Ciências
ULisboa

Faculdade
de Ciências
da Universidade
de Lisboa

Eng Energy & Environment

Environmental Impact and Life Cycle Analysis

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Assignments

Weekly basis

Case study

VS

Case study


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS


13 CLIMATE ACTION

Case study

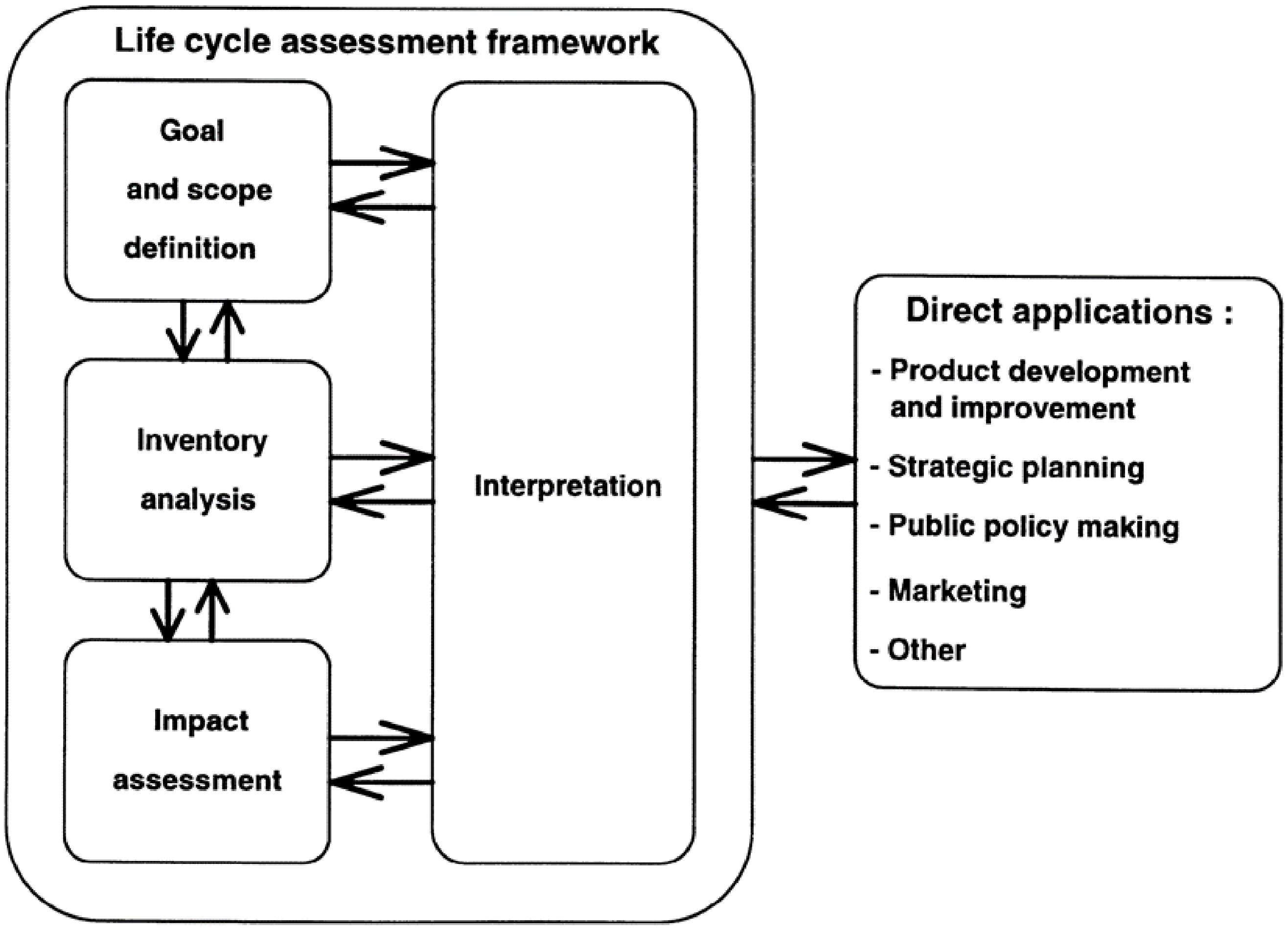


Figure 1 : Phases of an LCA

Case study

Âmbito/Scope: comparar lavar cabelo com líquido ou sólido considerando

FU-Functional unit/ unidade funcional: 1 lavagem

Materiais da embalagem (extração, produção, fim de vida)

Água da lavagem (uso)

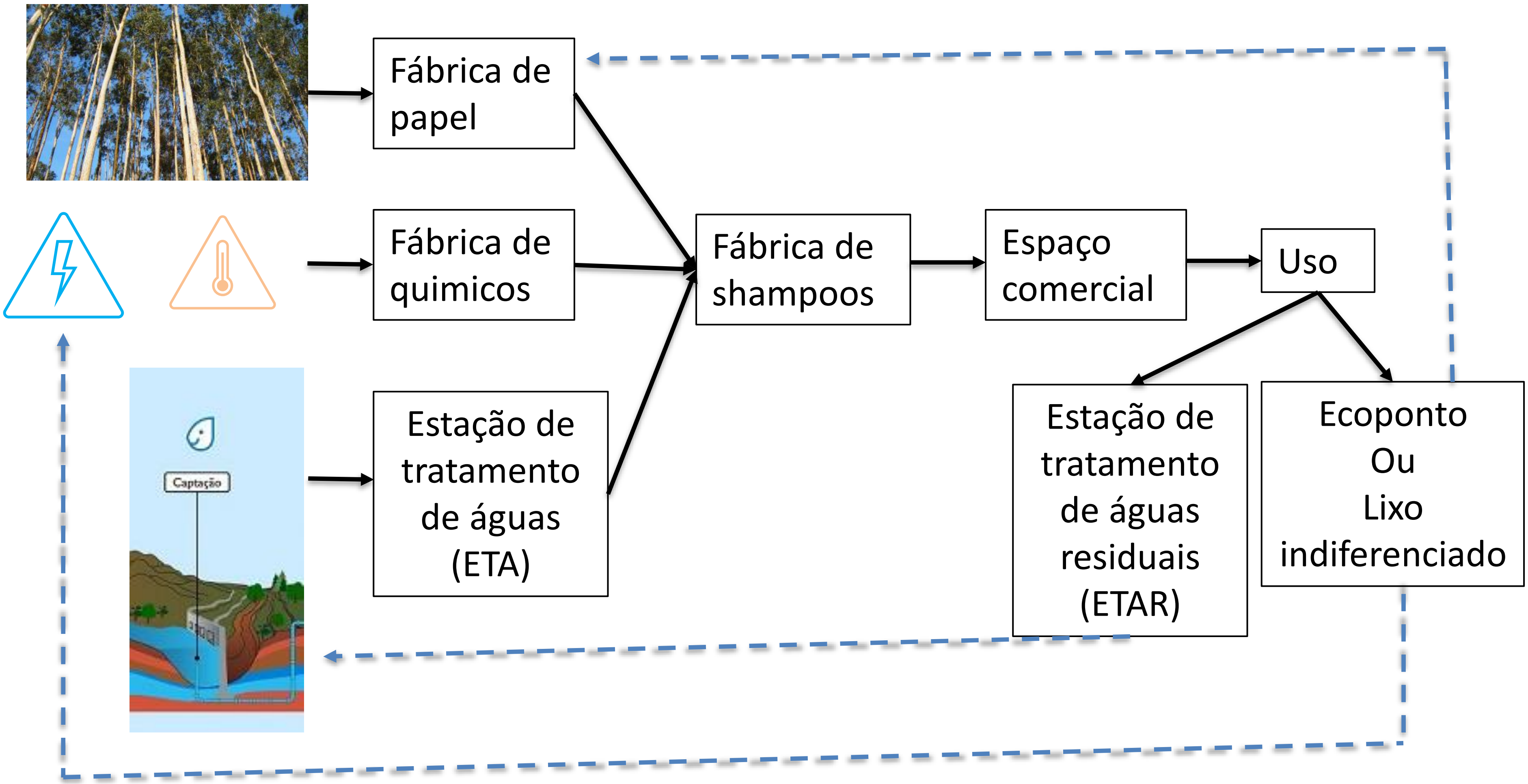
Gás natural e eletricidade (uso)

Químicos constituintes (extração, produção)

O que considerar??

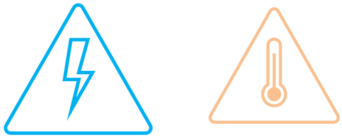
Case study

O que considerar?? – fronteira do estudo



Case study

O que considerar?? – fronteira do estudo



Fábrica de plástico

Fábrica de quimicos

Estação de tratamento de águas (ETA)

Fábrica de shampoos

Espaço comercial

Uso

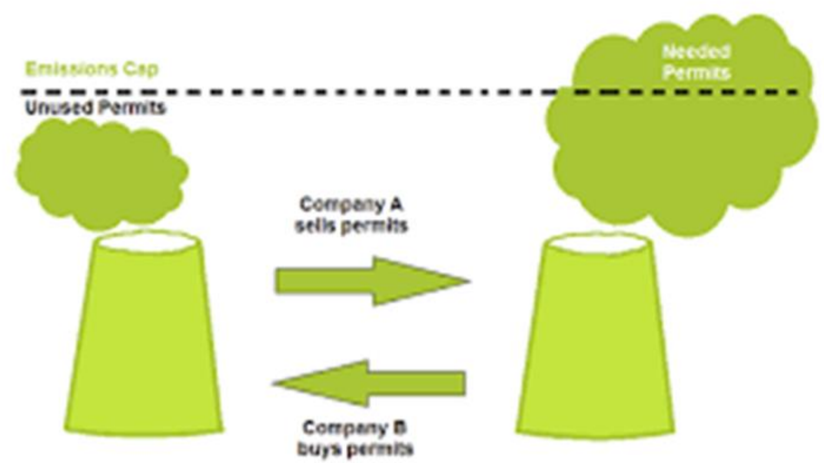
Estação de tratamento de águas residuais (ETAR)

Ecoponto
Ou
Lixo indiferenciado

Case study

GHG emissions

EU ETS benchmark Heat	47.3 gCO_{2eq}/MJ
EU ETS benchmark Electricity 2030	150 gCO2eq/kWh
EU ETS benchmark Electricity 2050	0 gCO2eq/kWh



$GWP_{100years}$

Case study

Emission factor database gCO_{2eq}/ unit

Construction materials "grey materials"

Chemicals

Fuels

Heat/vapour

Electricity

econvent

openLca

GREENHOUSE GAS PROTOCOL

Department for Environment Food & Rural Affairs

2006 IPCC Guidelines for National Greenhouse Gas Inventories

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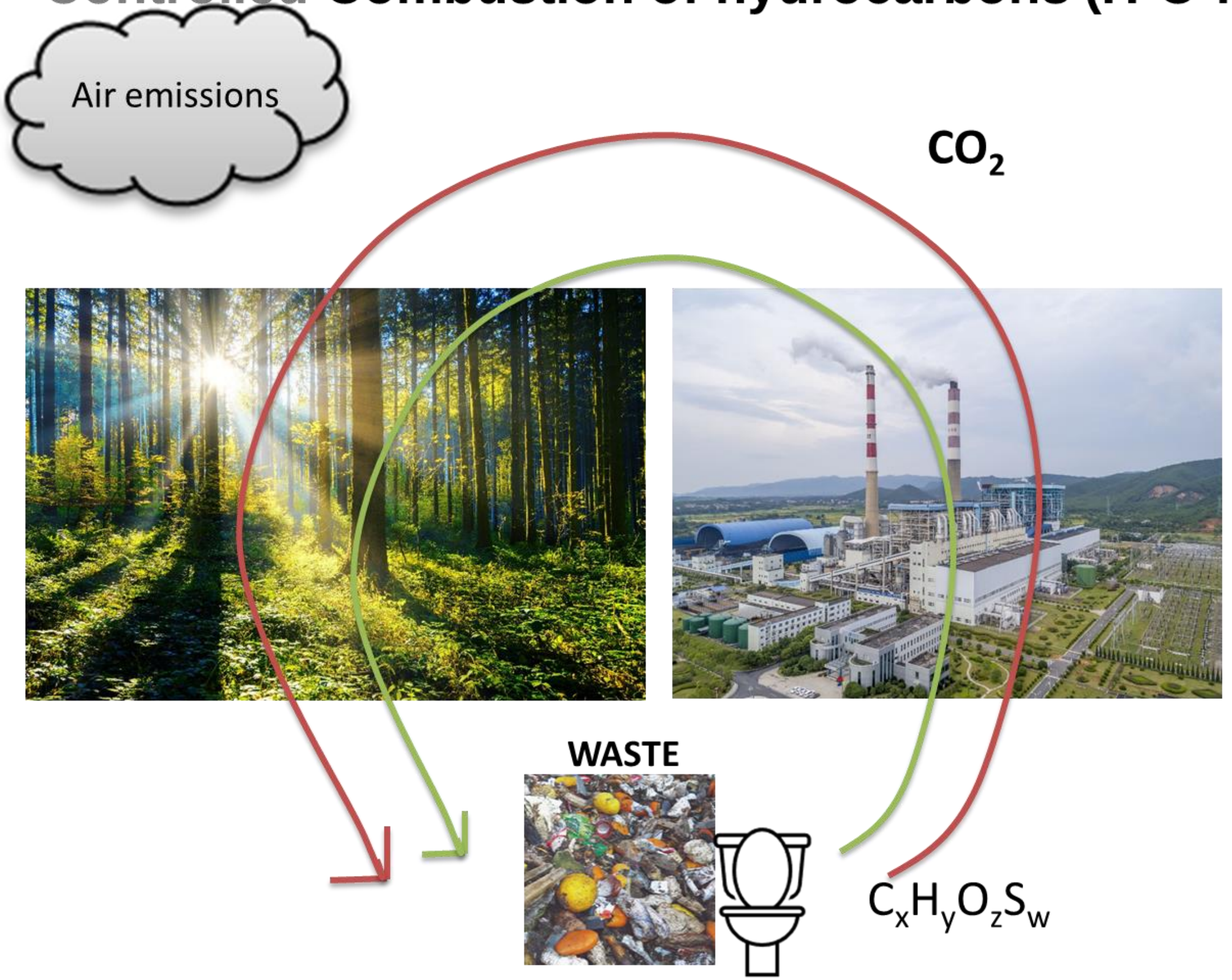
Scientific literature DOI:.....

Case study

Controlled Combustion of hydrocarbons (H-C-…)



Long cycle (FOSSIL FUEL)

Short cycle (BIOMASS/PART OF MSW)

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Case study

$$mCO_{2eq} = m_{CO2}*1+m_{CH4}*EQ_{CH4}+m_{N2O}*EQ_{N2O}+\ldots$$

$GWP_{100years}$

AR = Assessment report IPCC
EQ = Equivalence

Substance	AR1 (1990)	AR2 (1995)	AR3 (2001)	AR4 (2007)	AR5 (2013)
Carbon dioxide, fossil (CO_2)	1	1	1	1	1
Methane, fossil (CH_4)	21	21	23	25	28
Methane, biogenic (CH_4)	18.25	18.25	20.25	22.25	25.25
Dinitrogen monoxide (N_2O)	290	310	296	298	265
HCFC-141b	440	-	700	725	782
HFC-134a	1200	1300	1300	1430	1300
HCFC-22	1500	-	1700	1810	1760
HCFC-142b	1600	-	2400	2310	1980
CFC-11	3500	-	4600	4750	4660
CFC-12	7300	-	10600	10900	10200
Sulfur hexafluoride	-	23900	22200	22800	23500

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Materiais da embalagem (extração, produção, fim de vida)

Água da lavagem (uso)

Químicos constituintes

GREENHOUSE GAS PROTOCOL

Department for Environment Food & Rural Affairs

Base de dados??

Case study

Químicos

Químico	Valor Cradle-to-Gate	Referência da base de dados
Sodium Lauryl Sulfate (SLS)	1.63 Ton CO2eq/ton	Environmental Fact Sheet (#5) C12-14 and C12-15 Sodium Alkyl Sulphate (C12-14 mix AS) oleo/petrochemical anionic surfactant https://www.erasm.org/
Cocamidopropyl betaine	1.63 Ton CO2eq/ton	Environmental Fact Sheet (#28) C8-18 Alkyl Amidopropyl Betaine (CAPB) oleo/petrochemical amphoteric surfactant https://www.erasm.org/
Cocamide Diethanolamine	-0.88 Ton CO2eq/ton	Environmental Fact Sheet (#16) Cocamide Diethanolamine (CDEA) oleochemical non-ionic surfactant https://www.erasm.org/
Propylene glycol	4.67 Ton CO2eq/ton	OpenLCA Energies 2020, 13, 5653; doi:10.3390/en13215653
Titanium dioxide	1.43 Ton CO2eq/ton	2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 3, Chapter 3, Table 3.9) https://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php?ipcc_code=2.B.6&ipcc_level=2
HCL	0.89 Ton CO2eq/ton	Winipeg -canada
Water	0.149 kg CO2eq/m3	UK DEFRA
Tallow Oil	3.05 kg CO2eq/kg	Life Cycle Analysis of Greenhouse Gas Emissions from Biosynthetic Base Oil (BBO) compared to Poly-Alpha Olefin (PAO) Base Oil Prepared for Biosynthetic Technologies Prepared by Dustin Mulvaney, Ph.D., EcoShift Consulting February 3, 2014

Case study

Peso embalagem: 6 g

Contéudo: 60g

1.67 g/lavagem

$$\frac{60\ g}{1.67\ g/lavagem} = 36 \text{ lavagens}$$

6 g de material de embalagem

0.17 g de material de embalagem por lavagem

Case study

Material embalagem: e.g. mistura papel e cartão

Fator de emissão:

881.19 kg CO_{2eq}/Ton (0%reciclado) + 1041.804 kgCO_{2eq}/Ton (aterro) = 1923 kg CO_{2eq}/Ton

731.28 kg CO_{2eq}/Ton (100% reciclado) + 21.294 kg CO_{2eq}/Ton (reciclagem) = 753 kg CO_{2eq}/Ton

UK Government GHG Conversion Factors for Company Reporting

Material use

Index

			Primary material production	Re-used	Open-loop source	Closed-loop source
Activity	Material	Unit	kg CO_2e	kg CO_2e	kg CO_2e	kg CO_2e
Paper	Paper and board: board	tonnes	821.23			718.54
	Paper and board: mixed	tonnes	881.19			731.28
	Paper and board: paper	tonnes	919.4			739.4

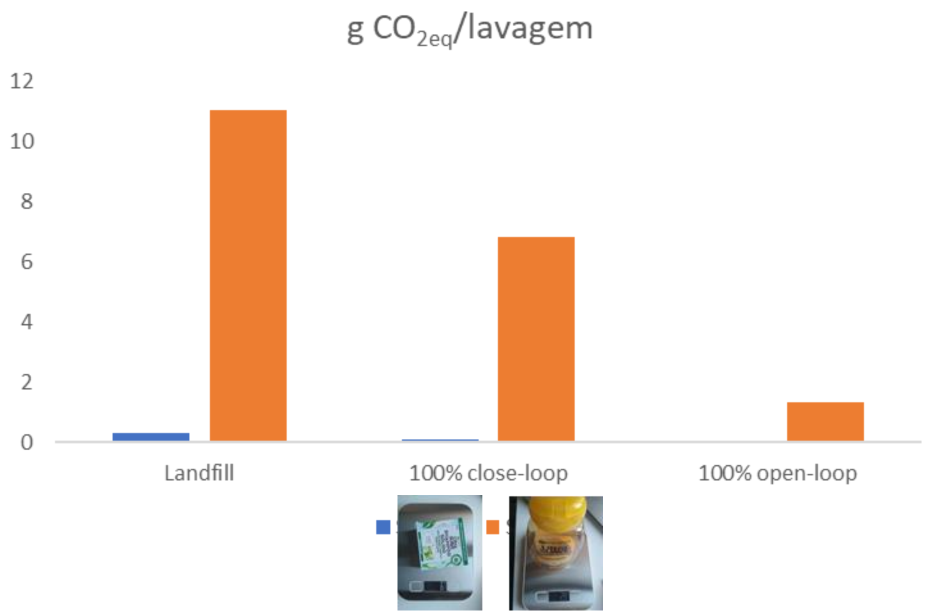
UK Government GHG Conversion Factors for Company Reporting

Waste disposal

Index

			Re-use	Open-loop	Closed-loop	Combustion	Composting	Landfill	Anaerobic digestion
Activity	Waste type	Unit	kg CO_2e	kg CO_2e	kg CO_2e	kg CO_2e	kg CO_2e	kg CO_2e	kg CO_2e
Paper	Paper and board: board	tonnes			21.294	21.294	8.951	1,041.804	
	Paper and board: mixed	tonnes			21.294	21.294	8.951	1,041.804	
	Paper and board: paper	tonnes			21.294	21.294	8.951	1,041.804	

Case study


g CO2eq/lavagem
12
10
8
6
4
2
0
Landfill
100% close-loop
100% open-loop

Case study

Uso de água: **por defeito 15 l agua/lavagem**

ETA

UK Government GHG Conversion Factors for Company Reporting

Water supply

Index

Company J multiplies the water used (cubic metres (m^3)) by the appropriate year's conversion factor called 'water supply' to produce its emissions.

Activity	Type	Unit	kg CO_2e
Water supply	Water supply	cubic metres	0.149
		million litres	149.0

For information about how the conversion factors have been derived, please refer to the Methodology paper' that accompanies the conversion factors.

ETAR

UK Government GHG Conversion Factors for Company Reporting

Water treatment

Index

Example of calculating emissions from water treatment

Company J report its emissions from mains water treatment, a Scope 3 emissions source. It gathers data from its utility bil

Company J multiplies the volume of water disposed of via the drains (in cubic metres (m^3)) by the appropriate year's conve

Activity	Type	Unit	kg CO_2e
Water treatment	Water treatment	cubic metres	0.272
		million litres	272.0

For information about how the conversion factors have been derived, please refer to the 'Methodology paper' that accoı

... WTT- UK & overseas elec | WTT- heat and steam | Water supply | Water treatment | Material use

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Department for Environment Food & Rural Affairs

Case study

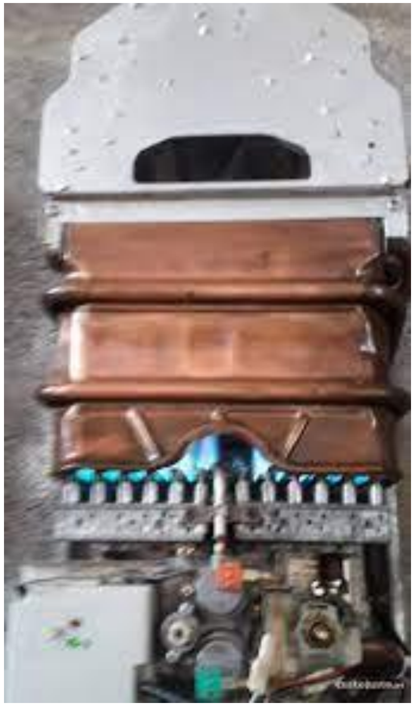
Uso de água: **por defeito 15 l agua/lavagem**

ETA 15L*10^-6*149*10^3= 2.235 g CO_{2eq}

ETAR 15L*10^-6*272*10^3= 4.08 g CO_{2eq}

Case study

Uso de água: **por defeito 15 l agua/lavagem**



Efic esquentador 90%

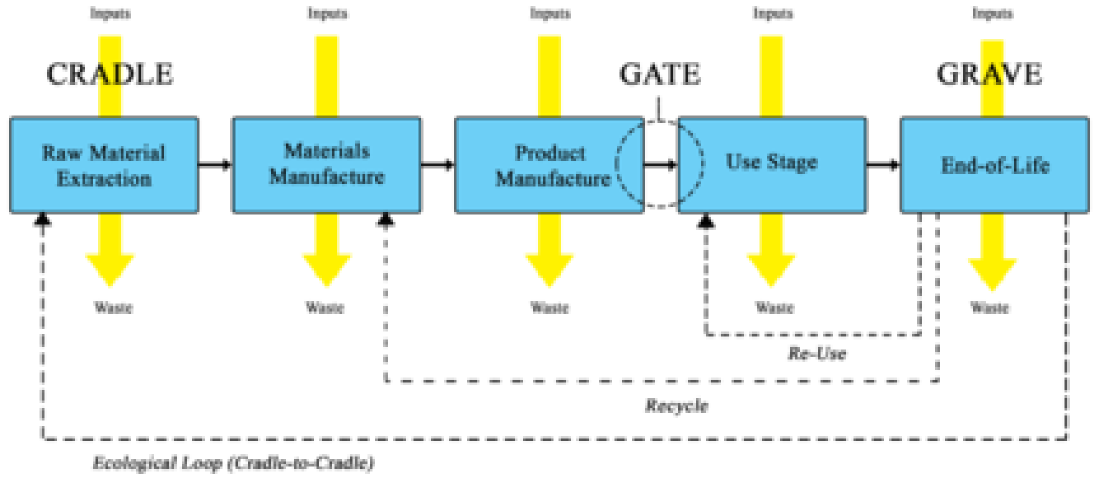
Determinação aquecimento água de 20°C para 45 °C: $mcp\Delta T$, cp 4.18 KJ/(kg.K)

Fator combustão gás natural:0.203 gCO2eq/kWh (ver DEFRA, separador FUELS)

Queima de gás natural

Case study

Uso de gás natural:



UK Government GHG Conversion Factors for Company Reporting

WTT- fuels

Index

Gaseous fuels	LPG	tonnes	347.0093
		litres	0.18383
		kWh (Net CV)	0.02719
		kWh (Gross CV)	0.02532
	Natural gas	tonnes	434.42892
		cubic metres	0.34593
		kWh (Net CV)	0.03474
		kWh (Gross CV)	0.03135
		tonnes	434.42892

Case study

Uso de gás natural para aquecimento de água:

Combustão no local (casa)	0.203 kgCO_{2eq}/kWh*0.48kWh= 0.097 kgCO_{2eq}
Extração e transporte para a rede de gás natural	0.035*0.48=0.0168 kgCO_{2eq}
Total gás natural	0.114 kgCO_{2eq}

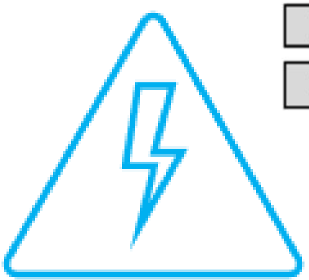
$\frac{mcp\Delta T}{0.9} = \frac{15*4.18*25}{0.9}$=1742 kJ = 0.48 kWh/lavagem

Case study

Uso de eletricidade por lavagem: 10 minutos

TIPOS DE LÂMPADAS

	COMUM	HALÓGENA	CFL	LED
CONSUMO	40 W	28 W	8 W	4 W
	60 W	42 W	12 W	6 W
	75 W	53 W	15 W	8 W
	100 W	70 W	20 W	10 W
DURABILIDADE	1 ano	1-3 anos	6-10 anos	15-25 anos
ECONOMIA	x	até 30%	até 80%	até 95%



Case study

Uso de eletricidade por lavagem: 10 minutos

Combustão no local produção **https://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production-4/assessment**	**198.4 gCO_{2eq}/kWh**
Extração e transporte gás natural e carvão UKDEFRA	52 gCO_{2eq}/kWh
Perdas transmissão 6%	1 kWh = x*(1-0.06) X= 1.06 kWh
Total eletricidade	(198.4+52)*1.06 = 265.4 gCO_{2eq}/kWh

Case study

Quimicos

Function	Ingredient	CAS	DID-list N°	Concentration (wt%)
Anionic surfactant	Sodium laureth sulfate	68891-38-3	8	13.00
Amphoteric surfactant	Cocamidopropyl betaine	61789-40-0	61	8.00
Non-ionic surfactants	Cocamide MEA	68140-00-1	50	1.25
Viscosity controlling agent	Propylene glycol	57-55-6	174	1.00
Preservative	Sodium benzoate	532-32-1	95	0.30
pH-adjustor	Chlorhydric acid	7647-01-0		0.80
Fragrance	alpha-hexyl cinnamaldehyde beta-pinene Dihydromyrcenol Hexyl salicylate Patchouli oil	101-86-0 127-91-3 2436-90-0 115-95-7 84238-39-1	142	0.50
Additional ingredients for additional functions (e.g. hair conditioning agent, hypo-irritancy agent)	Dimethicone	63148-62-9	110	1.00
Additional ingredients for additional functions (e.g. hair conditioning agent, hypo-irritancy agent)	Polyquaternium-10	68610-92-4		0.40
Additional ingredient for aspect (pearlescent / opacifying agent)	Glycol distearate	627-83-8	185	0.50
Solvent	Water			73.25

Case study

Quimicos

Function	Ingredients for base case	Ingredients for worst case	Percentage (%)	Amount (g) in 100 g of product
Saponified oils (92%)	Tallow	Tallow		57
	Coconut oil fatty acids	Coconut oil fatty acids	92%	14
	Stearic acid	Stearic acid		14
Emulsifying / humectant	Glycerine	Propylene glycol	6%	5.52
Perfuming	Perfume	Benzyl alcohol	1%	1.38
Colorant	Colorants	Colorants	0,1%	0.092
Chelating agent	EDTA	EDTA	0,2%	0.184
Bleaching agent	Titanium dioxide	Titanium dioxide	0,1%	0.092
Water	Water	Water	8%	8

Case study

Desafio #4:

Juntar materiais com químicos e uso em gráficos de barra com cada fase identificada

Responder e justificar

Qual a contribuição dos quimicos, embalagem e uso de água para o impacte/impacto total de CO2eq/lavagem?Qual a mais importante no uso (eletricidade, gás natural, ETA ou ETAR?)

Qual o cenário de reciclagem e fim de vida preferível?

Qual o shampoo que permite ter menor pegada carbónica?

Limitações do estudo?

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Desafio #4:

Apresentação dia 16 de Novembro sobre o caso de estudo e conclusões

14h30 Joana
14h50 Ivan
15h10 Henrique

Thanks

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