Carbon Added information, incentives and instruments: rationale and challenges in the electricity sector

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and

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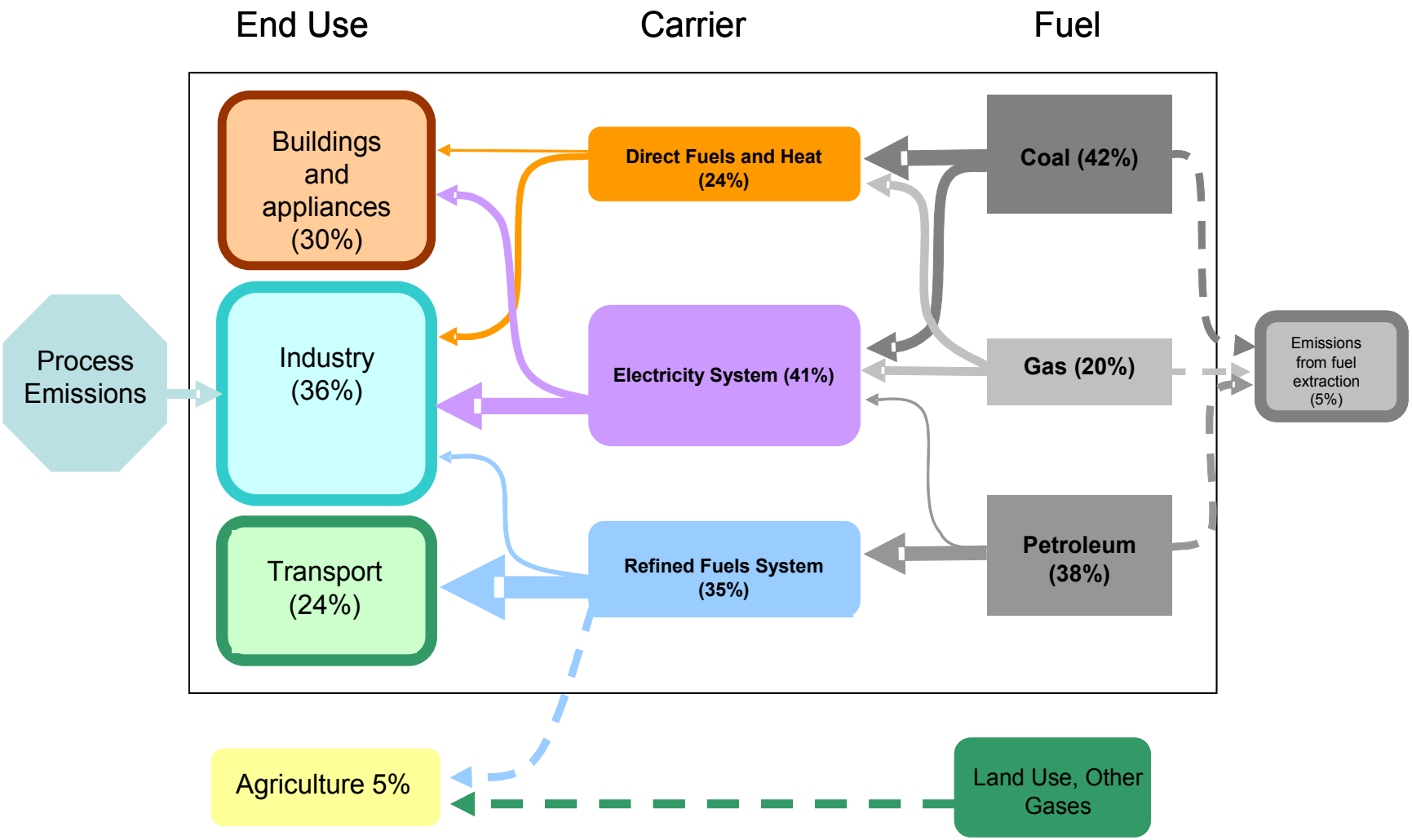
Overview

- Michael Grubb:
  - Basic structure of global energy-CO2 flows
  - Global economics of energy-CO2 abatement: a (really) simple view
  - Structural evolution of global ‘top down’ General Equilibrium modeling
  - The central challenge of manufacturing
  - Unpicking the supply chain – example of cement
  - **The economics of substitution, not efficiency**
- Tim Laing:
  - Why is tracking carbon in electricity a problem?
  - Why creating a better method may be useful?
  - How could we start to think about doing it?

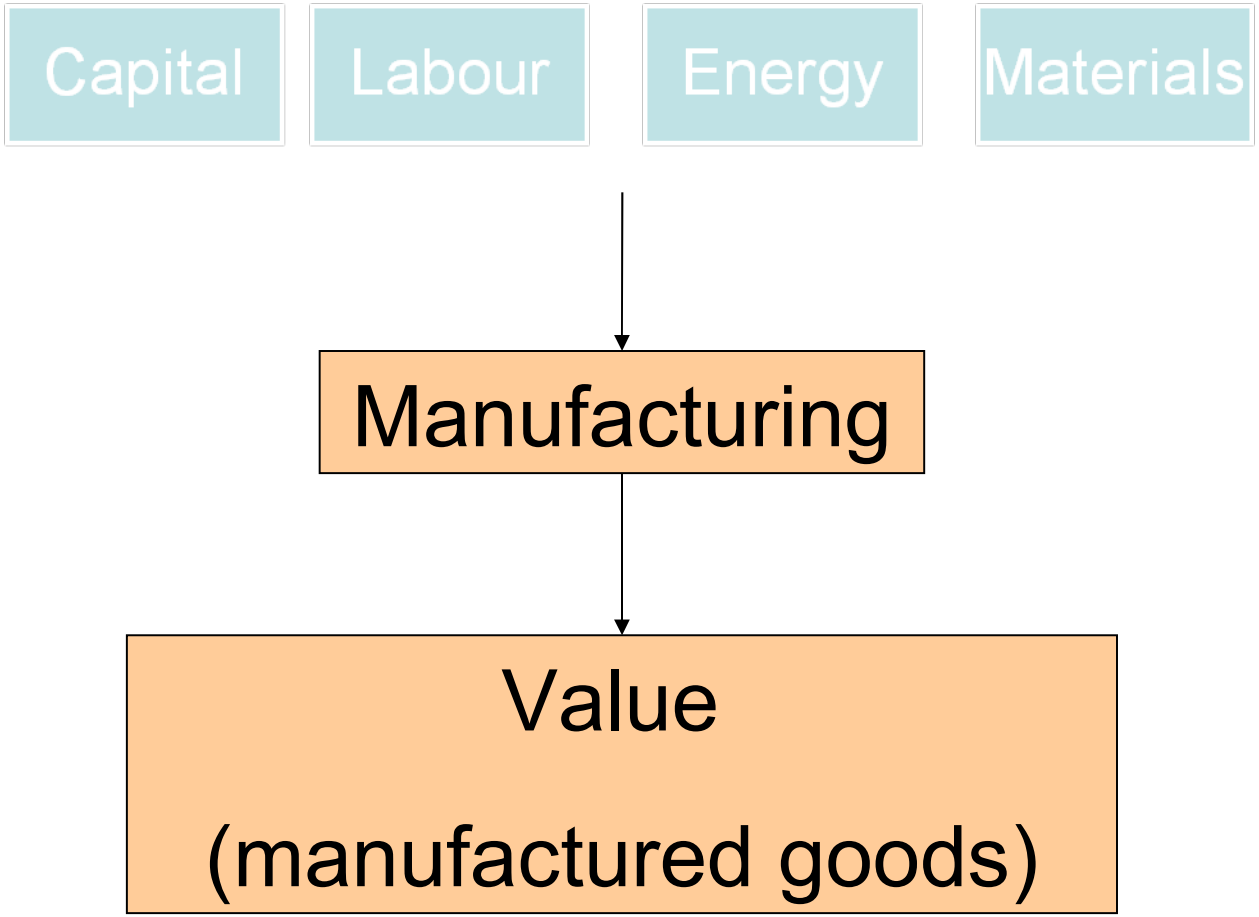
The energy system

- and limits of end-use disaggregation in global energy-abatement modelling



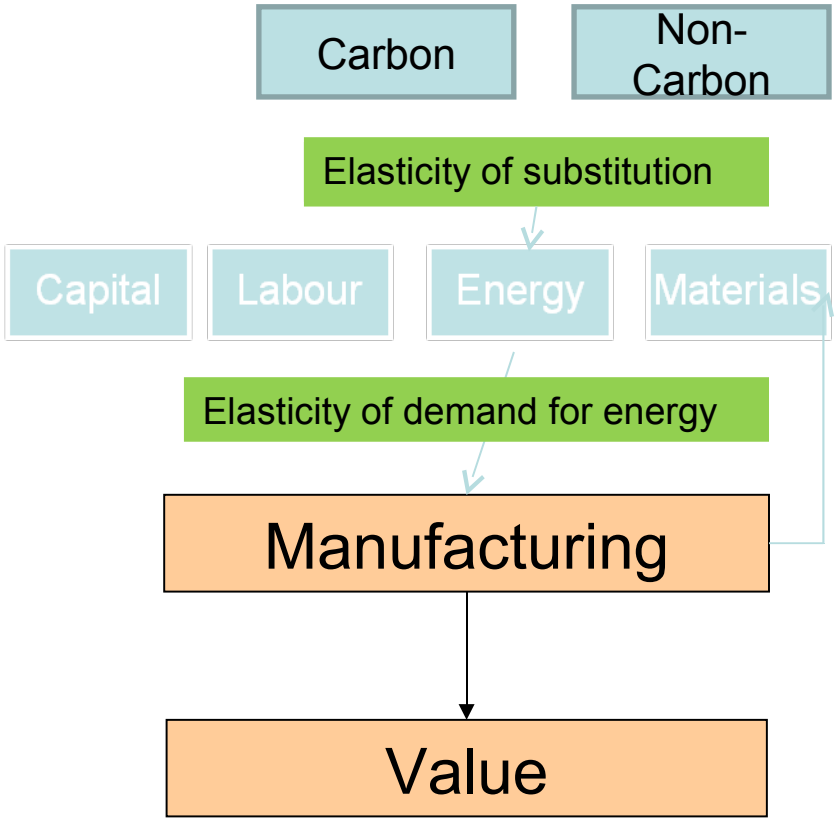
Source: CO2NNECT

A simple world

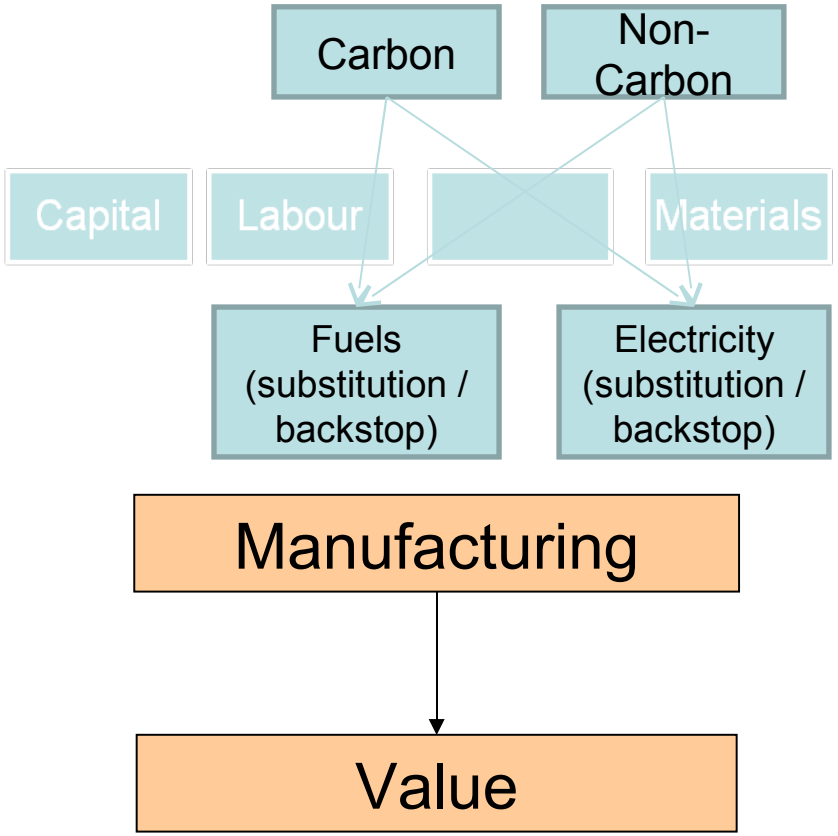


Global 'General Equilibrium' abatement modelling

Simple



More sophisticated



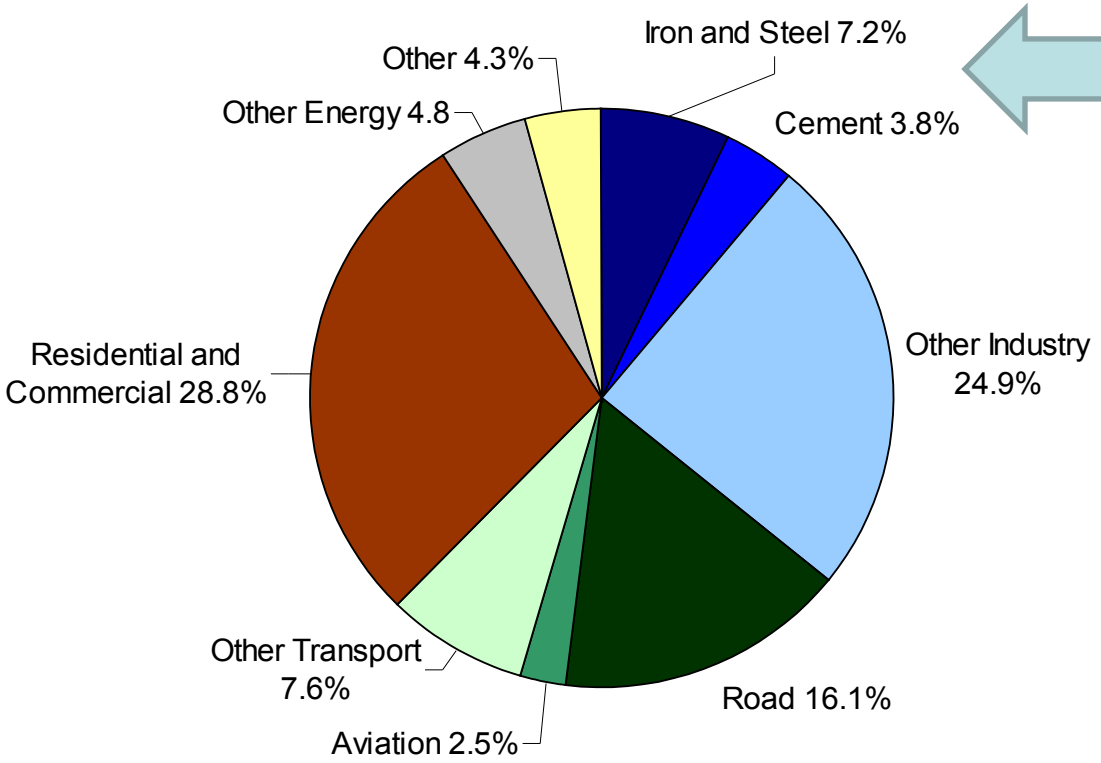
The process of global abatement modeling over past 20 years consists almost entirely of more sophisticated modeling of energy sector with elasticities and direct technology substitution in energy supply

This is a problem

- *All* energy resources have problems (external costs) and limitations
- Climate change limits the most abundant fossil fuel (except for CCS, which itself carries problems and limitations)
- Exergy analysis points to a *huge* physical potential to improve efficiency with which we deliver the energy services we demand, particularly in transport and buildings
- But manufacturing has been seen as different – particularly in relation to core industrial production, and process emissions
- We have remarkably little understanding of how much energy services we *really* demand – *particularly* in manufacturing
- Global abatement assessments point to manufacturing and aviation as the Achilles' Heel of global decarbonisation

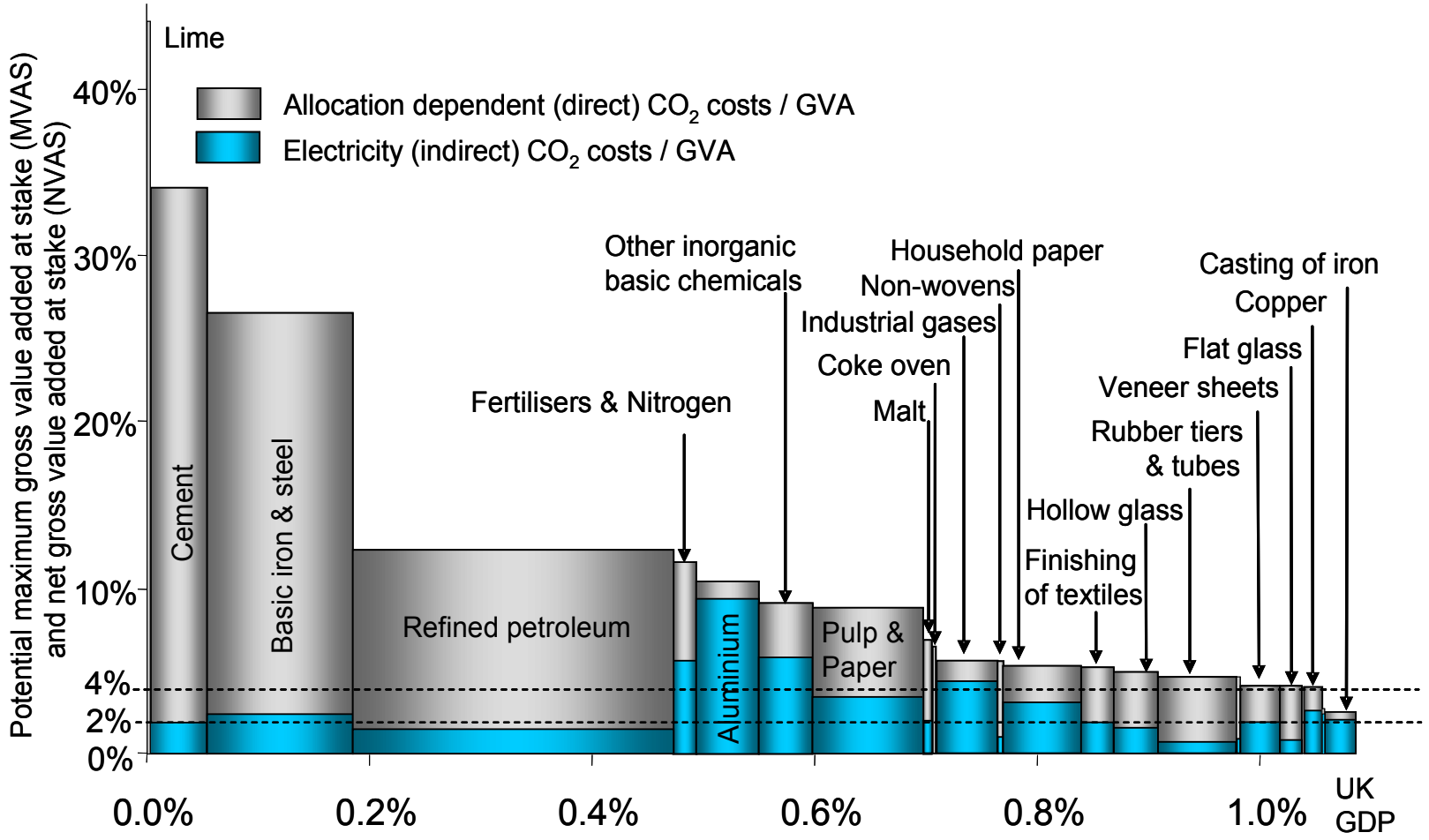
Manufacturing remains the biggest global emitting end-use sector

Much of the apparent progress in reducing OECD manufacturing consumption has been illusory, reflecting outsourcing particularly to China



PLUS process emissions that approximately double cement and steel sector emissions

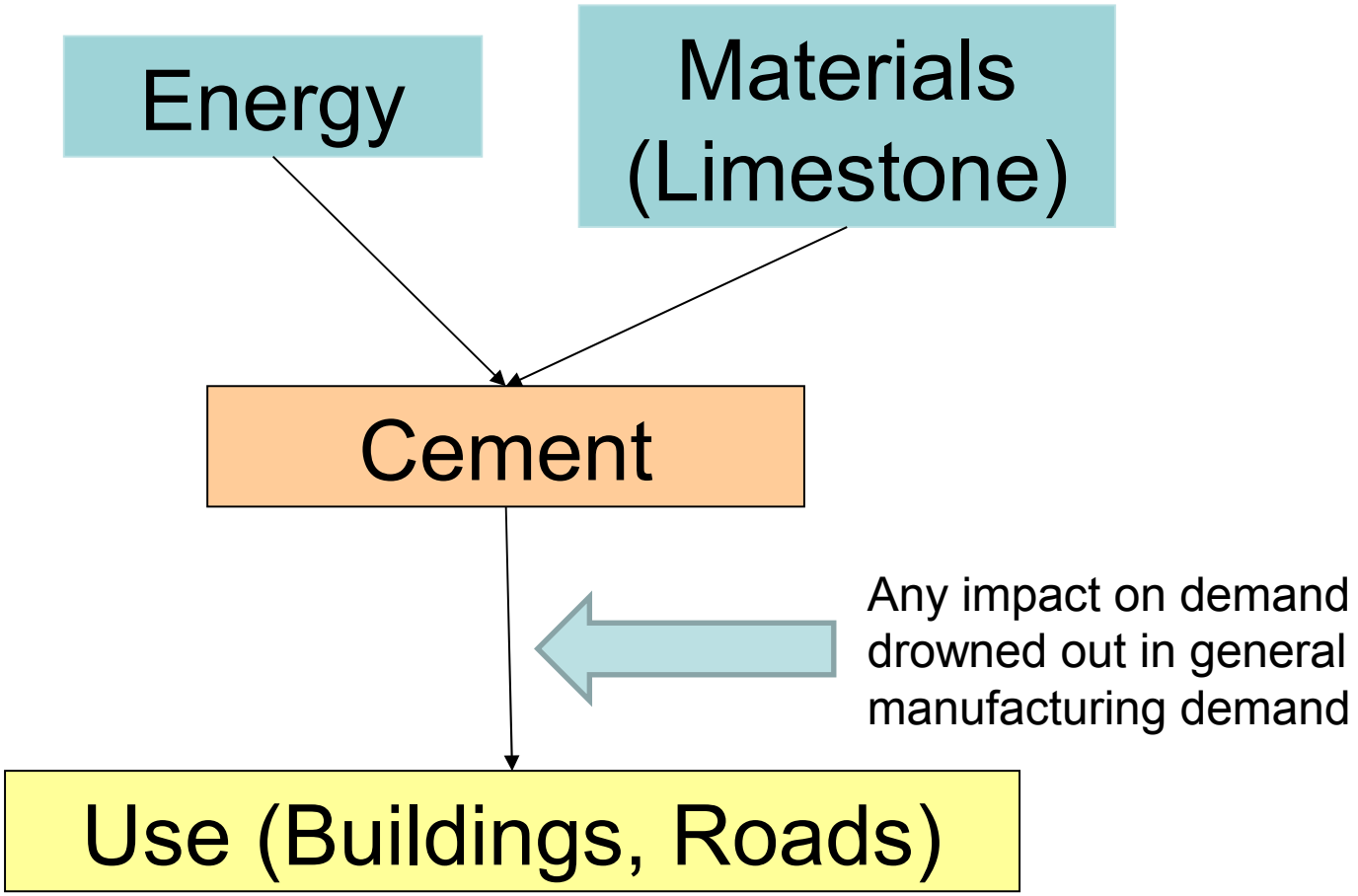
Within manufacturing, carbon emissions are *heavily concentrated* in a few primary production activities that contribute only a small share of value-added



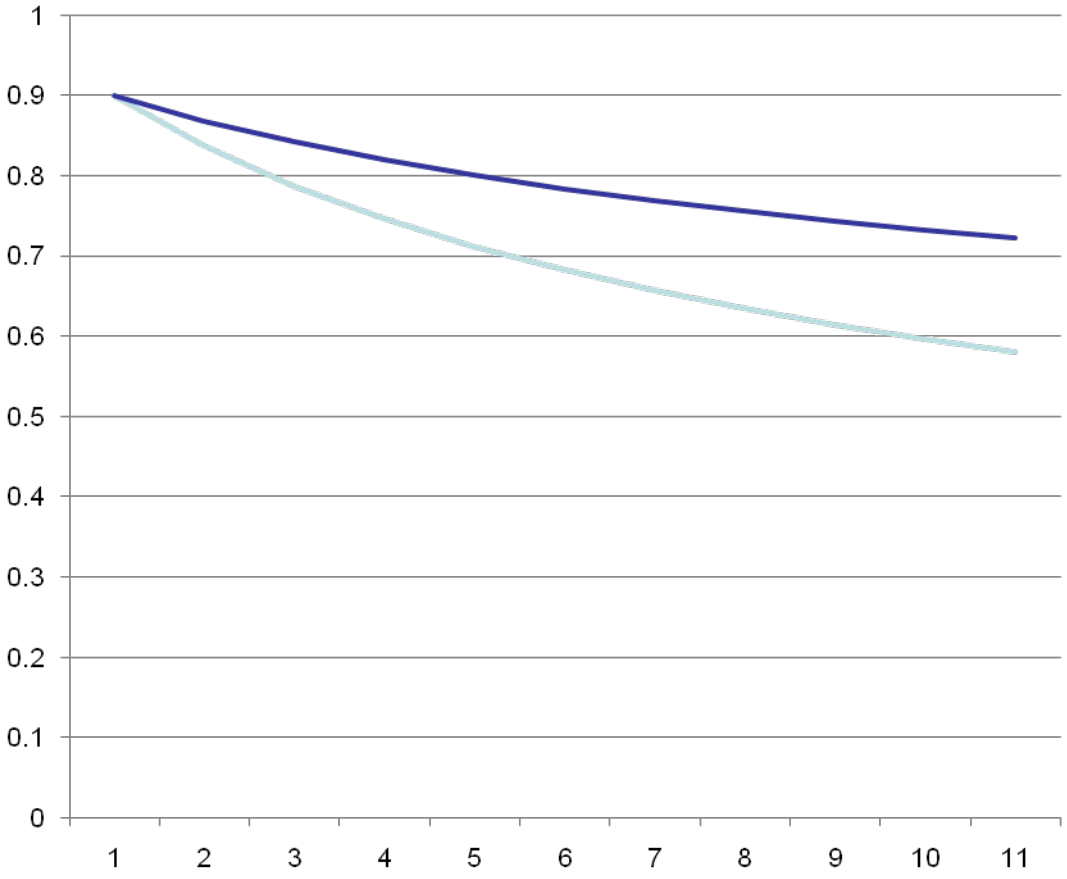
Price increase assumption: CO_2 = €20/t CO_2, Electricity = €10/MWh

Sources: Climate Strategies: Hourcade et.al *(2007). Differentiation and dynamics of EU ETS industrial competitiveness impacts*

Energy demand in a simple manufacturing chain
- a representative view of most economic models (if we're lucky)



Impact of elasticity response (illustrative)



Elasticity -0.2

Elasticity -0.4

Time, impact of restructuring and EU ETS ??

Trebling of carbon input costs

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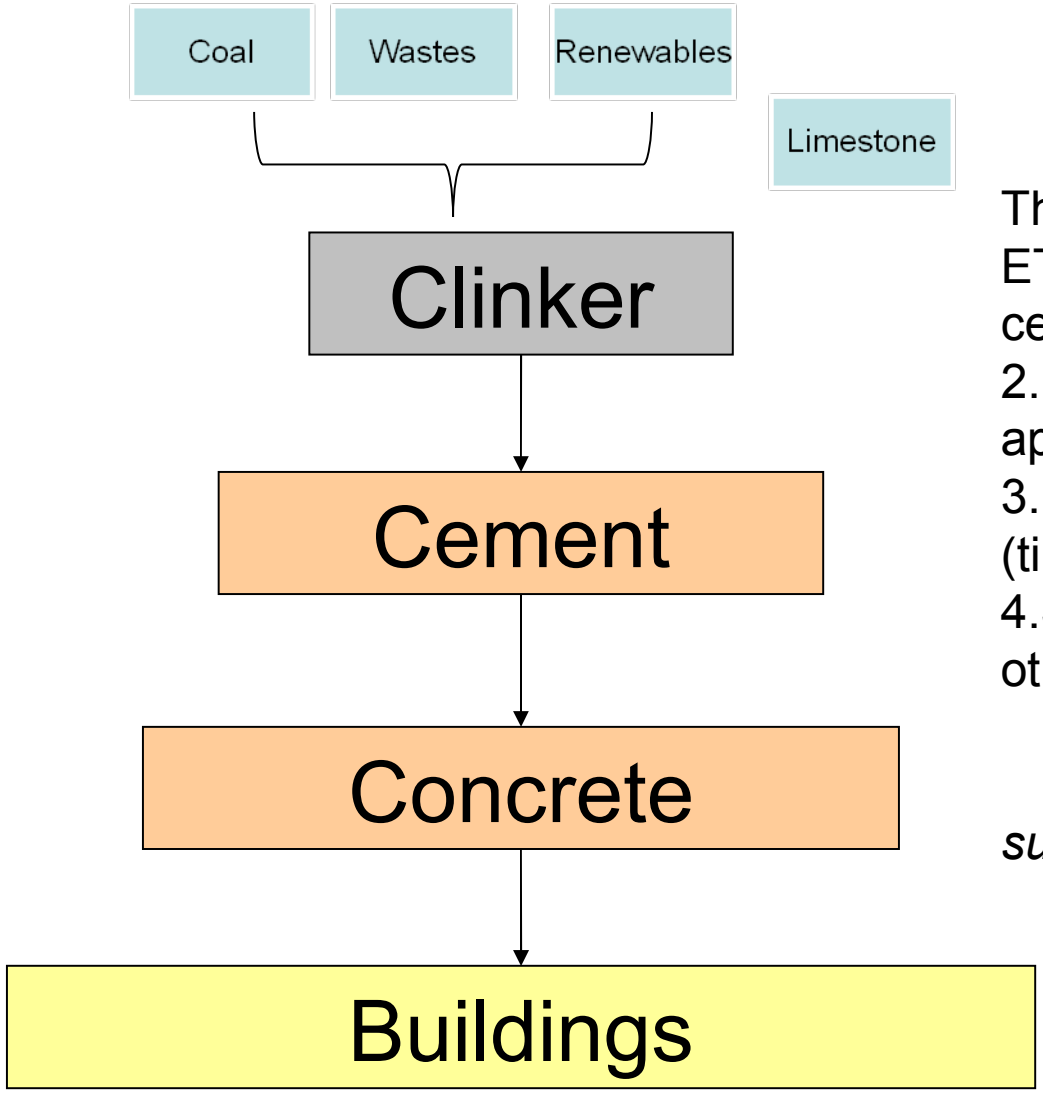
Cement Production Chain

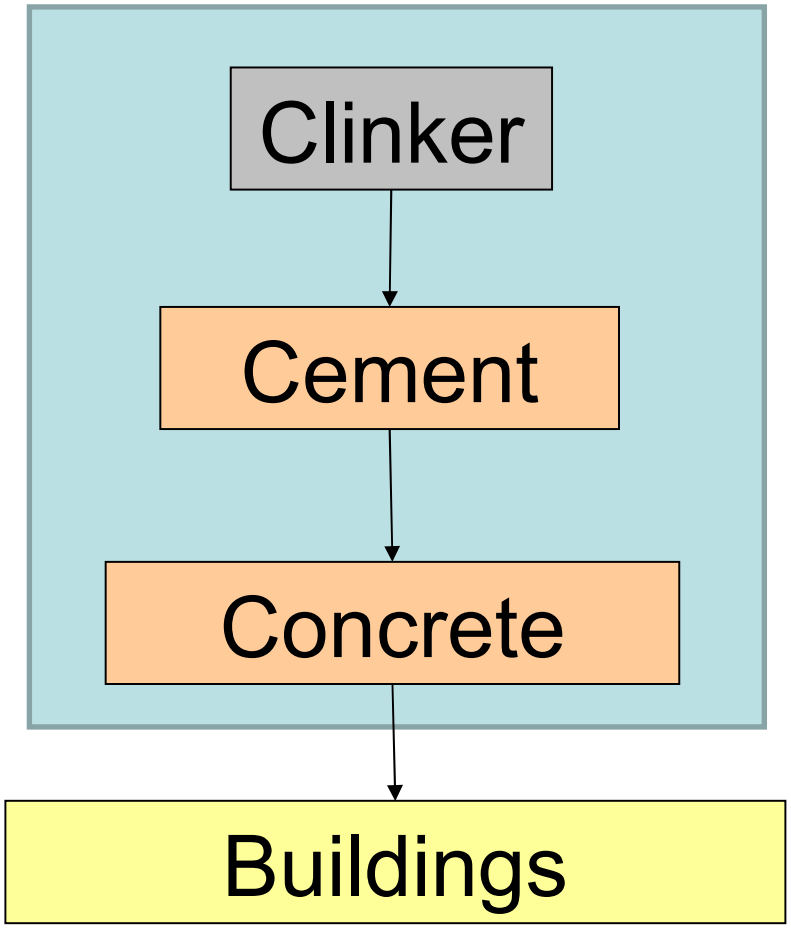


The 'cement surprise' in the EU ETS has been the ability of the cement sector to reduce emissions
2. Increased plant efficiency (but approaching limits)
3.Recycled and renewable fuels (tires, biomass)
4.Substitution of clinker by mixing other inputs to cement

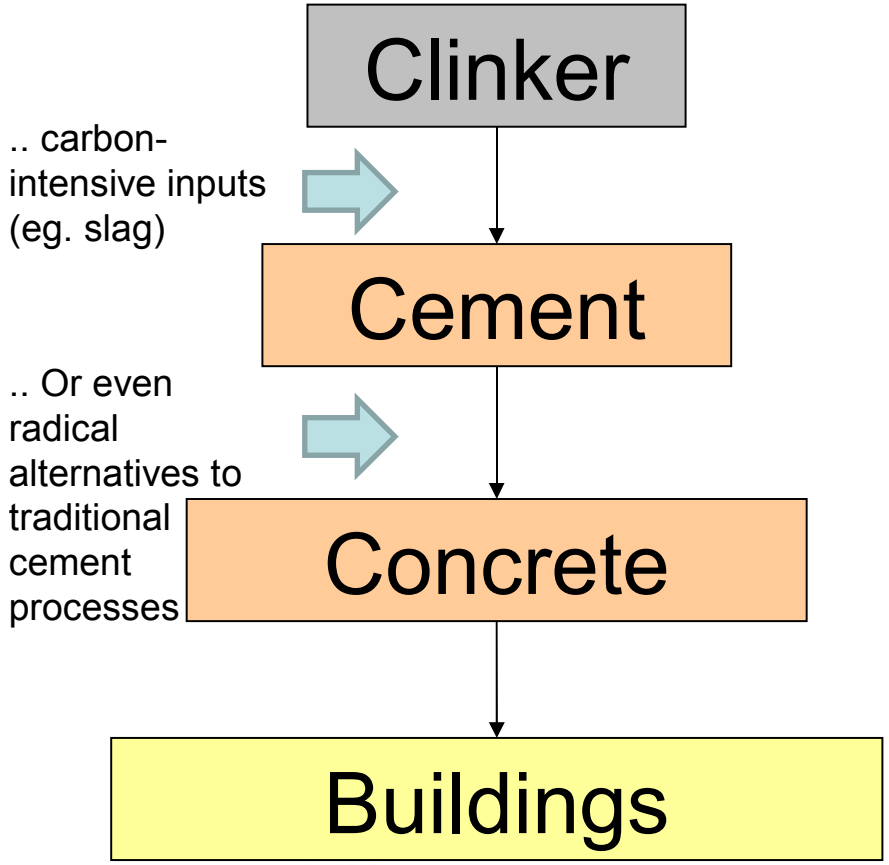
(2) and (3) are both *substitution processes*

Substitution within supply chain requires unbundling

Vertically integrated supply chain



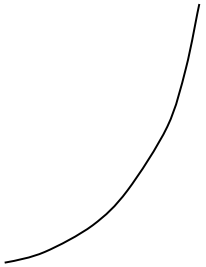
Unbundled supply chain allows possibility of substitution ..



Elasticities assume a particular functional form that may represent efficiency but not substitution effects

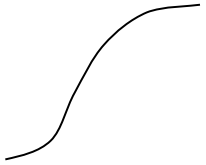
Standard elasticity:
Emissions from cement (clinker)
at cost Cck

$$E = constant \times Cck^{-\beta}$$

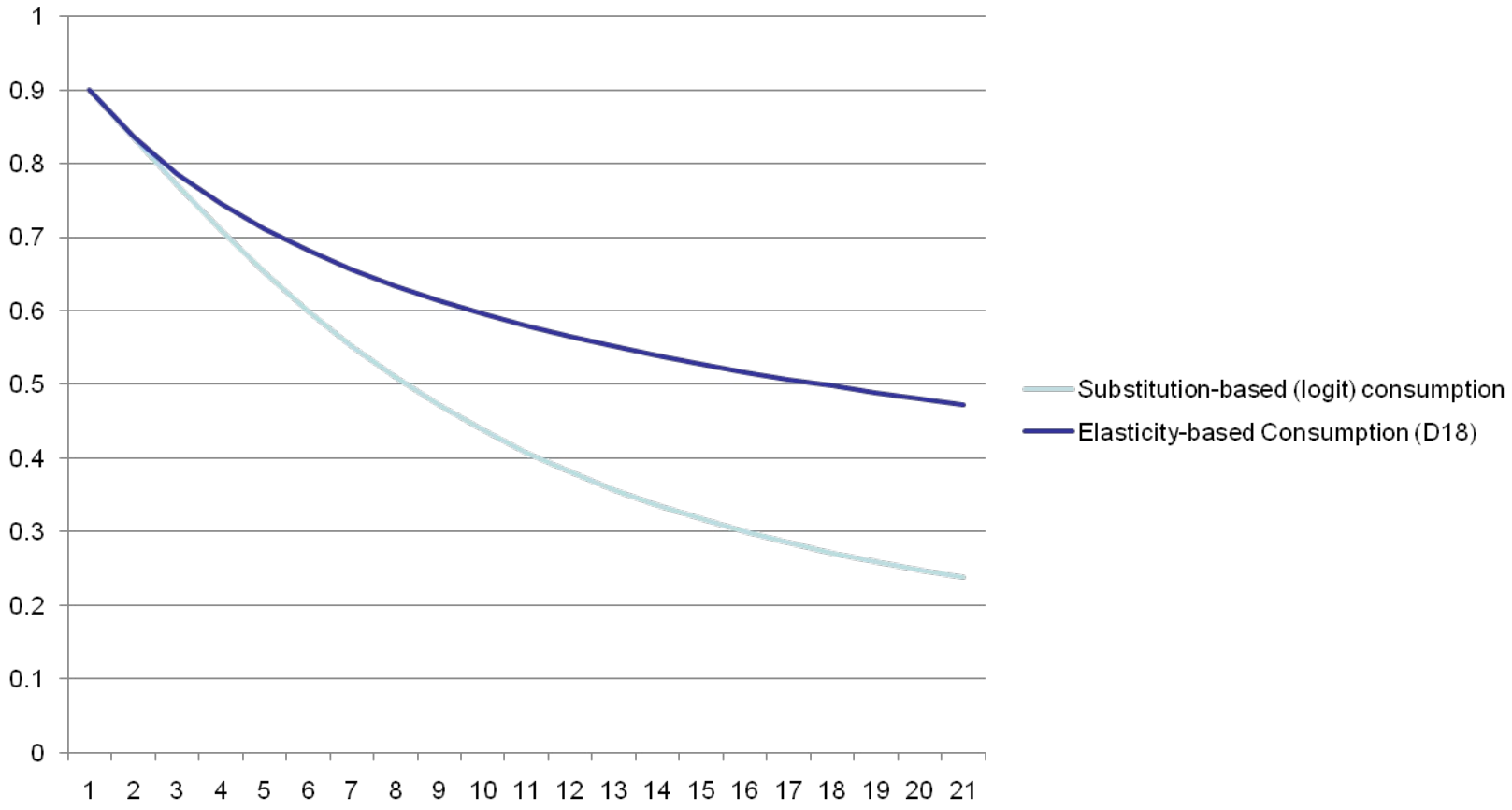


Logit substitution function
(Csub is cost of substitute)

$$Sck = \frac{(Cck)^{-\eta 1}}{(Cck)^{-\eta 1} + (Csub)^{-\eta 1}}$$



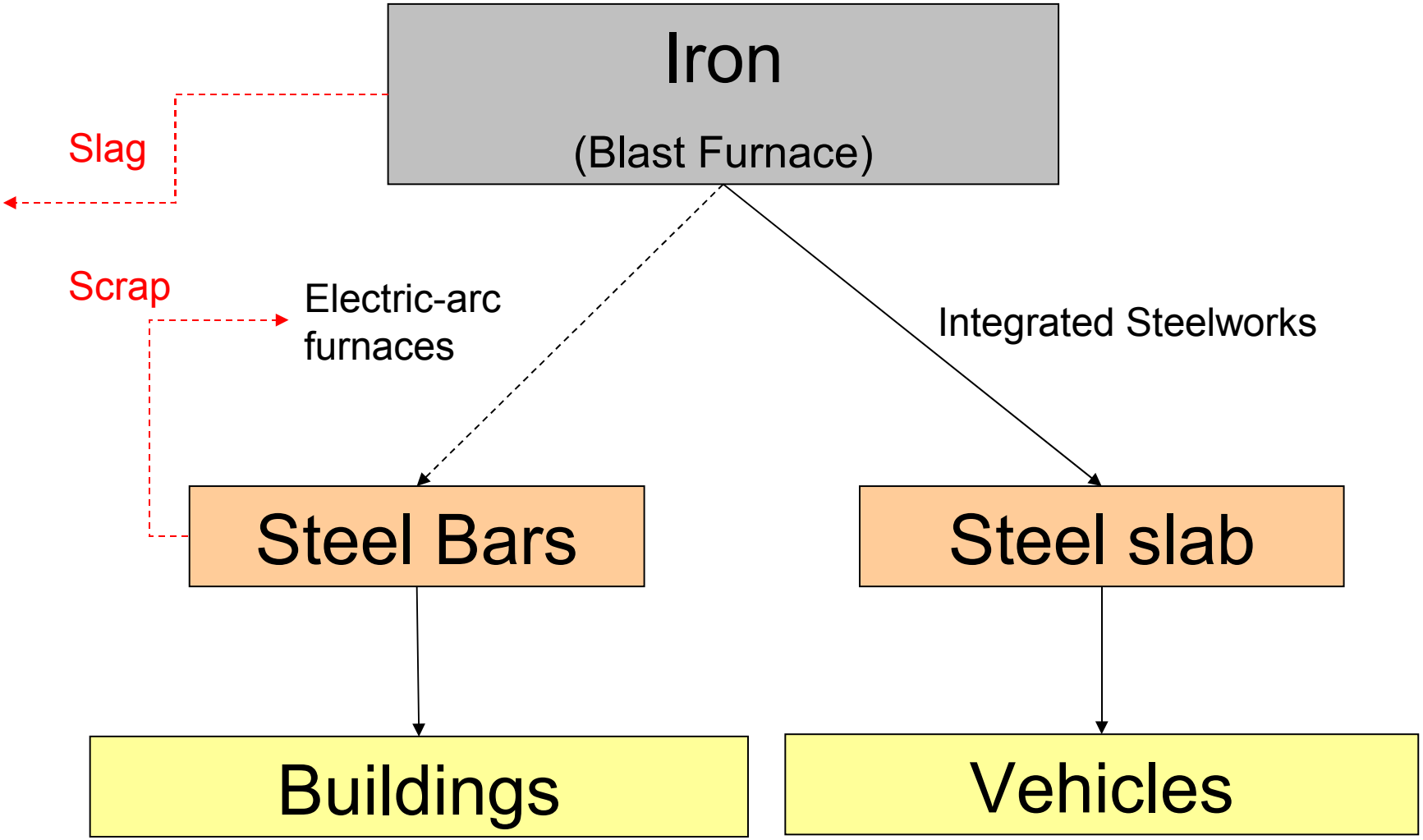
At large cost difference, economics of efficiency (through elasticity) diverges fundamentally from substitution



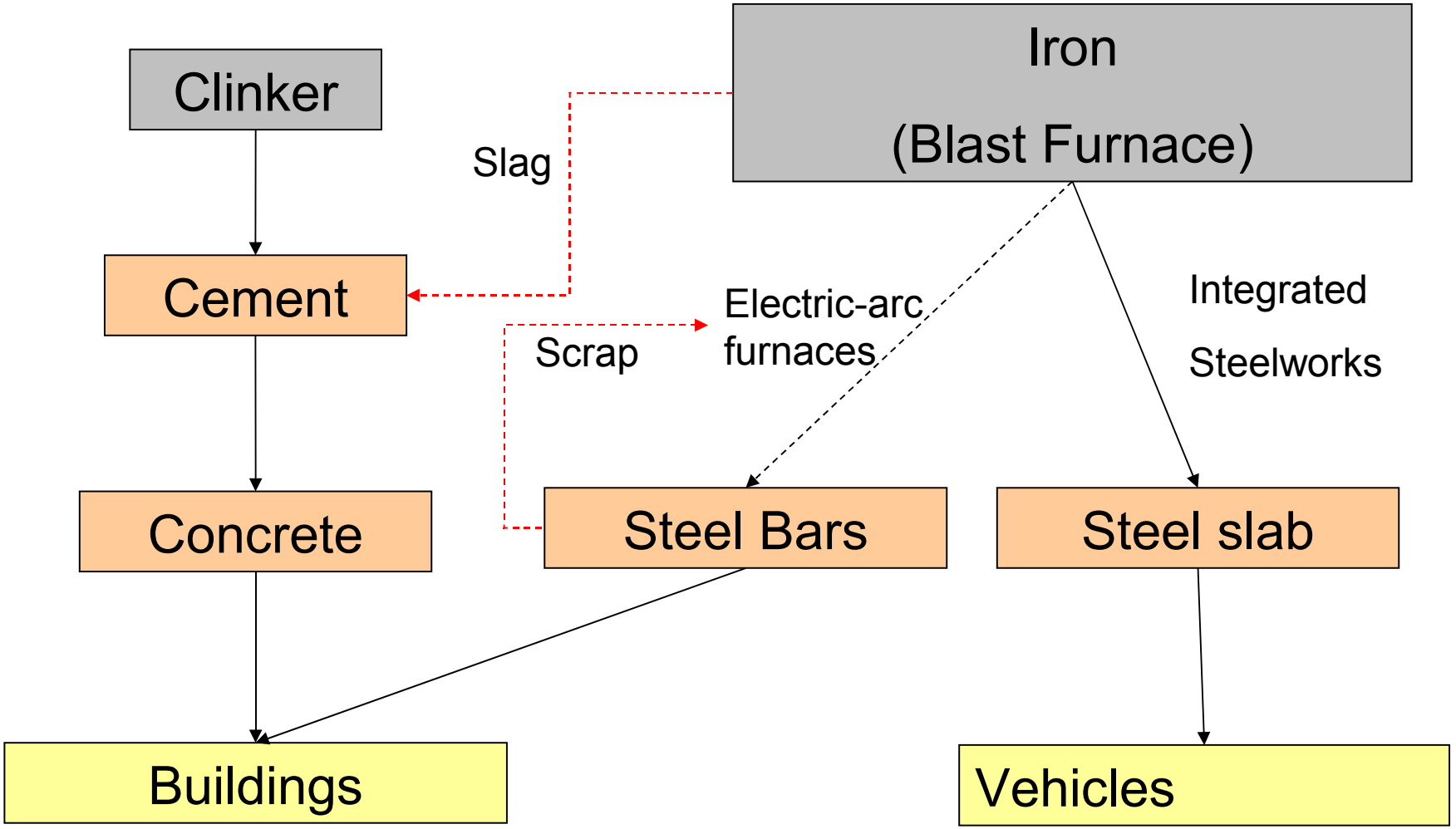
Carbon input costs x 3

Carbon input costs x 5

Iron and Steel

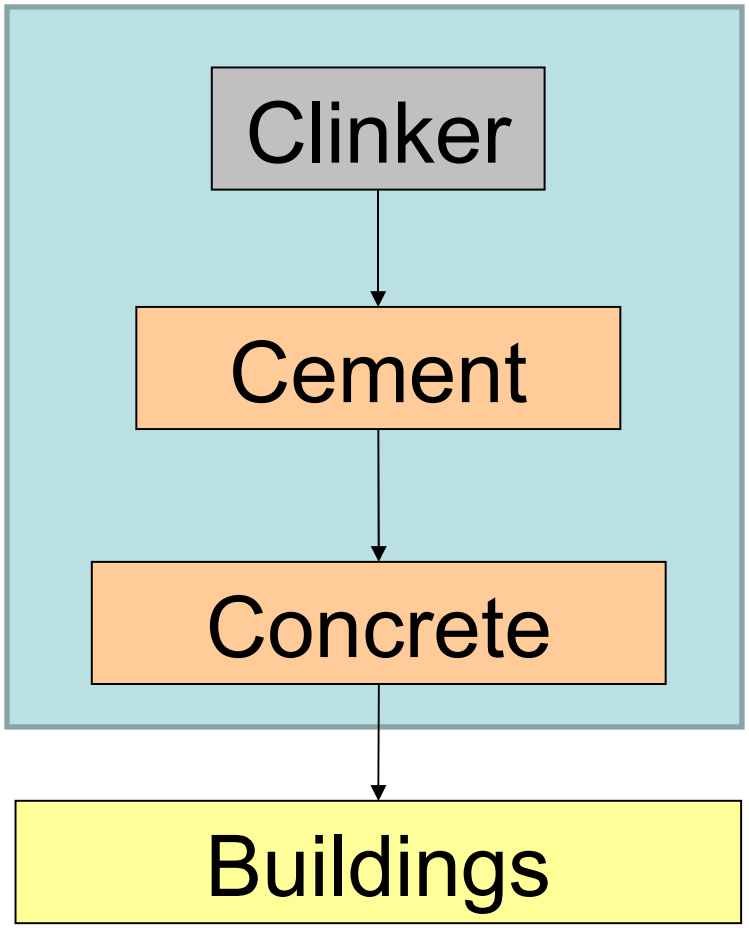


Cement and Iron Production Chain

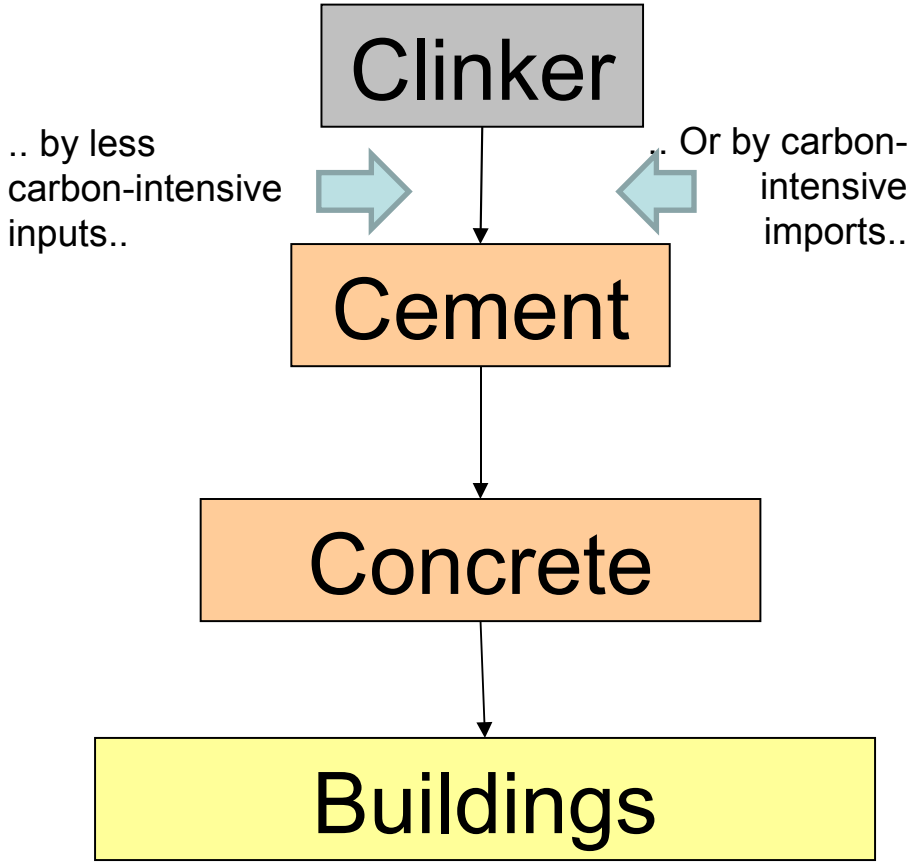


But with a carbon price, unbundling also introduces problem of import substitution / carbon leakage

Vertically integrated supply chain



Unbundled supply chain allows possibility of substitution ..



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- Unbundling creates *potential* for more effective response, but necessitates policy to deal with leakage

Politically, the favoured response in the EU, US and Australia is free allocation; argument that "benchmarked" allocation preserves incentives to abatement …

- **Fixed free allocation** with new entrant / closure rules can deter *investment leakage*, but may do little to shield operational decisions & thus can risk leakage + windfalls
- **Output-based allocation** should be more effective at tackling both windfall profits and leakage (a good thing) providing it is applied to the carbon-intensive step in production:
  - .. suppresses incentive to factor carbon costs into production and price decisions (good or bad, depends on whether focus is on distribution or efficiency)
  - .. hence takes out the incentive to use the product more efficiency, or to substitute it with lower-carbon product, throughout the rest of production & the consumption (bad: Chart 11)

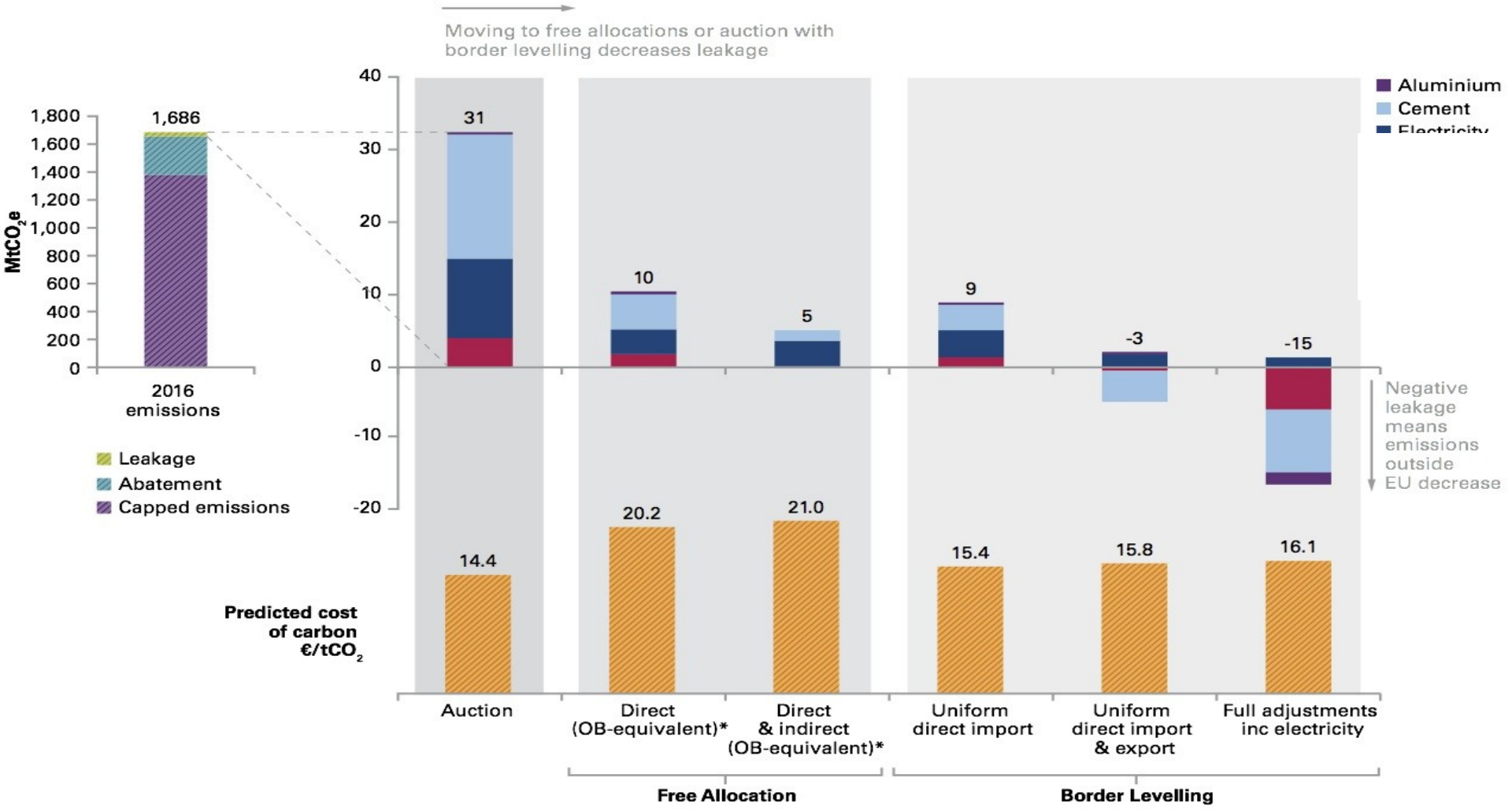
- *.. But by how much ?*
  - US and EC studies suggest impact by 2020 small, raising carbon prices a few percent: concern that these models do not represent product substitution which would be dominant efficiency loss
  - CASE modeling finds much bigger impacts, raising carbon prices by 30%

Allocation approach	CO2 price in 2016
Auctioning	14.4
Output-based inc.electricity	27
Output-based for steel & cement direct	20
Output-based direct and indirect	21

Source: Climate Strategies (2009): Droege S. et al.,

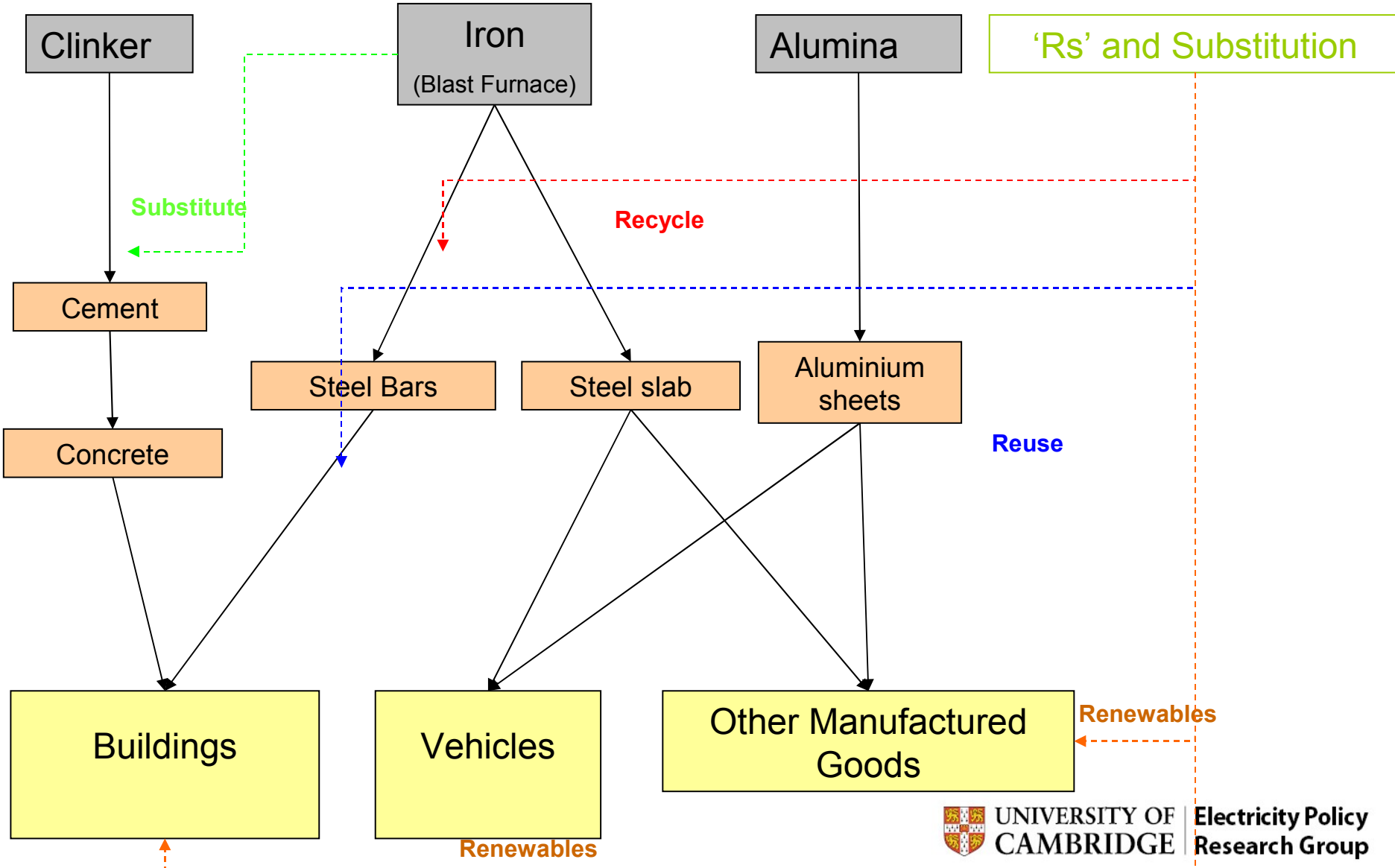
Tackling Carbon Leakage in a world of unequal carbon prices

CASE Results: Border Levelling better than free allocation at reducing leakage and (adverse) impact on carbon price



Source: Carbon Trust (2010), *Tackling carbon leakage: sector-specific solutions for a world of unequal carbon prices*

A complex world – which we need to understand much better before jumping to conclusions on mitigation costs or policies



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.. in which the most efficient mitigation requires response to cumulative carbon at each step of supply chain

- Start with primary production emissions
- Track the carbon to the next step, add the carbon at the next step
- Include tracking any carbon *payment*
- Wherever a carbon price is applied, charge it on the *total carbon*, *minus the carbon already paid for*
- The approach can operate across borders in ways directly analogous to VAT: “carbon added information, instruments ..”
- Creates an incentive for entities at each step to respond to full cost of embodied carbon; and for governments “upstream” to apply carbon charges themselves so as to keep the revenue: “.. and incentives”
- But how far downstream … ?

Why is tracking carbon in electricity a problem?

- Electricity is a homogenous good
  - The electrons we consume are all the same
  - Impossible to say electrons I buy come from Plant A or B, unless I have a dedicated line
  - The grid 'smears' out the different carbon intensities into a grid average
- Also level of renewables has been determined by UK government under a quantity scheme (and emissions savings across EUETS)
  - So if I purchase 'green' electricity am I contributing anything?
    - The renewables would be there anyway and the grid average used for reporting is unchanged
    - So businesses can't claim credit for green energy purchases
      - DEFRA advice as of June 2008
  - Removes demand-pull effect

Why creating a better method may be useful?

- Electricity is a crucial input into the production processes of many final goods – thus to have 'full' carbon-added accounting need electricity
- Competitiveness and Leakage concerns in certain electricity intensive industries
  - Aluminium
    - Emissions mainly from electricity – converting alumina to aluminium – at grid average 4% of EU ETS
  - Leads to calls for border-taxation
    - What levels should we base taxation on?
- Helps create niche markets, and empowers consumers
- Funding low-carbon power
  - Low-carbon power more capital-intensive 'infrastructure electricity
  - Repayment of capital depends on electricity price (+support)
  - Elec price depends on marginal unit of generation – coal prices, gas prices, carbon prices - Volatile + unrelated to own costs
  - Can there be a separate contractual market that provides more stability?

What do we do at the moment?

- Consumers can buy ‘green’ energy
  - In UK 2009 319,000 did
  - So what are they buying?
- OfGem Green Supply guidelines and certification scheme
  - Feb 2010 – voluntary, only domestic and SME
  - *Transparency*, *Evidence of Supply*, *Additionality* (inc offsets, retirement of certificates not required), *Accreditation*
- Which of these (if any) provides additional green power?
  - Three dedicated companies with different degrees of confidence
  - Plus various tariffs at all ‘Big 6’

A radical alternative

Could low/zero carbon electricity be a *distinct commodity with separate regulatory and accounting structures*?

- What could we do today?
  - Prove low-carbon electricity is ***additional*** to the system
    - Retirement of relevant certificates to avoid double counting
  - Ensuring that low-carbon power sold is matched by low-carbon generation
  - Ensure that such electricity was not included in the rest of the grid calculations
- Greater Technical possibilities: with power electronics
  - 'zero carbon' carried through a *DC component* in electricity networks
  - Preferential supply to DC uses (eg IT, battery charging)
  - Exploit greater efficiency of DC transmission and reduce need for transformers
- *Creating low carbon electricity services as a separately regulated marketed commodity, "Green Power (GP) contract market* NOT *denominated purely in cost per kWh"?*
  - Funding, contractual model closer to infrastructure than spot commodity
  - Is this possible with open competition between the "two types" of electricity?