

Basic economic concepts of Climate Change

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Topics to be discussed:

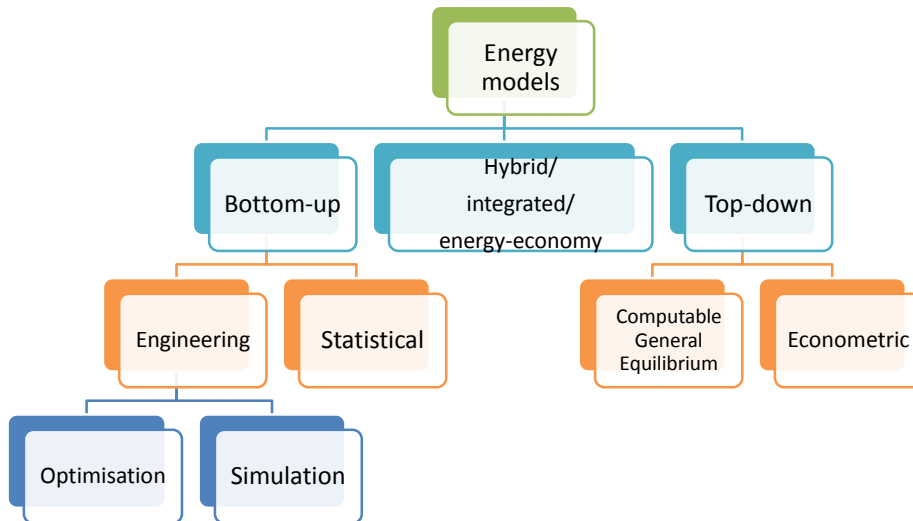
1. Modelling approaches
2. Cost-Benefit Analysis
3. Marginal Abatement Cost Curves

Modelling approaches

Climate/energy policy assessment

- Medium to long term outlook
- For analysing decarbonisation pathways/energy demand and supply scenarios
- Covering one or more sectors/entire economy
- Top-down/bottom-up/integrated modelling approaches

Examples of modelling techniques



Based on Swan and Ugursal, Mundaca and Neij, Nakata et al

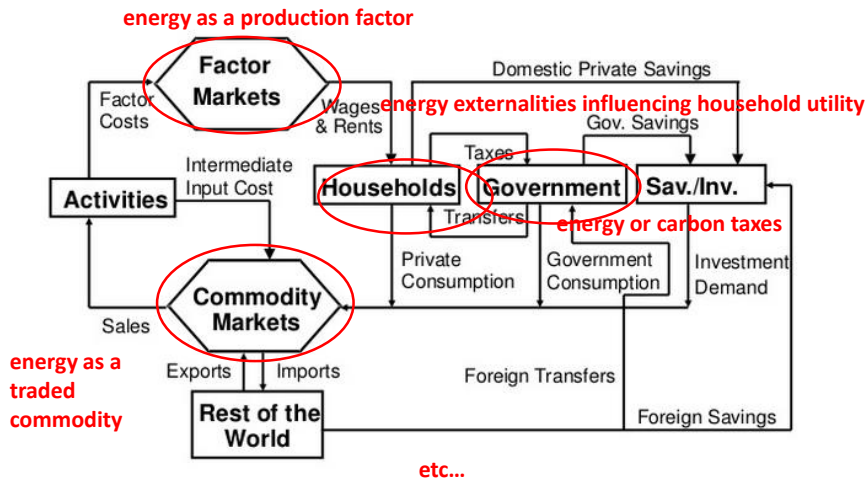
Bottom-up

- Detailed and physically realistic energy sector, explicit representation of technologies
- Uses disaggregated data
- Engineering philosophy
- Often only single sector and single country
- Partial equilibrium
- Useful energy demand, the drivers of demand (e.g. GDP) and prices are exogenous

Top-down

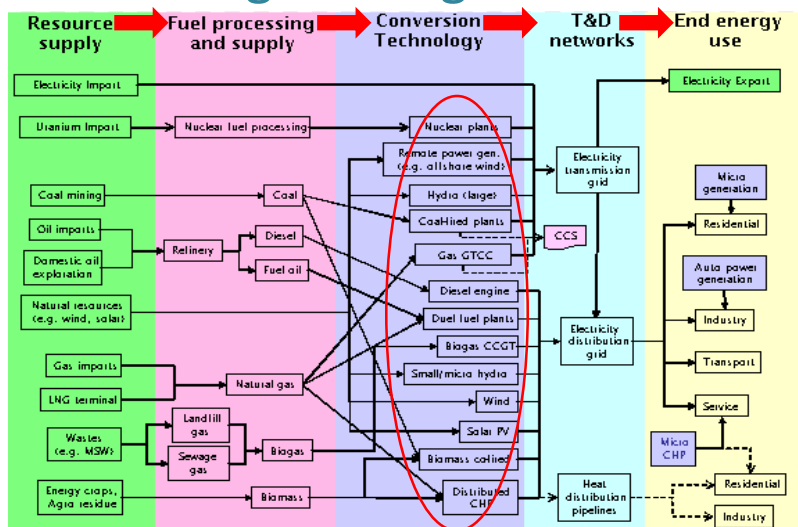
- Aggregate representation
- Uses aggregate data
- Economic foundations
- Focus on entire economy, single country, regional or global
- General equilibrium approach, macro-economic feedbacks
- Endogenous prices, quantities, GDP

Conceptual chart of a top-down CGE model



Source: The Report of the Globalization Working Group in the Economic Outlook Committee, the Economic Council, Japan

Conceptual chart of bottom-up engineering model



Source: MARKAL reference energy system

explicit technological detail

Cost-Benefit Analysis

Market

CBA often works with prices

but prices are applicable within a certain framework:

- Market competition: perfectly competitive, oligopoly, monopoly
- Supply side technologies
- Legislative framework (taxes, emission limits, social policy, etc.)
- Infrastructural developments (electricity networks, gas pipelines, etc.)
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Need to remember this when using CBA to give policy advice

Externalities

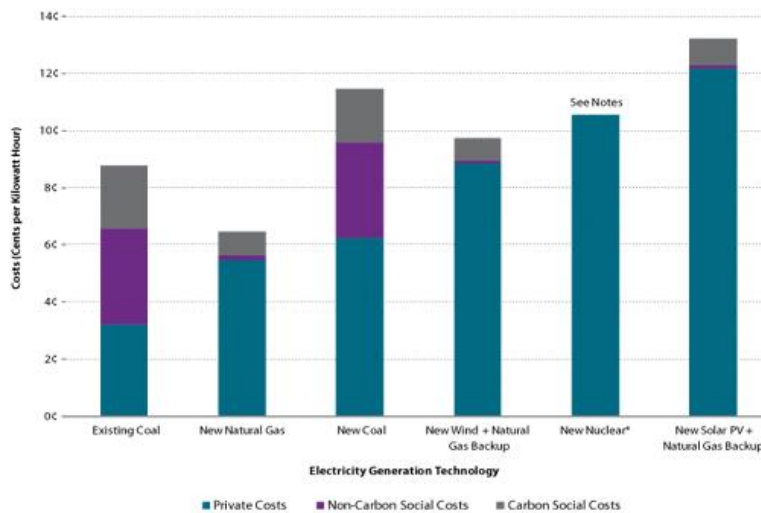
Costs and benefits outside the market with which no payment is associated, affecting third parties

Examples of externalities caused by energy supply/demand:

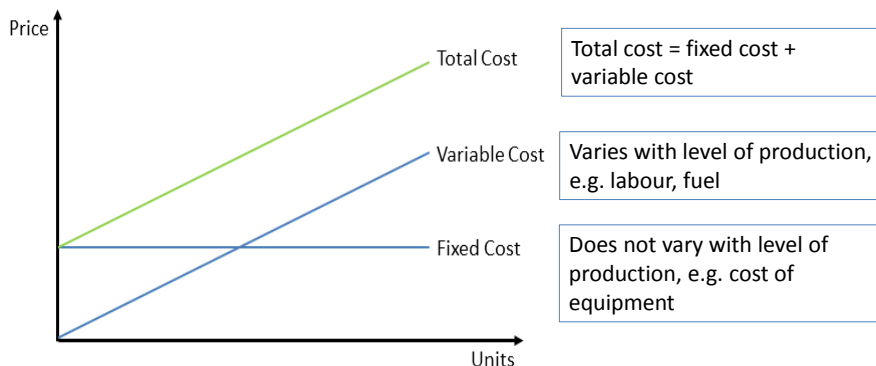
- Climate change
- Air pollution
- Water pollution
- Soil pollution
- ...

Social cost = private cost + negative externalities

Social cost vs private cost



Fixed vs variable cost



Incremental vs total cost

- For climate policy the relevant cost is the incremental cost
- If we know we need to invest in lighting we have to buy a lightbulb anyway – the question is how much more does an efficient lightbulb cost than a traditional one?
- Additional cost is the cost of mitigation, not the total cost

Net Present Value

- Benefits – Costs
- But the timing of costs and benefits matters, so you need to discount future costs and benefits

$$NPV = \sum_{t=0}^T \frac{(Benefits_t - Costs_t)}{(1+r)^t} =$$

$$= B_0 - C_0 + \frac{B_1 - C_1}{(1+r)} + \frac{B_2 - C_2}{(1+r)^2} + \frac{B_3 - C_3}{(1+r)^3} + \dots + \frac{B_T - C_T}{(1+r)^T}$$

- Use current or projected market prices for small impacts where available, not applicable to non-marginal impacts

Annualised cost

- Equivalent Annualised Cost: the cost per year of owning and operating an asset over its entire lifespan
- Used to compare investments with different lifetimes (useful in MAC curve calculation)

$$EAC = \frac{NPV}{\left(\frac{1 - \frac{1}{(1+r)^T}}{r} \right)}$$

- where $\left(\frac{1 - \frac{1}{(1+r)^T}}{r} \right)$ is the present value of the annuity factor

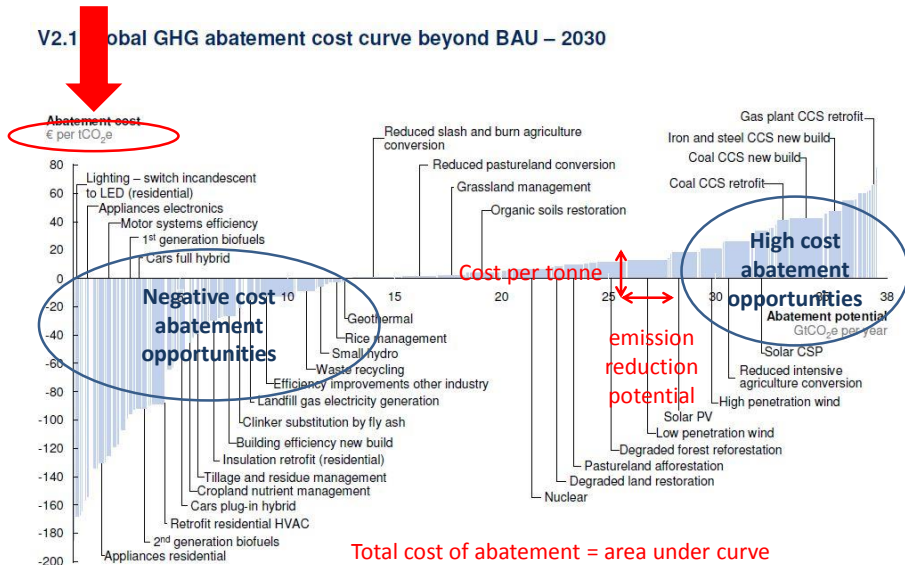
Marginal Abatement Cost Curve

MACC

- A MAC curve is defined as a graph that indicates the marginal cost (the cost of the last unit) of emission abatement for varying amounts of emission reduction
- 2 basic types: either model-derived or expert-based/technological

Expert-based MACC

V2.1 Global GHG abatement cost curve beyond BAU – 2030



Source: McKinsey

Steps of calculating an expert-based MACC

1. Identify a baseline
2. Identify all GHG abatement options (e.g. energy efficiency, renewable energy, fuel switching, CCS, etc.) compared with the baseline
3. Calculate the GHG emission reduction for all measures
4. Calculate the annualised cost of the measures by including all relevant costs and benefits. These should include:
 - a) Investment cost
 - b) Operation and maintenance cost (including fuel costs)
 - c) Energy savings
 - d) Revenues
 - e) etc.

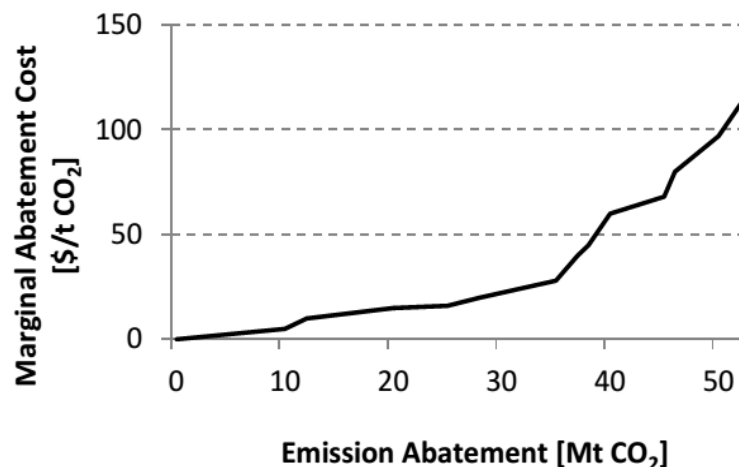
You may include only private costs and benefits or also externalities (social costs and benefits) depending on the aim of the analysis.

Costs and benefits may change over time (technical development, resource scarcity, etc.) and will be sensitive to assumptions such as economic lifetime of investment and return on investment. Discount rate assumption also needed.
5. Divide NPV by emission reductions to arrive at cost per one tonne of CO₂ reduced.
6. Rank the measures according to cost.

Properties of expert-based curves

- build on information regarding current technology costs and expert judgement on how these may evolve in future
- treat the various technological options entirely independently of each other, do not take into account interactions (e.g. house insulation and heating system)
- do not consider barriers which prevent/slow down adoption of cost-effective technologies (e.g. access to capital for covering initial investment cost, limited information, split incentives/landlord-tenant dilemma)
- do not consider economic feedbacks, i.e. interactions between the energy and economic systems (e.g. significant decarbonisation impact on fossil fuel prices)

Model-derived MACC



source: Kesicki et al (2011)

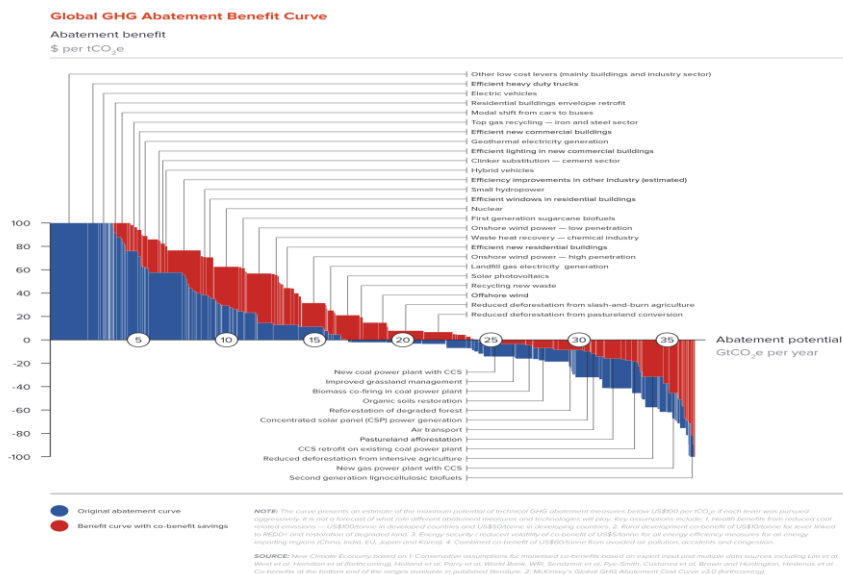
Steps of calculating a model-derived MACC

1. Inserting costs of technologies into model
2. Defining overall emission limit and running the model, then noting cost of reaching emission limit
3. Repeating (2) with different emission limits

Properties of model-based curves

- Properties depend in part on type of model used to generate the curve
- Specific technological options required for abatement cannot be identified on curve
- Interaction between technologies accounted for
- May account for economic feedbacks, if based on top-down model

Social MACC/Benefit curve



Thank you for your attention!

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