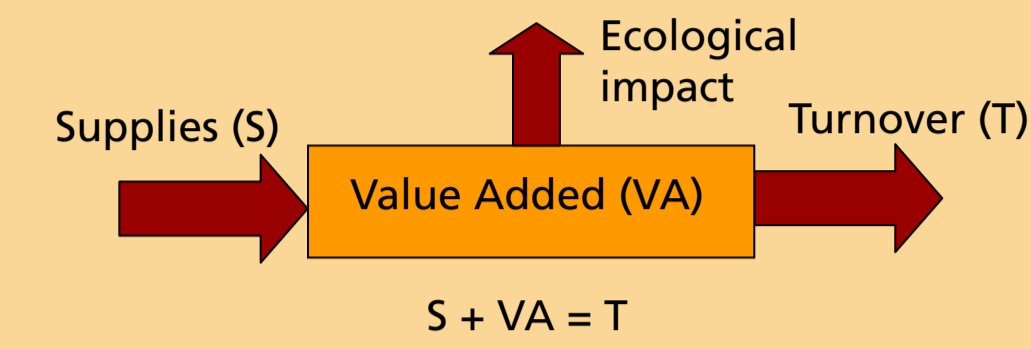
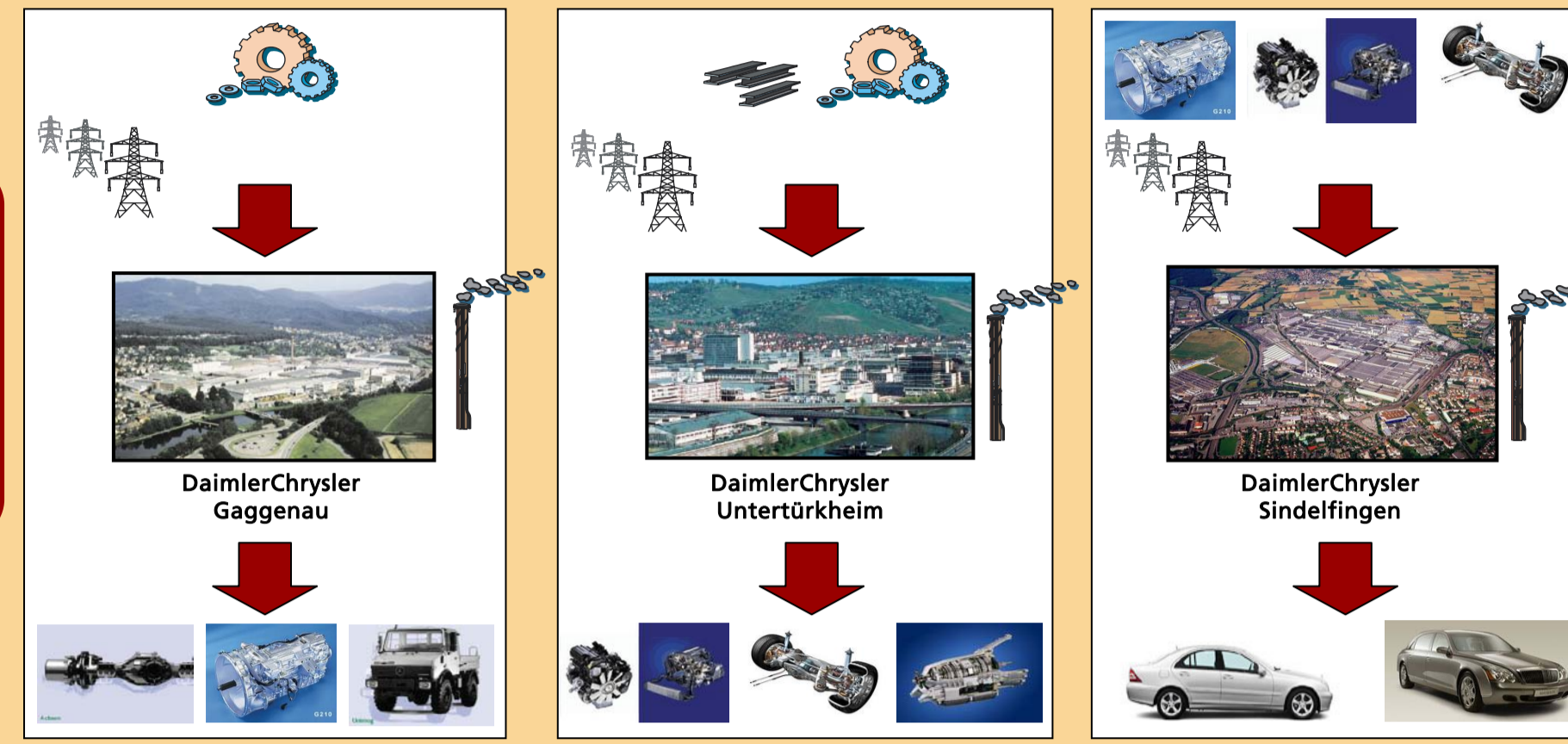


Beyond LCA: Measuring Climate Intensities of Sites or Companies

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Problem Formulation

How can the environmental performance of sites or companies be assessed? Especially if ... several products and different product ranges are produced ... different vertical ranges of manufacture are covered
-> Hence, the ecological impact has to be referred to different revenues?



Ecological impact referred to value added (VA)
-> Damages to vs. utility for society

How can in- and outsourcing activities be taken care of?

Companies are held responsible for environmental impacts of their preliminary and downstream processes outside the individual company. Thus, the ecological "backpacks" of these processes have to be attributed to the company in addition to its direct impacts.
-> A concept of comprehensive corporate responsibility has to be included into the indicator system.

State-of-the-Art

Do existing indicator systems include preliminary and downstream processes?

No! Not on company level

Yes! On product level
Life Cycle Assessment (LCA) includes ecological impacts along a product's entire life cycle "from cradle to grave".
But: generally too costly and time-consuming to be used for all of a company's products, *cannot be used on company level.*

New Approach

Is there an environmental performance indicator system that can do both? ... on company level and ... including preliminary and downstream processes

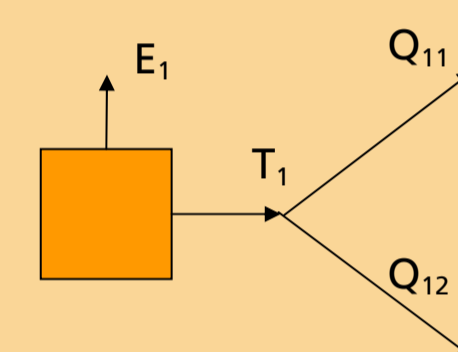
Yes!
Concept of Cumulative Climate Intensities
Leaves aside question of aggregating environmental impacts. Focus on *climate impact*, measured as Global Warming Potential (GWP) of a company's greenhouse gas (GHG) emissions.
Able to measure other impacts, such as toxicity, acidification or ozone depletion.

How are the Cumulative Climate Intensities of companies respectively sites calculated?

Single Step Process

$$\mu_i = \frac{E_i}{VA_i} = \frac{E_i}{T_i}$$

$$E_{ik} = E_i \cdot \frac{T_{ik}}{T_i} = E_i \cdot \frac{Q_{ik} \cdot P_{ik}}{T_i} = \mu_i \cdot Q_{ik} \cdot P_{ik}$$



μ_i : Cumulative Climate Intensity of company i
 E_i : Direct emissions (GWP) of company i
 E_{ik} : Cumulative GWP ("backpack") that company i assigns to its products k
 P_{ik} : Price of product k produced by company i
 P_{jk} : Price of product k delivered from supplier j to company i
 Q_{ik} : Quantity of product k delivered from supplier i to company i
 Q_{jk} : Quantity of product k produced by company j
 S_j : Supplies of company j to company i
 T_i : Turnover of company i
 T_{ik} : Turnover generated by company i for its products k
 VA_i : Value Added of company i

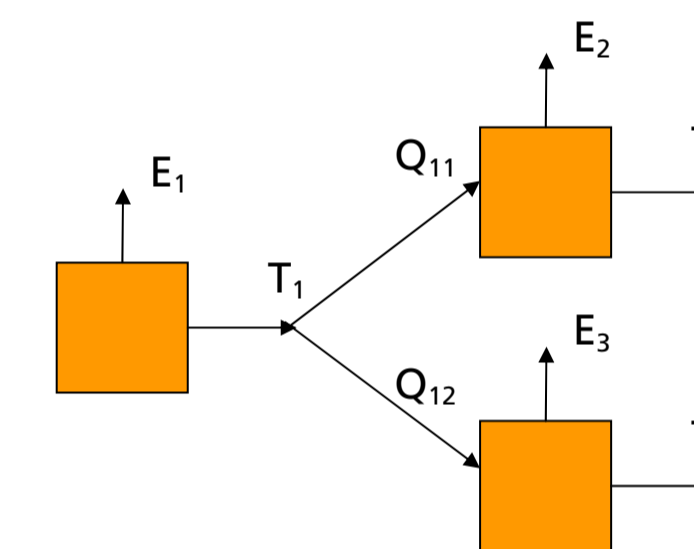
Economic allocation of GHG emissions to products, i.e. on the basis of the preliminary products' share of the corresponding supplier's total turnover

How can preliminary processes be included?

Production and Supply Processes

$$\mu_i = \frac{1}{T_i} \cdot \left[E_i + \sum_{j \in \{Supplier(i)\}} \mu_j \cdot \left(\sum_{k \in \{Supplies(j \rightarrow i)\}} Q_{jik} \cdot P_{jik} \right) \right]$$

Numerator: direct plus indirect emissions
Denominator: direct plus indirect value added, adds up to turnover



Which concept of comprehensive responsibility underlies the Concept of Cumulated Climate Intensities?

- Indirect GHGs attributed to a company on the basis of the preliminary products' share of the corresponding supplier's total turnover
- GHGs assigned economically, i.e. on the basis of the (economic) ability to carry the costs for the climate impact
- Thinking in organizational units respectively product bundles
- Corresponding with the "co-operation principle" within environmental policy
- Corresponding supplies account for 20% of the supplier's turnover, then 20% of the supplier's GHGs are attributed to the supplies
- ➔ Company is responsible for the suppliers' entire product ranges; as their business partner, it ensures the entire existence of its suppliers
- ➔ Indicator rewards to ecologically balance out entire product range; ecological "alibi products" are not enough, but have to make up a considerable share of the company's turnover

How can downstream processes be included?

By basing the indicator system on the object categories by *Dyckhoff* (production theory).

- ➔ A company is assigned indirect GHGs from its suppliers (in a broader sense: who supply preliminary products and disposal services)
- ➔ A company assigns its GHGs to its customers who buy products or disposal services by delivering waste to the company

Comprehensive Formula

$$\mu_i = \frac{1}{T_i} \cdot \left[E_i + \sum_{j \in \{Supplier(i)\}} \mu_j \cdot \left(\sum_{k \in \{Supplies(j \rightarrow i)\}} (Q_{jik}^G \cdot P_{jik}^G) \right) + \sum_{j \in \{Disposer(i)\}} \mu_j \cdot \left(\sum_{k \in \{Disposals(j \rightarrow i)\}} (Q_{jik}^B \cdot P_{jik}^B) \right) \right]$$

μ_i : Cumulative Climate Intensity of company i
 E_i : Direct GWP of company i
 P_{jik}^G : Disposal price of "bad" k (=waste) disposed by disposer j for company i
 P_{jik}^B : Price of "good" k delivered from supplier j to company i
 Q_{jik}^G : Quantity of "bad" k (=waste) disposed by disposer j for company i
 Q_{jik}^B : Quantity of "good" k delivered from supplier j to company i
 T_i : Turnover of company i

What are the strengths and open questions of the Concept of Cumulated Climate Intensities?

Strengths

- ! Measures a company's or site's climate intensity, including comprehensive responsibility for preliminary and downstream processes.
- ! Can be applied to both production and disposal companies.
- ! Can be applied to measure other specific environmental intensities, such as toxicity, acidification or ozone depletion.
- ! Can be calculated quite simply (information needed: turnover, prices and amounts of products/services bought and sold, direct GHG emissions, climate intensities of suppliers and disposers).
- ! Climate intensities of business partners allow for an integrated supply and disposal chain management without needing to overview entire supply and disposal chains.
- ! Benchmarking becomes possible between different companies and over time.
- ! Contains a wide focus: less GWP (minimal principle) and/or higher value (maximal principle) enhance climate intensity.
- ! Indicator rewards to ecologically balance out entire product range; ecological "alibi products" are not enough, but have to make up a considerable share of the company's turnover, thus, setting an incentive for ecological products to move from niche to mass products.

Open Questions

- ! Introduction of the indicator system:
For the system to work, all actors within an entire production system have to pass on their Cumulative Climate Intensities to their business partners.
-> Climate Intensities might be estimated on the basis of generic data (LCA)
- ! Definition of consistent "accounting rules", e.g. definitions of company boundaries, a company's business operations, and depreciations principles.

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