Co-product Allocation

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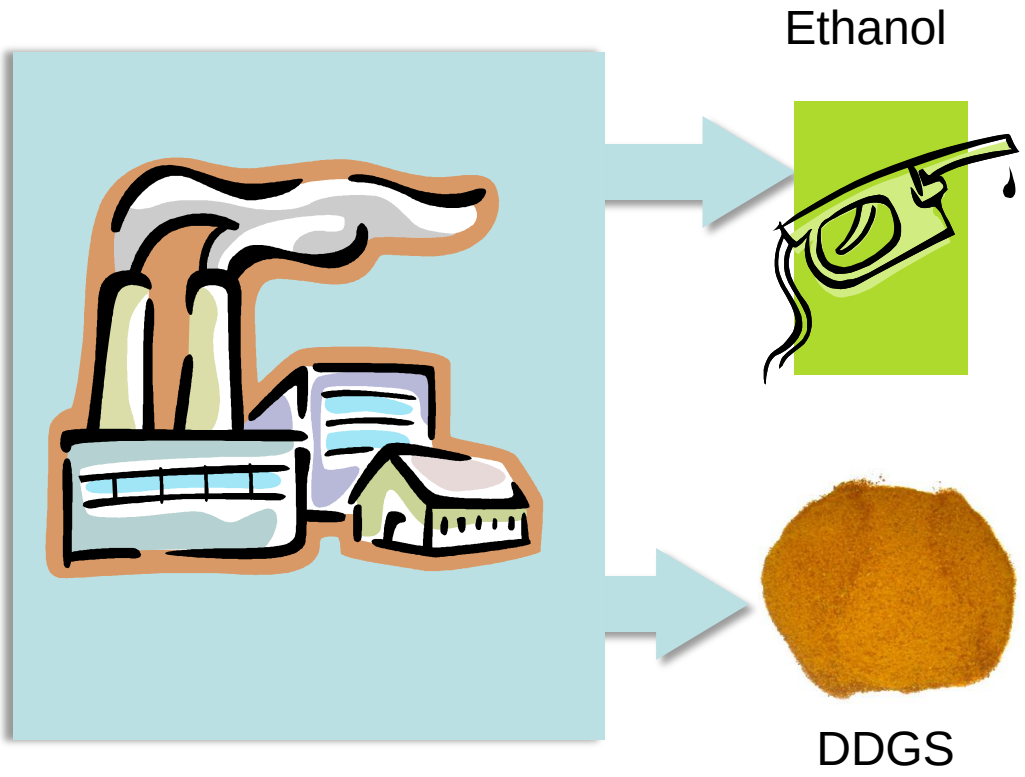
Co-Product Treatment

- Co-Product Treatment
  - Co-products are produced alongside the primary product of study
  - Example: For ethanol the main co-product is dry distiller's grains and solubles (DDGS)



Co-Product Treatment

- If we allocate all the burdens at the ethanol plant to ethanol it would receive no “credit” for producing the co-product (which has some use as a cattle feed)

- If we assume that the factory is intended to produce two products (ethanol and DDGS) then we still need a way to divide up the burdens among the 2 products

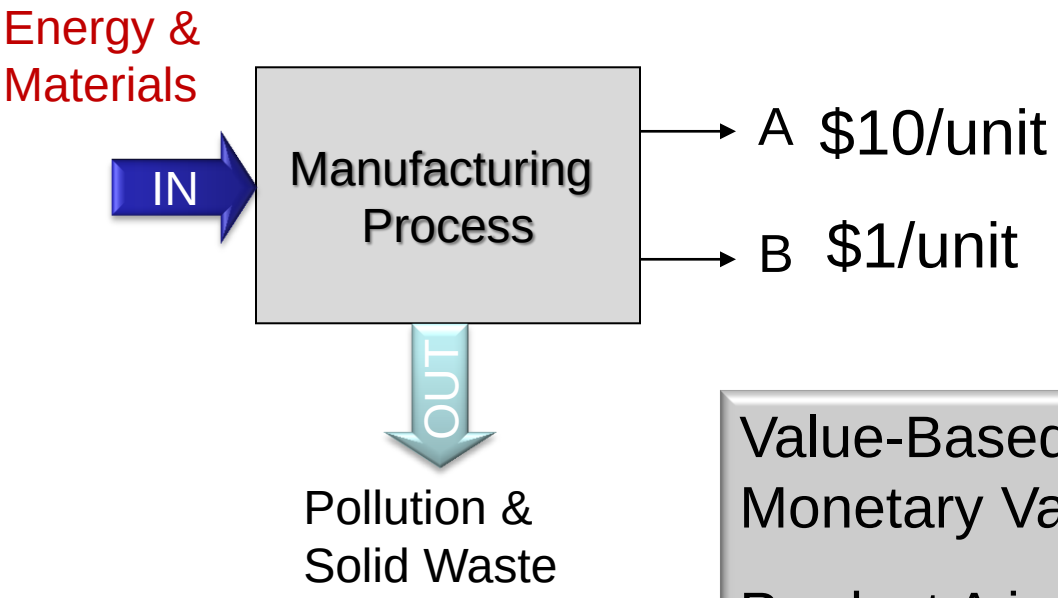
Ways to deal with Co-Products

- The “best” way is to avoid co-product allocation altogether, but this is rarely possible

- Assuming we have to allocate burdens, there are many ways to do this
  - Allocation based on value (value can be $, weight, energy content, etc.)
  - System expansion
    - Broadens system boundary to introduce new functional unit
    - Or subtracting the environmental burdens of an alternative way of producing the co-product or the co-product’s equivalent

Value-Based Allocation: LCA of Product

Products A and B are produced at the same factory. Assuming Products A and B are produced at the same rate…

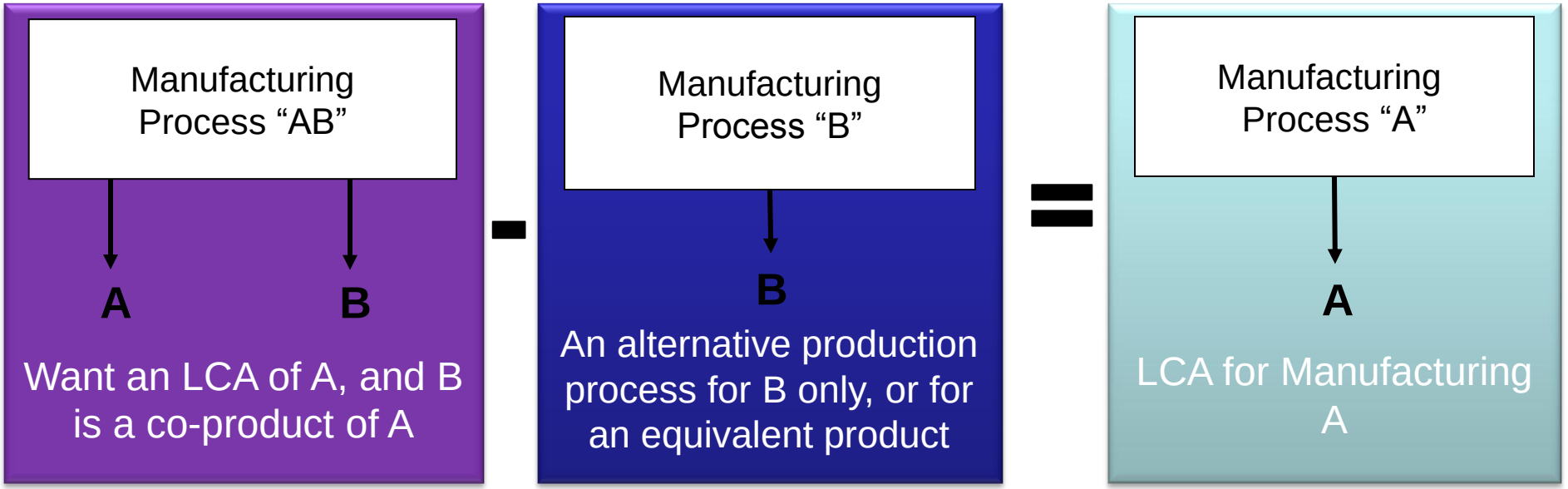


Value-Based Allocation using the Monetary Value of Products:

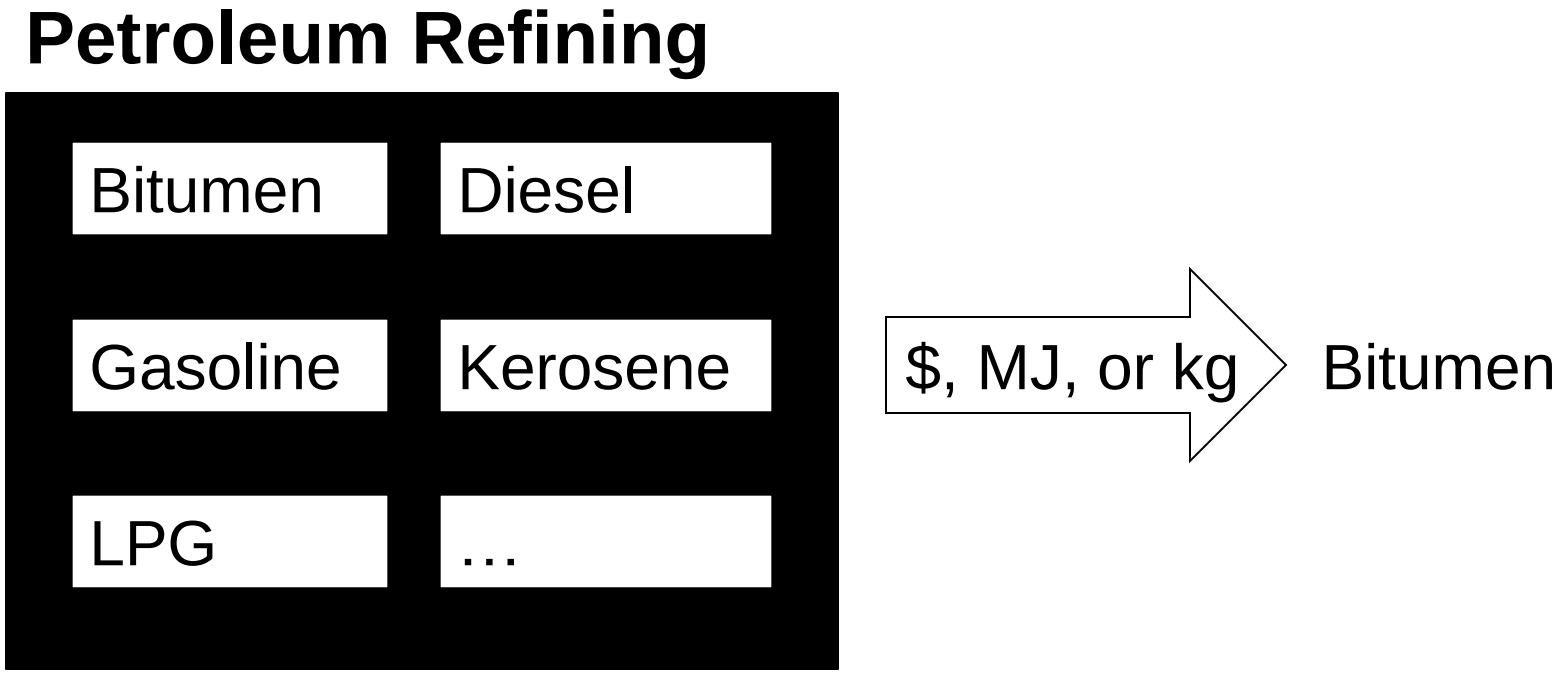
Product A is allocated 10/11 of all inputs and outputs from the system

Product B is allocated 1/11 of these

System Expansion: LCA of Product A

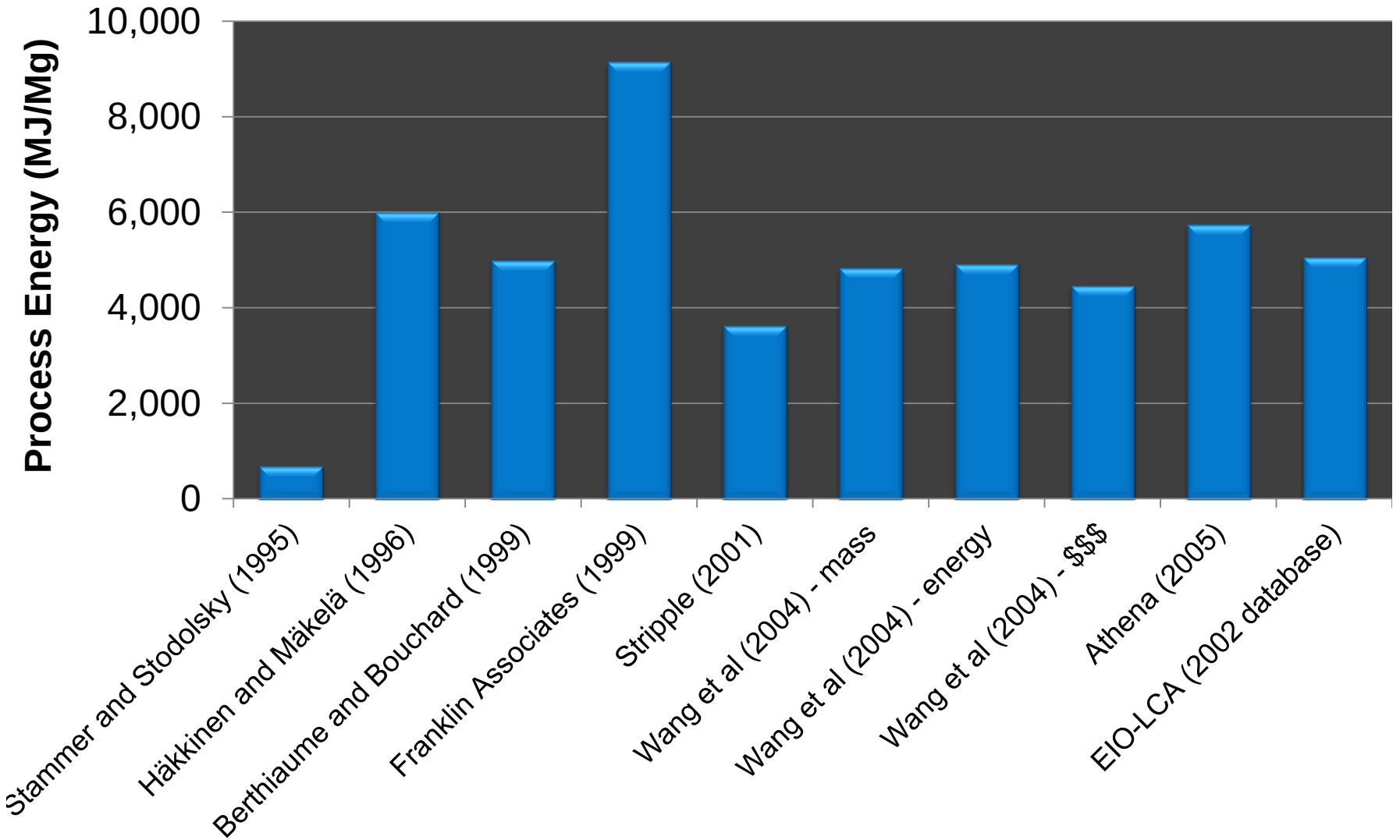


Allocation within a Refinery



Refining often treated as “black box” system, where products are allocated based on their relative economic value, energy content, or mass (value-based allocation)

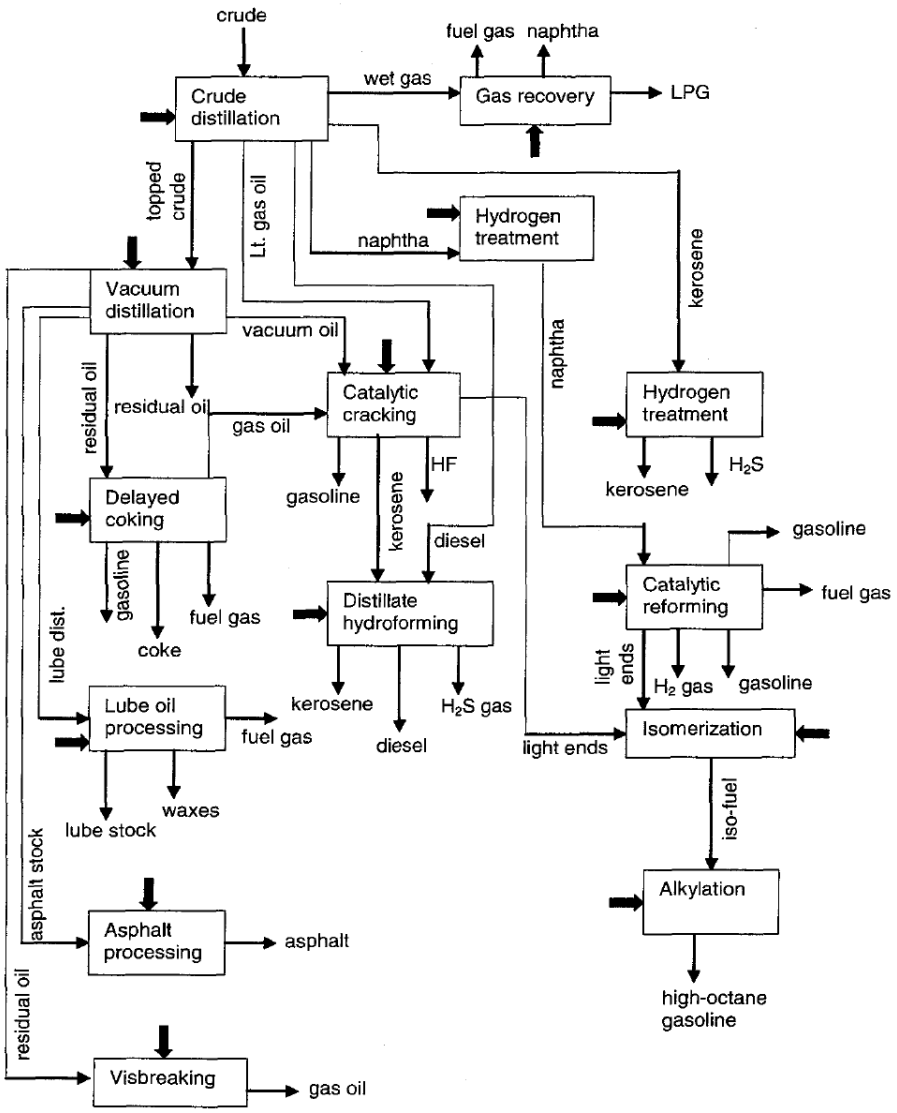
Process Energy in Bitumen



Allocation of Bitumen in a Refinery

- Bitumen is one of many products produced at a refinery
- Low profit compared to the primary refinery products (gasoline, diesel, naptha, kerosene, etc.)
- Most processes are dedicated to refining lighter fractions
  - Goal of refining is to remove heavy residuals

Allocation of Bitumen in a Refinery



By mass: 4,840 MJ/Mg

By energy content: 4,920 MJ/Mg

By economic value: 4,470 MJ/Mg

Source: Wang et al. (2004) “Allocation of Energy Use in Petroleum Refineries to Petroleum Products” *Int J LCA 9(1) 34-44*

Is there a better way?

- ISO 14044 suggests that allocation is best avoided when possible
  - Possible to isolate bitumen-only process
  - Establish rationale for performing each process (e.g., is vacuum distillation really performed to manufacture bitumen?)
- Only “asphalt processing” is specific to bitumen
  - Accounts for only 1% of total refinery emissions (Brown et al. 1996)
  - If only account for “asphalt processing”, process energy drops to ~2,500 MJ/Mg
  - Resulting CO_2, other emissions will drop as well

Other Allocation Issues

- Concrete SCMs
  - Fly ash
  - Slag
  - Silica fume
  - Etc.
- Asphalt additives
  - Polymers
  - Rubber
  - Glass
  - Etc.
- Recycling of pavements