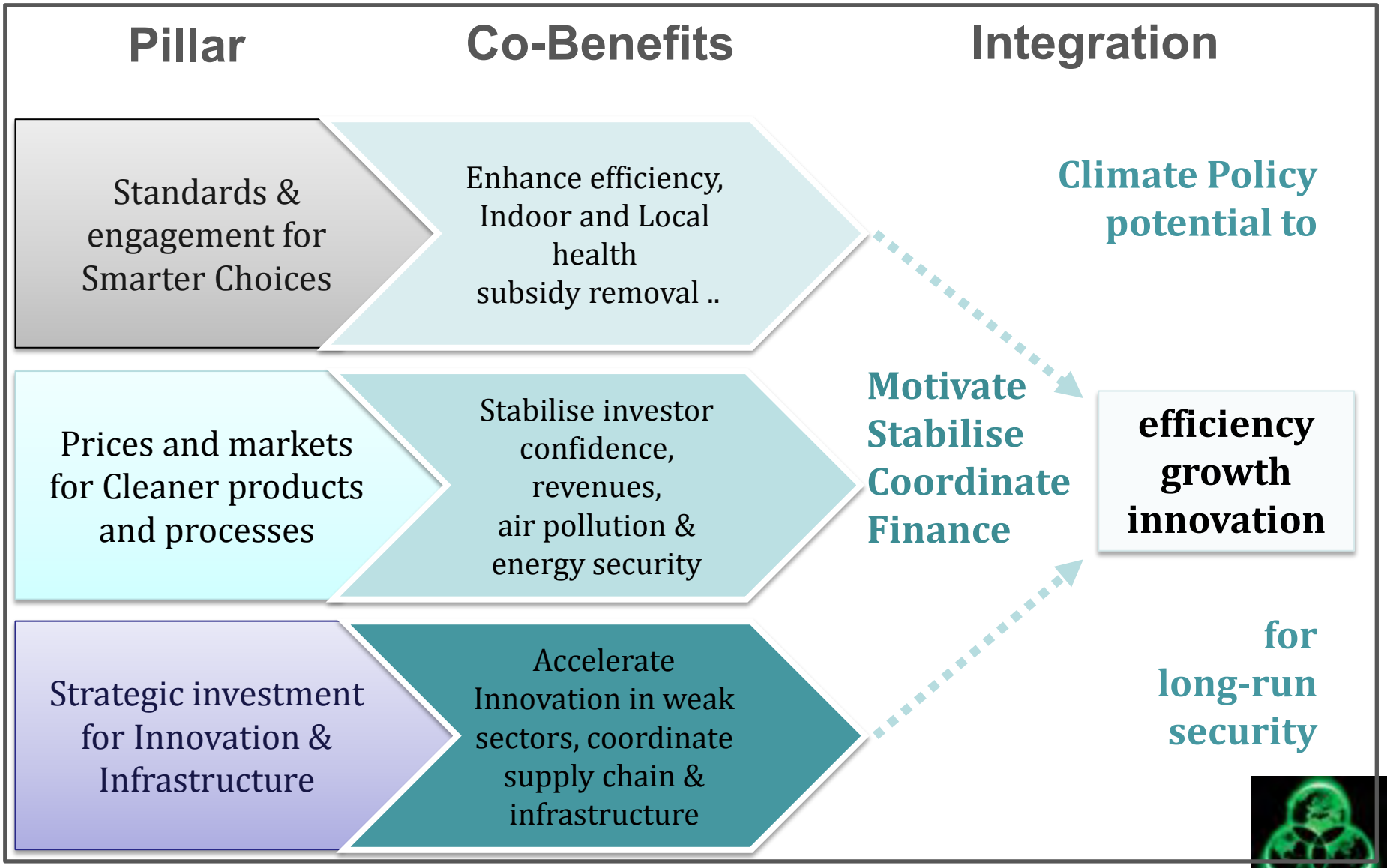

Figure 12-4 Potential joint benefits in energy and climate policy

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

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**