

Modelling indirect emissions within UK TIMES

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Outline

- Background
 - Indirect energy system emissions
 - Consumption based emissions accounting
- Goal
- Methodology
 - Emissions factors
 - TIMES methodology
- Issues



Background: Indirect emissions

- Lifecycle emissions:
 - Direct emissions (combustion) +
 - Indirect emissions (embedded)
 - infrastructure, manufacturing, construction, land use and transport
- Considering direct emissions only underestimates the impact of energy technologies
 - Up to 25% of lifecycle emissions from fossil fuel energy are indirect
 - Renewables and bio-energy are often considered carbon neutral



Emissions accounting

- **Production-based emission accounting:**
emissions are assigned to the economic sector in which they are emitted
- **Consumption-based emission accounting:**
emissions are assigned to the end product in which they are embodied



Indirect energy systems emissions

- Indirect-UK
 - Assigning energy system-related emissions from industry, services, transport, agricultural sectors endogenises lifecycle emissions
 - Decarbonisation and electrification UK energy policy focus
- Indirect-RoW
 - Carbon leakage from imported biomass, imported materials and energy technologies



Project Goals

1. How much of the UK carbon budgets will be used to build new energy infrastructure?
2. What is the carbon leakage of the UK energy system under a range of scenarios?
3. What are the implications of including indirect emissions to the optimal energy mix under both territorial (production) and global (consumption) based account?

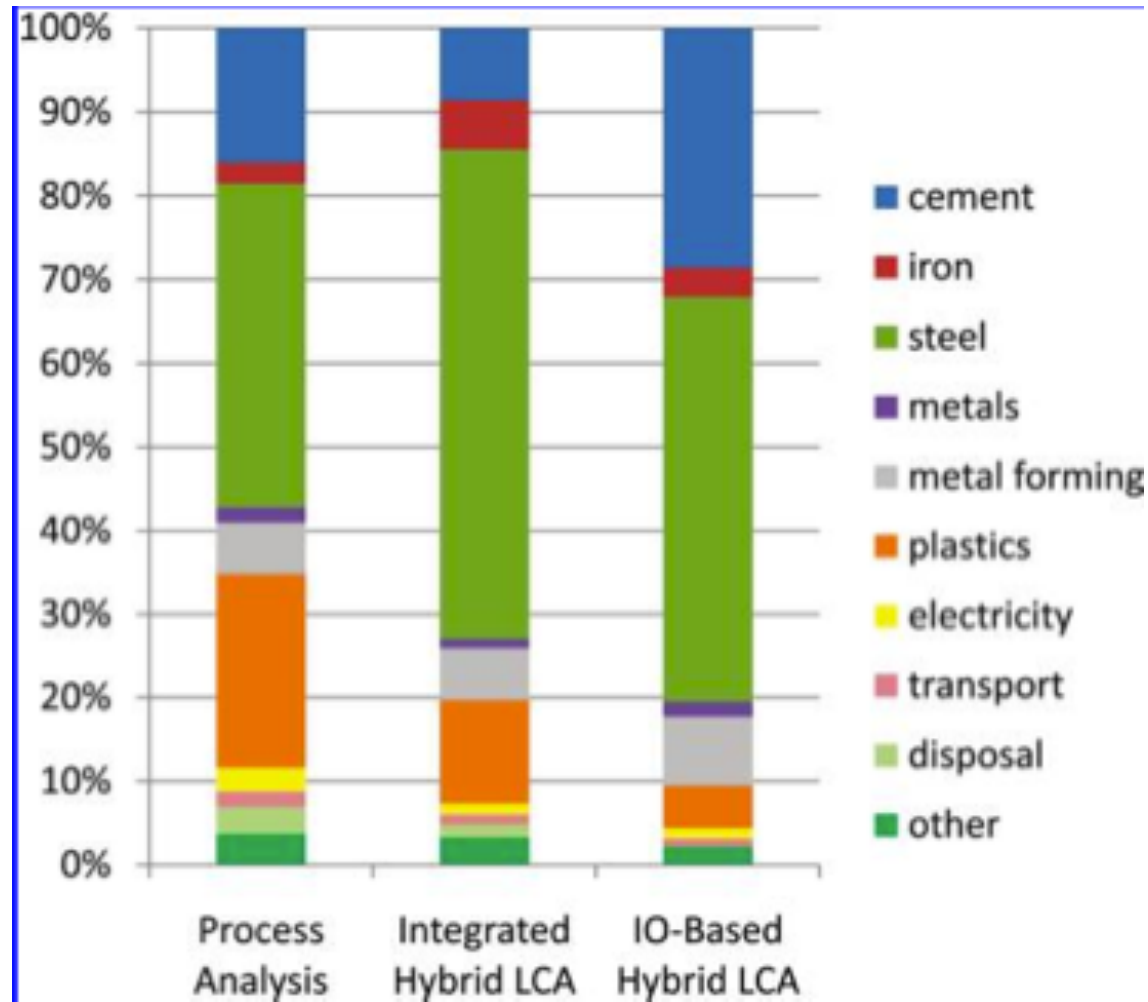


Methodology: Indirect emissions factors

- Input-output (IO) model:
 - describe the value of transactions between different parts of the economy
- Environmentally extended IO (EEIO) model:
 - Ties environmental indicators to monetary flows
 - Produces lifecycle emissions for economic activity



Lifecycle CO₂: Case study of wind turbine



Methodology: Indirect Emission Factors (IEF)

- Associate each energy technology with one of 224 EEIO sectors
- Data refining
 - Remove direct emissions (already accounted for in TIMES)
 - Distinguish domestic and international emissions
 - For domestic indirect emissions, distinguish sectors (upstream, electricity, industrial subsectors, services, transport)
 - Extract upstream emissions from energy mining etc., to remove double counting
- Convert from monetary flow to capacity denominator ($\text{gCO}_2/\text{£}$ to gCO_2/PJ_a)



Methodology: TIMES implementation

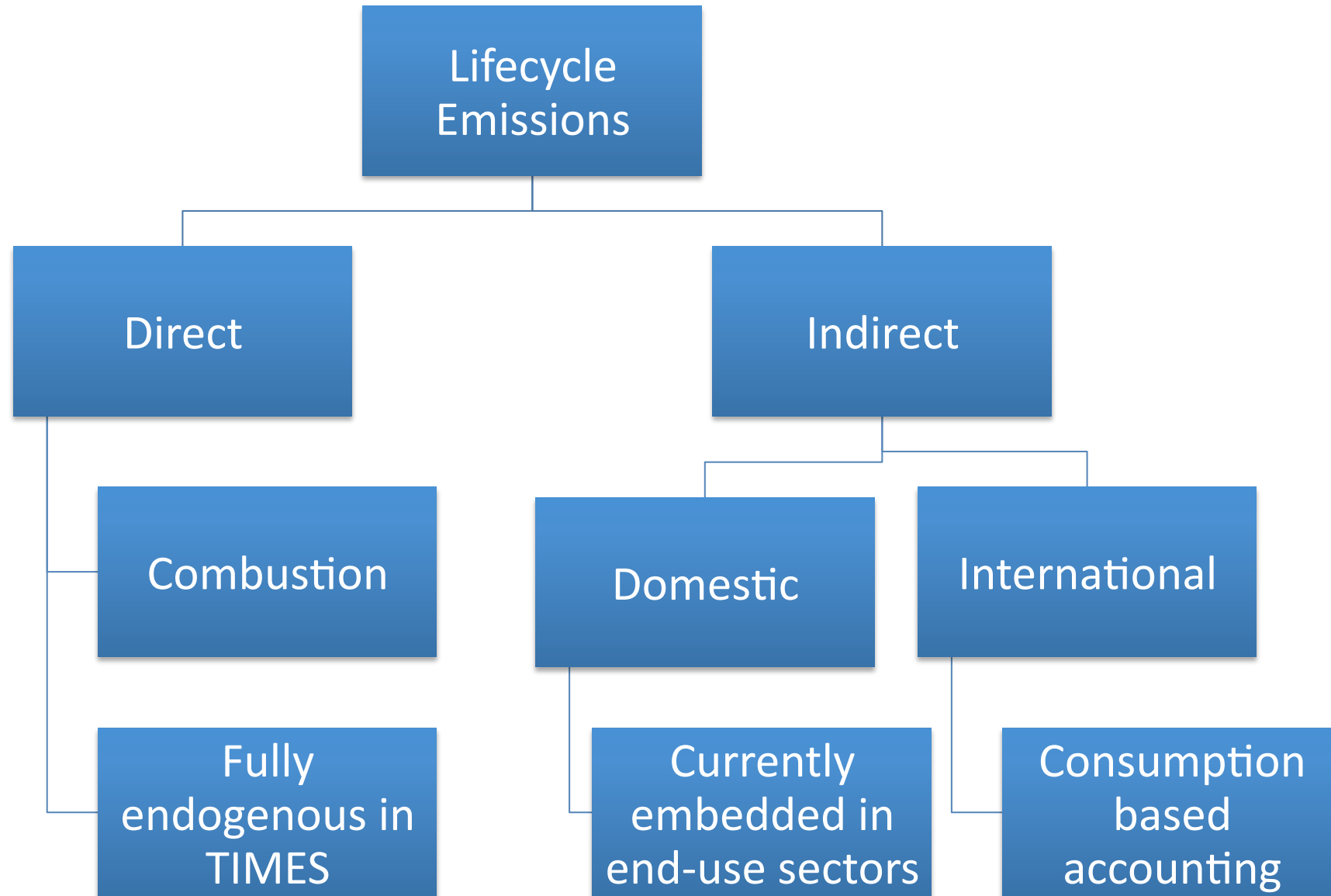
1. Apply IEF to all energy technologies
 - Using ENVCAP parameter
2. Remove domestic indirect emissions from relevant sectors



Methodology: Consumption based accounting

- Include non-domestic emission factor in total emissions
- Remove emissions from exported energy,
- Include emissions from imported energy (incl. biomass, electricity, upstream emissions from fossil fuels)





Issues

1. EEIO model is static, fixed at 2009
 - Need to simulate forward
 - Share of domestic vs. non-domestic IEF
 - Domestic IEF
 - Use industrial decarbonisation trajectory
 - Non-domestic IEF
 - Scenario based or use TIAM outputs



Issues

2. Cost scaling:

- EEIO outputs are on the basis of monetary flow
- => IEF scale directly with technology cost
- Must examine this assumption

3. Iteration is needed to balance domestic IEF



Issues

4. To annualise indirect emissions and include current capacity?



Feedback welcome

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- Project funded by UK Energy Research Centre
<http://www.ukerc.ac.uk>

