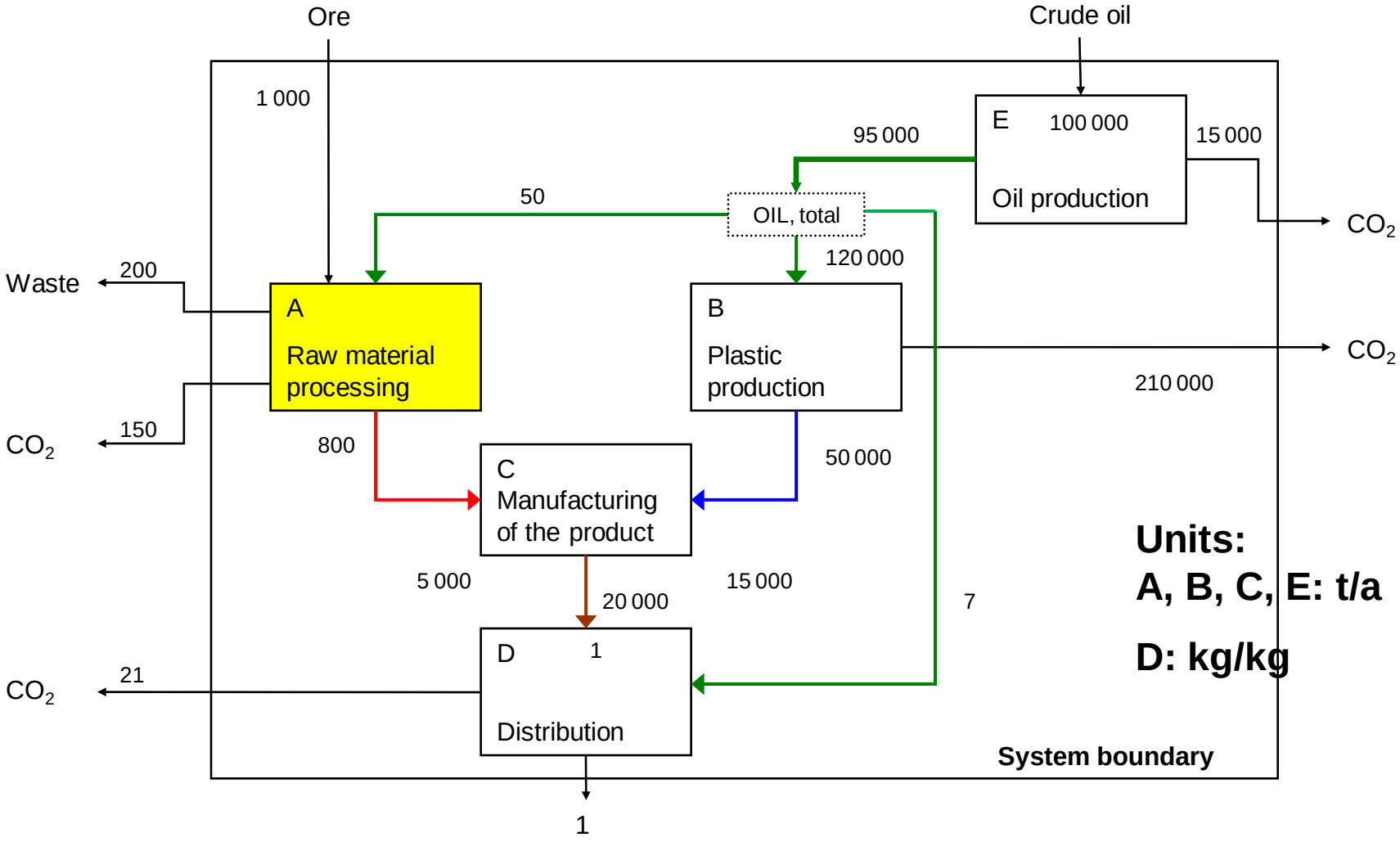
Example: Office Punch

Flow Chart with Raw Data



Calculation – Mathematical Representation

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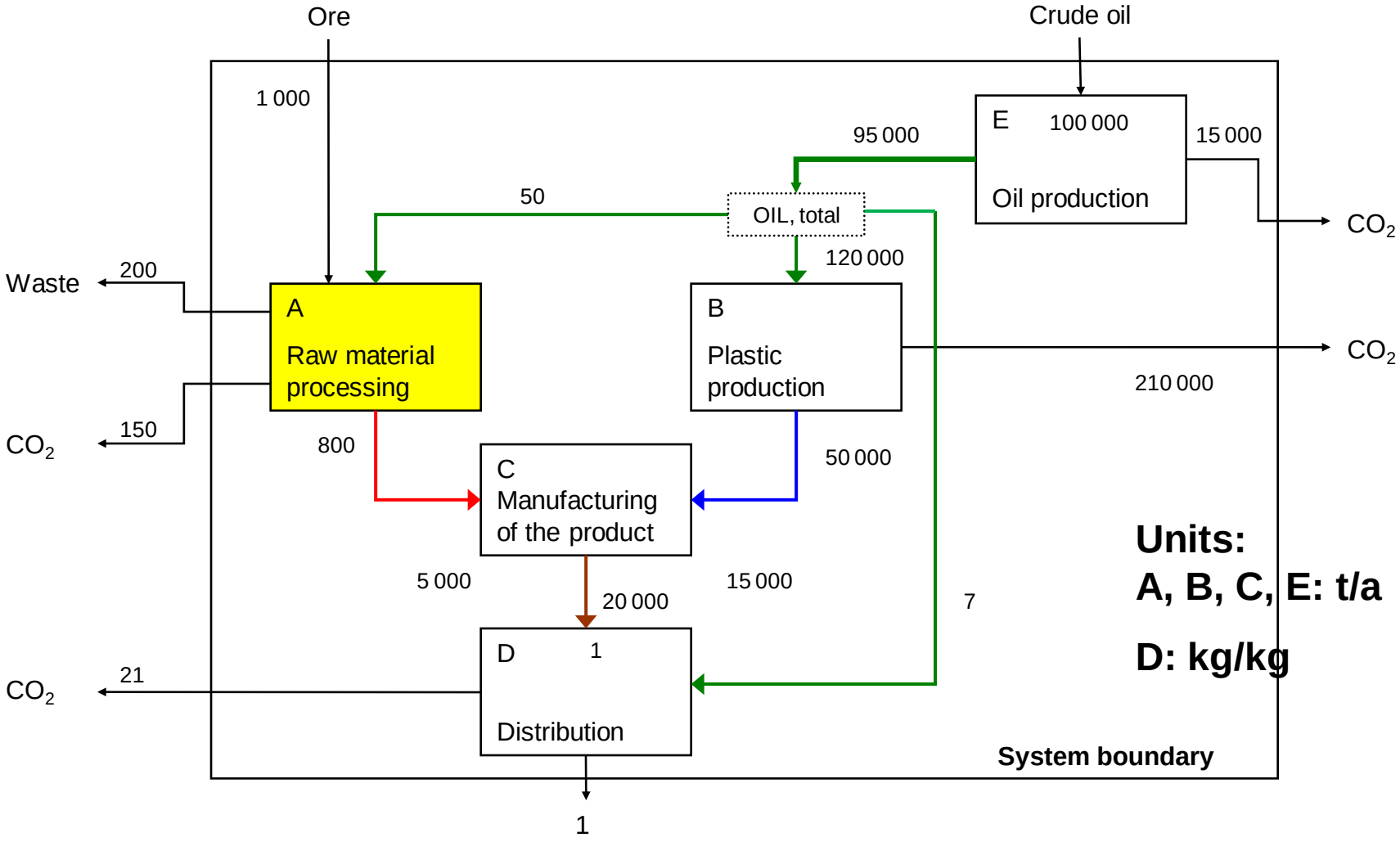
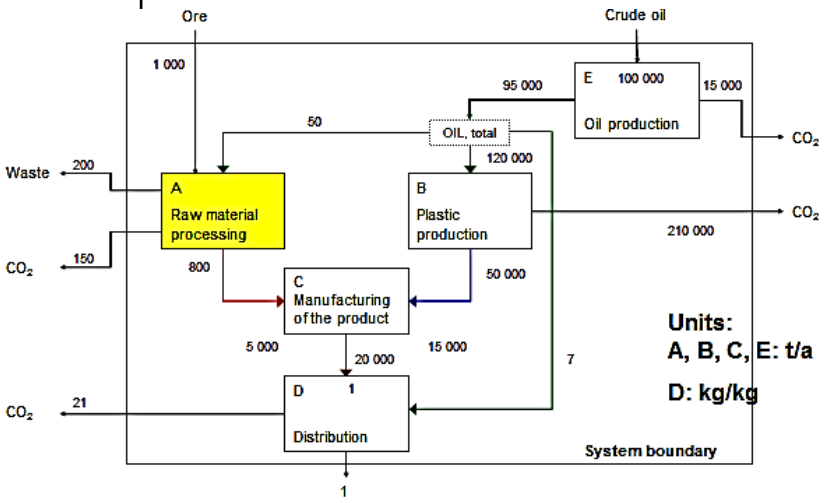
1. Identify the relevant product of the process ("raw data") and relate the inputs and outputs to a unit of the respective product ("normalisation")
   Division of the raw data by the unit of the product.
2. Calculation of the (intermediate) product flows (“internal flows") and raw materials related to the functional unit of the system
3. Calculation of the emissions related to the functional unit of the system
4. Addition of all flows of the same elementary flow for the entire system
5. Documentation of the calculation

Flow Chart with Raw Data



Division of the Raw Data by the Unit of the Product.

Raw material processing	Raw data	Normalized to the product flow of the process
	t/a	kg/kg per year
Input:		
Ore A		
Oil_a		
Output:		
Product flow (metal)		
CO_2		
Waste		



Division of the Raw Data by the Unit of the Product.

Raw material processing	Raw data	Normalized to the product flow of the process
	t/a	kg/kg per year
Input:		
Ore A	1000	1.25
Oil_a	50	0.0625
Output:		
Product flow (metal)	800	1
CO_2	150	0,1875
Waste	200	0.25

Product of the process raw material processing:

Metal

Calculation – Mathematical Representation

TECHNISCHE UNIVERSITÄT DARMSTADT

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   System of equations with n equations (n = number of product flows)
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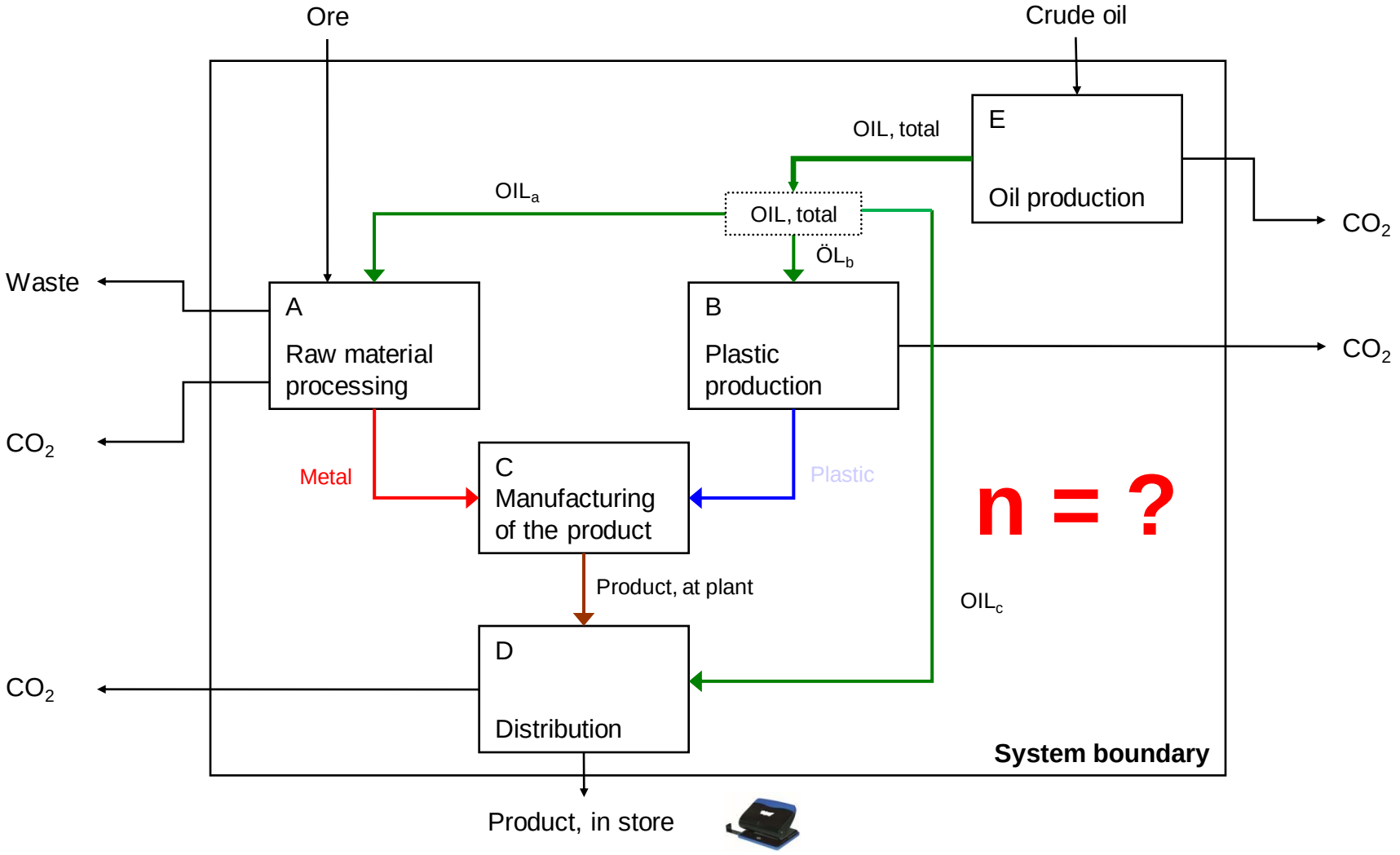
System of Equations with n Equations (n = Number of Product Flows)



List of Processes/Product Flows (n = 5) supplemented by Raw Material Flows (n = 7)

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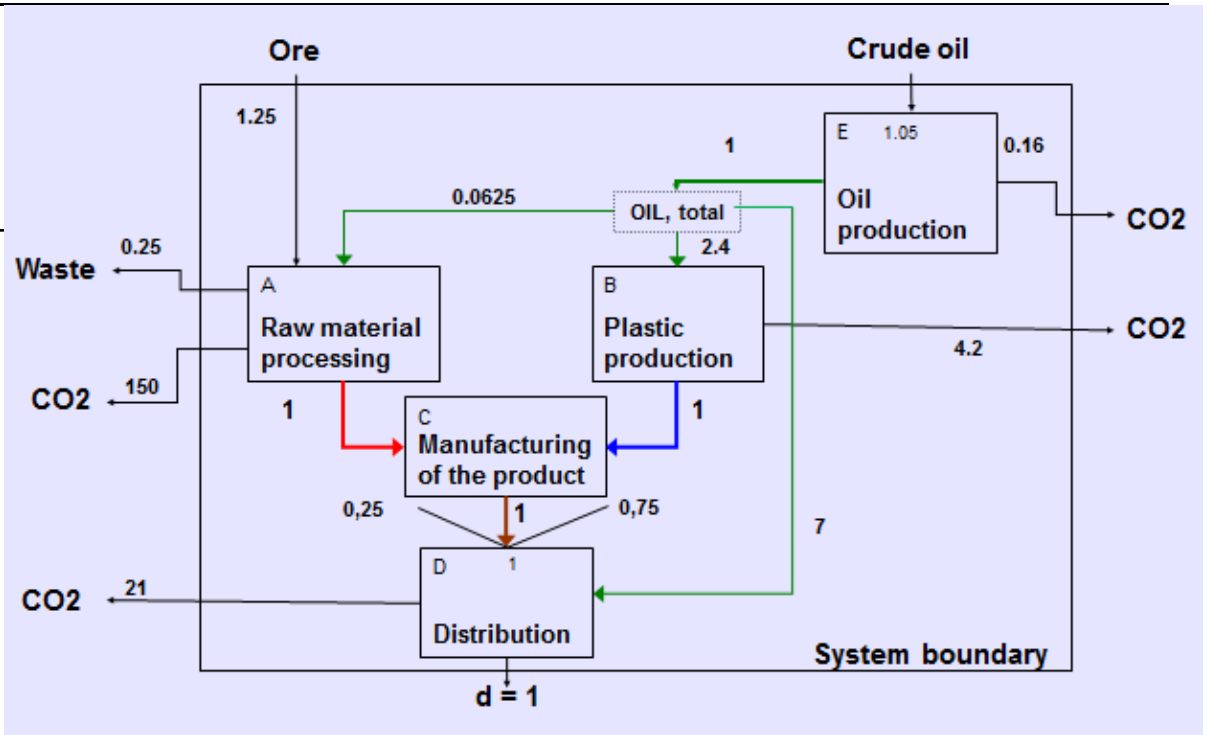
Name	Symbol
Product, in store	**a**
Product, at plant	**b**
Plastic	**c**
Metal	**d**
Oil	**e**
Crude oil	f
Ore	g

Creation of a system of linear equations for n = 7



List of product flows

Name	Symbol
Product, in store	a
Product, at plant	b
Plastic	c
Metal	d
Oil	e
Crude oil	f
Ore	g

Creation of a system of linear equations for n = 7

a =

b =

c =

d =

e =

f =

g =

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Solution of the System of Equations

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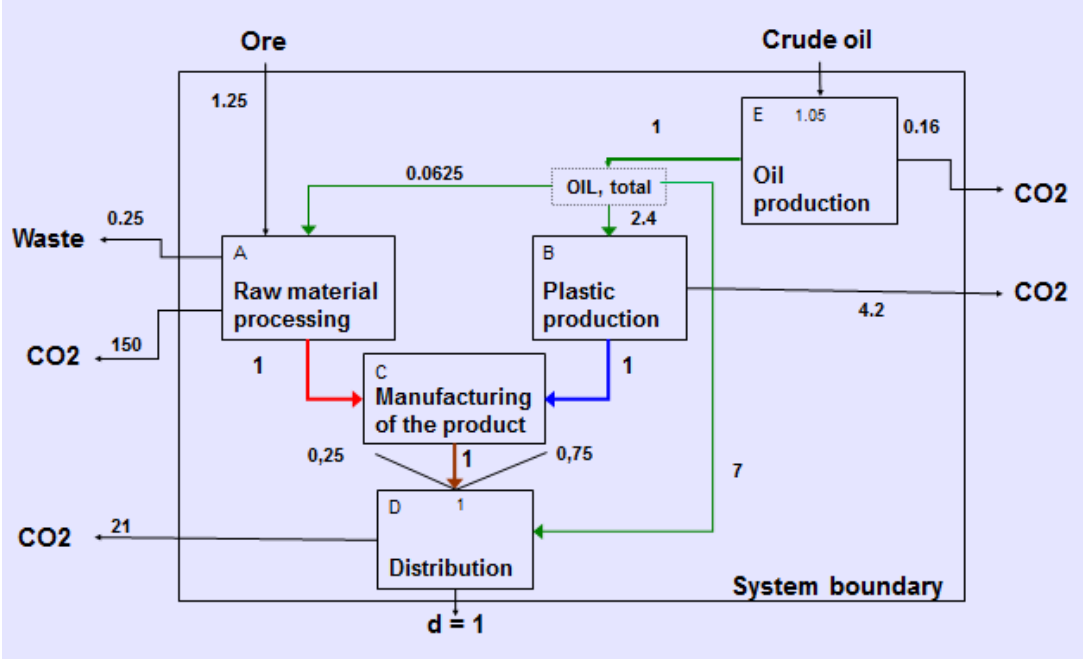
a = 1 = FU (functional unit)



Calculation of all product flows which are needed to produce the functional unit :

b = 1 x a

c = 0,75 x b

d = 0.25 x b

e = 0,0625 x d + 2,4 x c + 7 x a

f = 1,05 x e

g = 1,25 x d

Calculation – Mathematical Representation

TECHNISCHE UNIVERSITÄT DARMSTADT

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   System of equations with n equations (n = number of product flows)
3. Calculation of the emissions related to the functional unit of the system
   Multiplying the product flows with factors
4. Addition of all flows of the same elementary flow for the entire system
5. Documentation of the calculation

List of Emissions

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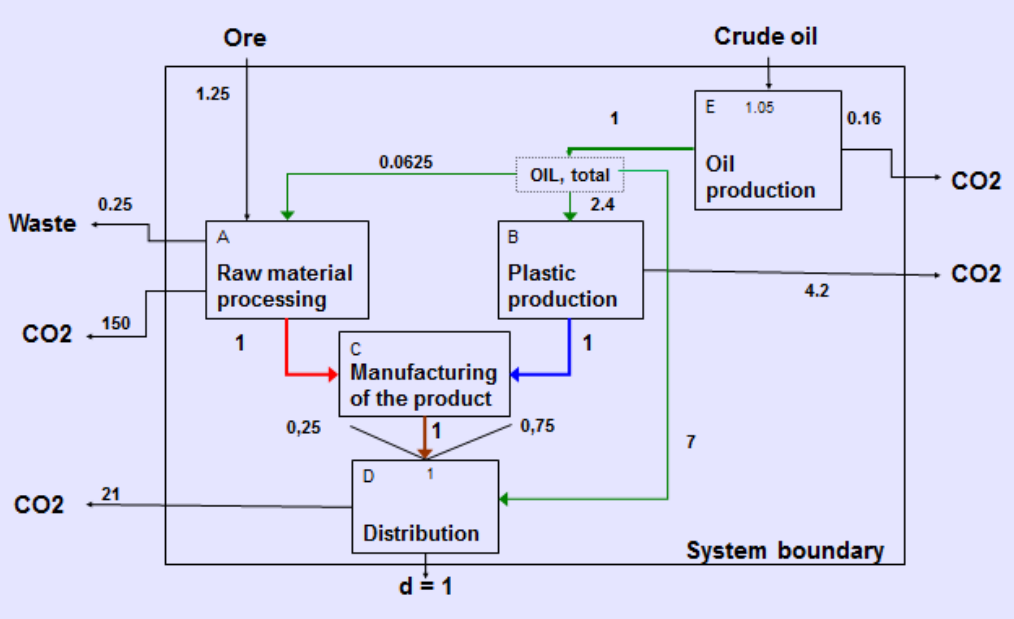
Process	Emissions
Product, in store	
Product, at plant	
Plastic	
Metal	
Oil	

List of Emissions



Process/Product flow	Emissions
Product, in store	
Product, at plant	
Plastic	
Metal	
Oil	

Calculation of Emissions

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Example: Process A raw material processing

Product flow Metal:

- 0,25 * 0.25 kg waste/kg metal = 0,0625 kg Waste/ functional unit
- 0,25 * 0,1875 kg CO_2/kg metal = 0,047 kg CO_2/ functional unit

Calculation – Mathematical Representation

TECHNISCHE UNIVERSITÄT DARMSTADT

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3. Calculation of the emissions related to the functional unit of the system
   Multiplying the product flows with factors
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Addition of all flows: Example flow CO_2

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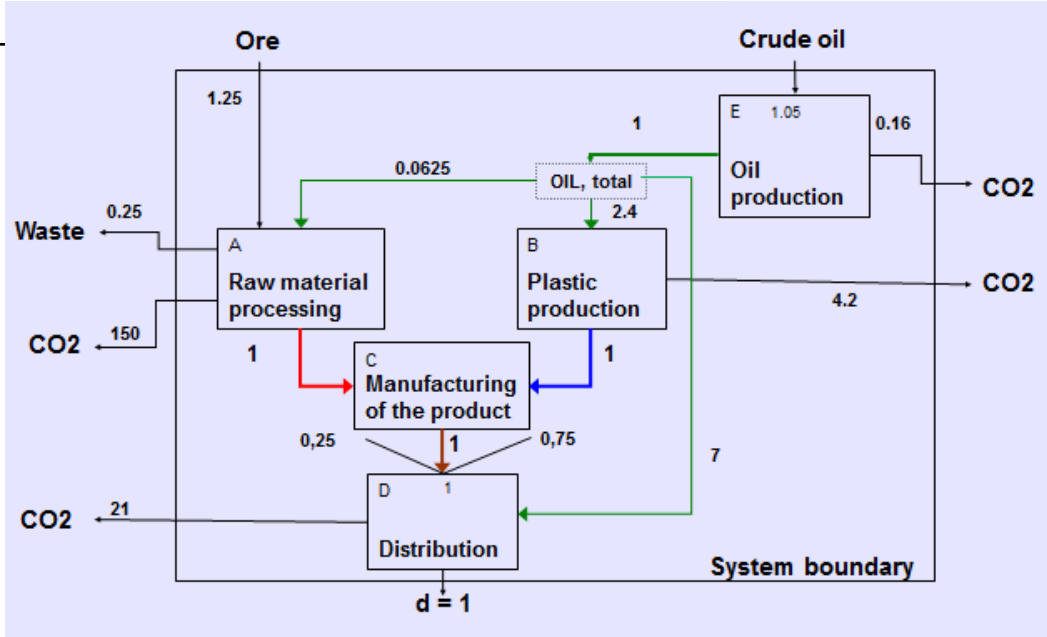
Calculation of the total emission per functional unit (FU):



Process/Product flow	kg CO_2 /a per kg FU
Product, in store	
Product, at plant	
Plastic	
Metal	
Oil	

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Calculation – Mathematical Representation

TECHNISCHE UNIVERSITÄT DARMSTADT

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Documentation of the Calculations
Example Flow Raw Material Processing

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Raw material processing	Raw data	Normalized to the product flow of the process	Normalized to the functional unit	Elementary flows
	t/a	kg/kg per a	kg/kg FU per a	kg/kg FU per a
Input:				
Ore A	1000	1.25		0.31
Oil_a	50	0.0625	0.016	
Output:				
Product flow d (metal)	800	1	0.25	
CO_2	150	0.1875		0.047
Waste	200	0.25		0.0625

!!!! Incomplete

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Sum of the Elementary Flows per Functional Unit

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	kg/kg FU
Input:	
Ore A	0.31
Oil	9.28
Output:	
CO_2	25.59
Waste	0.0625
FU (punch in store)	1