

O que se entende por sustentabilidade?



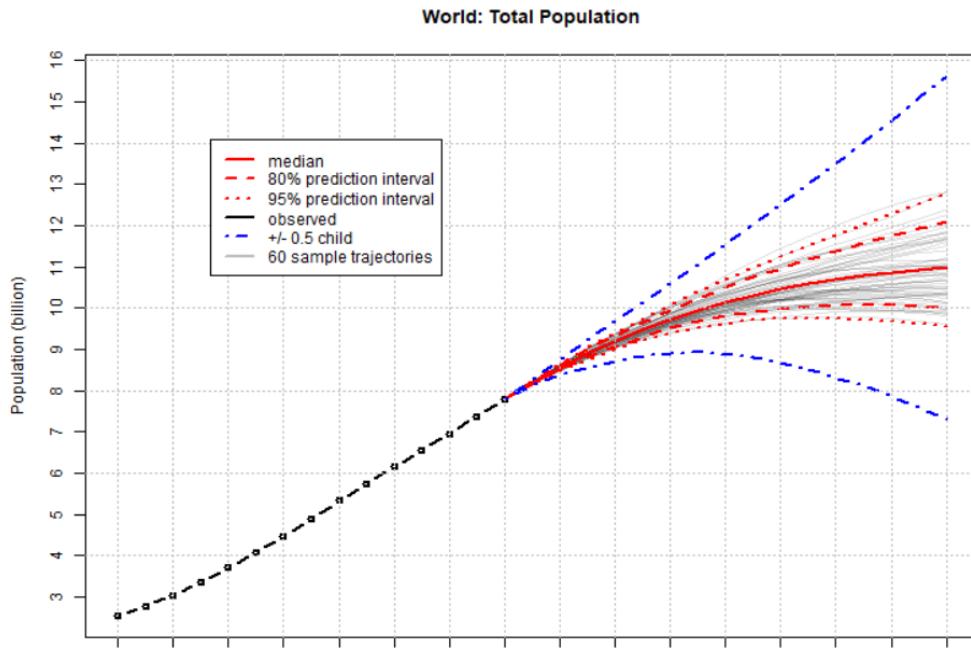
O que se entende por sustentabilidade?



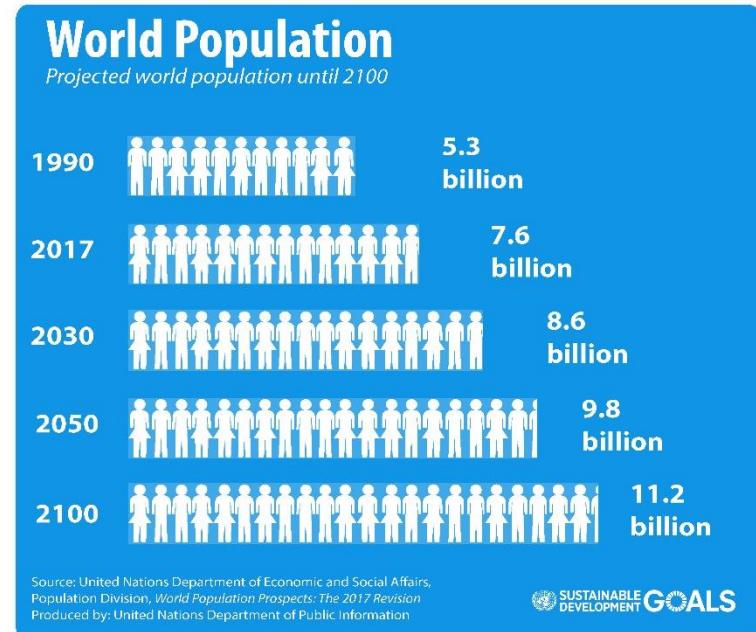
See what three degrees of global warming looks like

<https://www.youtube.com/watch?v=uynhvHZUOOo>

Sustentável?



© 2019 United Nations, DESA, Population Division. Licensed under Creative Commons license CC BY 3.0 IGO.
United Nations, DESA, Population Division. *World Population Prospects: The 2017 Revision*. Produced by: United Nations Department of Public Information



Fonte: <https://population.un.org/wpp/Graphs/Probabilistic/POP/TOT/900>

O aumento da população mundial provoca um aumento na procura/exploração dos recursos naturais provocado pelo aumento do consumo per-capita (em especial pelas economias emergentes: Índia, China, Brasil)

Sustentável?

F. Krausmann et al.

Global Environmental Change 52 (2018) 131–140

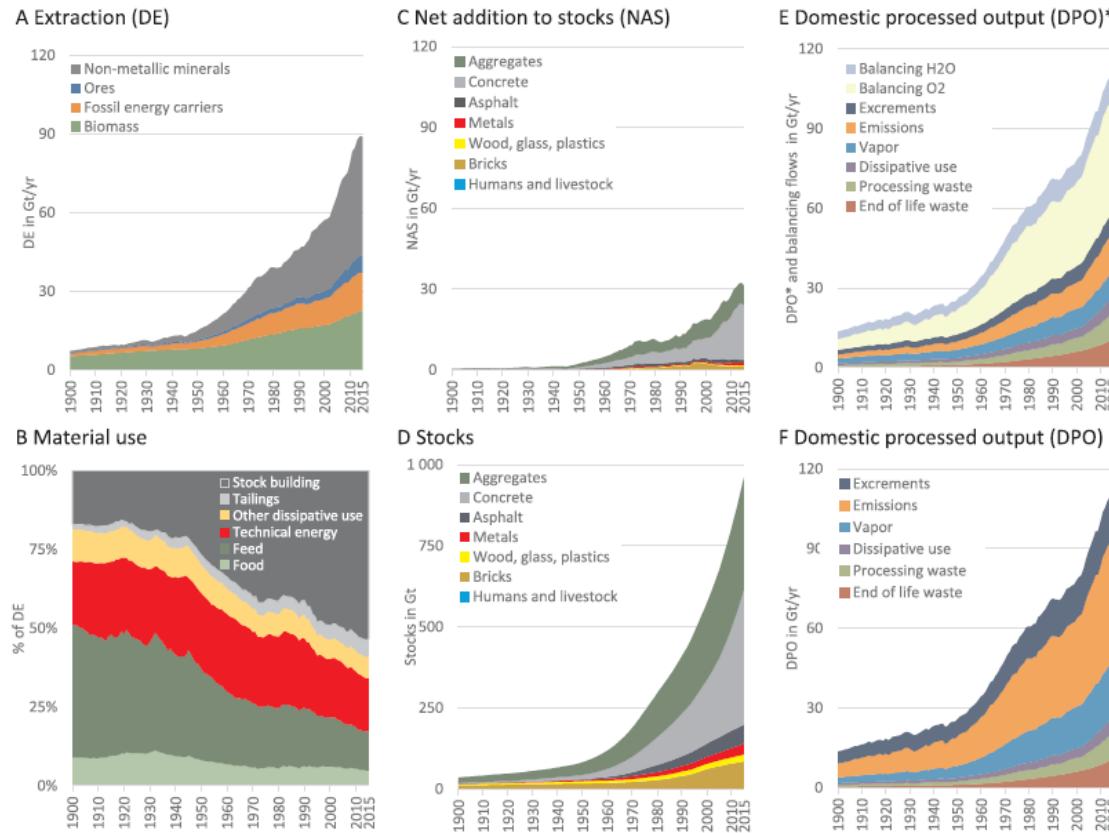
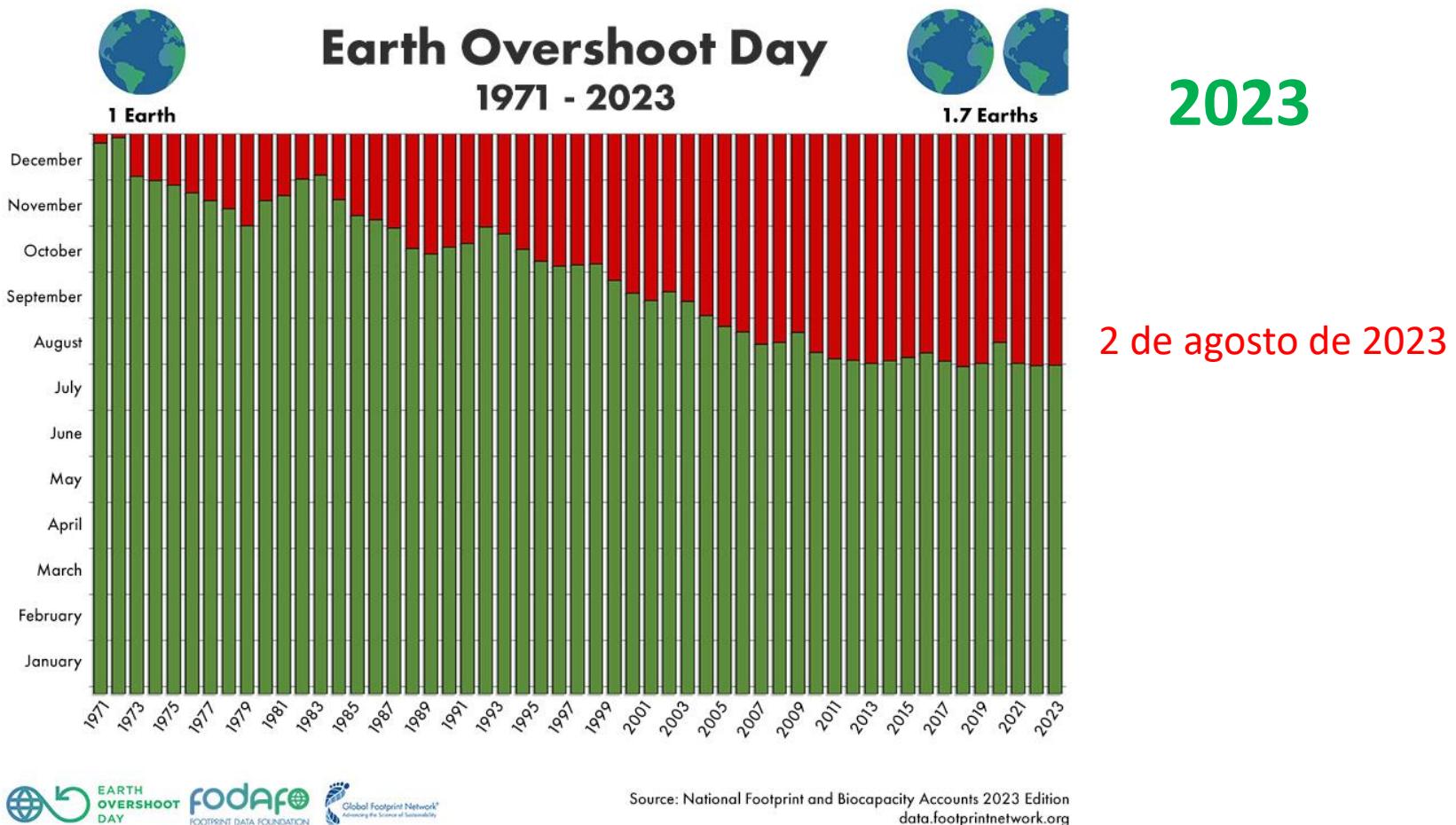


Fig. 2. Global material flows in Gt/yr and stocks in Gt from 1900 to 2015. A: material extraction by main material group; B: share of major use types in total extraction; C: yearly net additions to stock (NAS); D: stocks of humans, livestock and manufactured capital in Gt; E: the fraction of domestic processed output that actually originates from DE (DPO*) separate from balancing oxygen and water F: DPO by main type including balancing oxygen and water.

Fonte: Krausmann et al., Global Environmental Change 52 (2018) 131-140.

Sustentável?



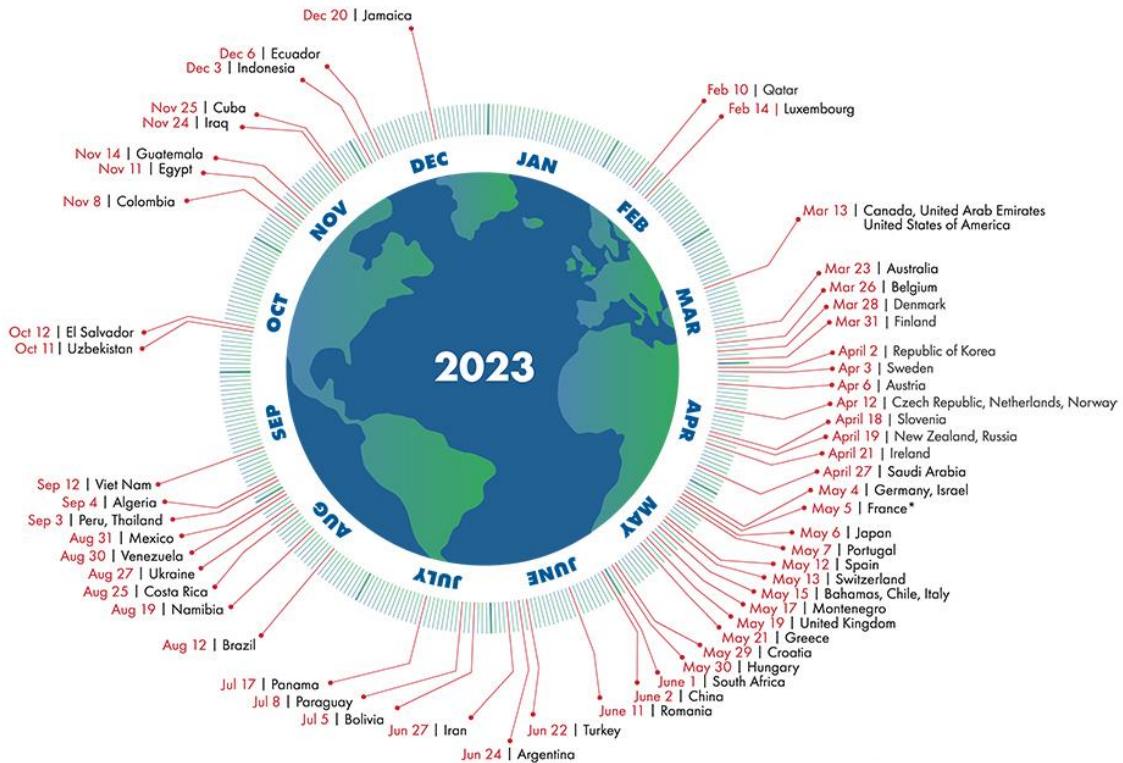


Cada ano, o **Dia da Sobrecarga da Terra** marca a data em que a humanidade usou todos os recursos naturais que o planeta pode renovar durante o ano inteiro entrando em **défice ecológico**.

2 de agosto de 2023

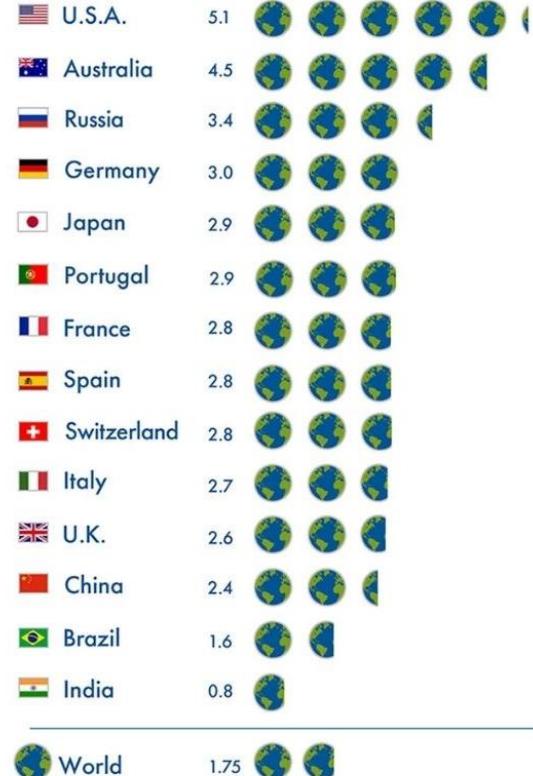
Country Overshoot Days 2023

When would Earth Overshoot Day land if the world's population lived like...



For a full list of countries, visit overshootday.org/country-overshoot-days.
*French Overshoot Day based on nowcasted data. See overshootday.org/france.

Source: National Footprint and Biocapacity Accounts, 2022 Edition
data.footprintnetwork.org



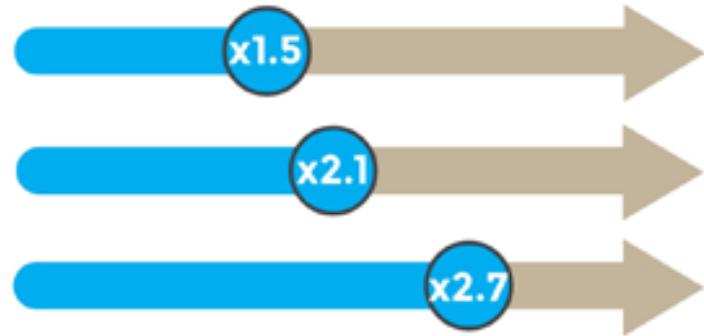
Source: National Footprint and Biocapacity Accounts 2022
Additional countries available at overshootday.org/how-many-earths

Sustentável?

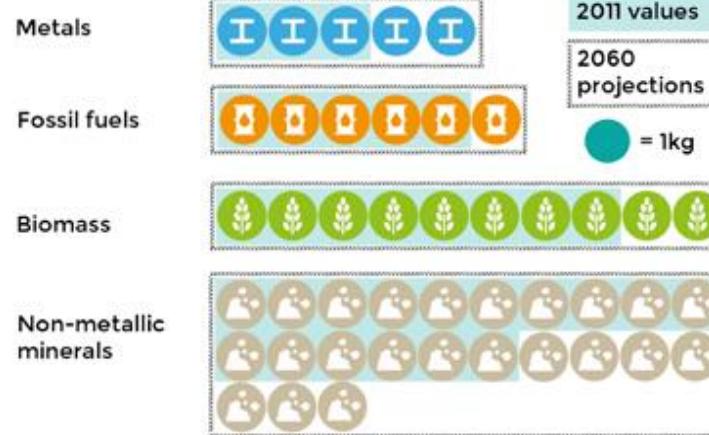
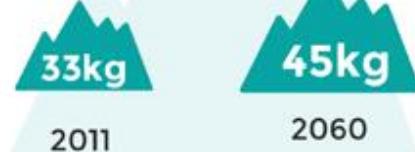
Average global per capita income in 2060 will converge to 2011 OECD average levels

Global changes, 2011-2060

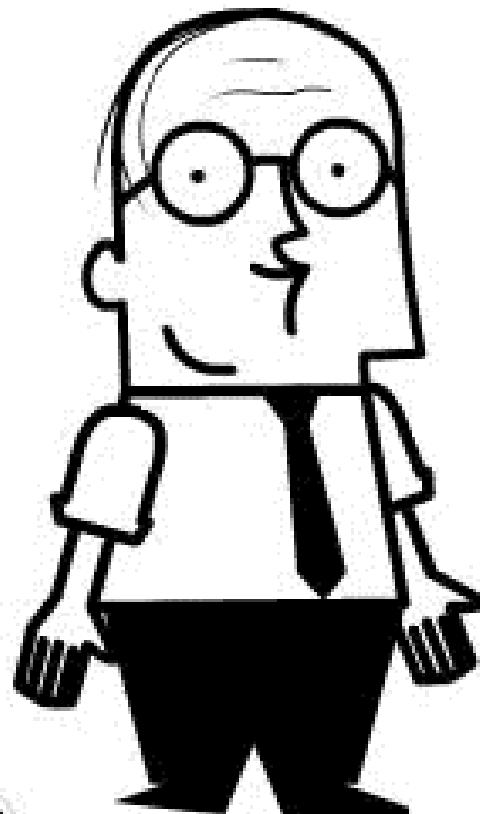
Population
Total materials use
Income per capita



Materials use per capita per day



Materiais e Sustentabilidade



www.iglooanimations.com

Sustentabilidade

“The quality of causing **little or no damage** to the environment and therefore able to continue for a long time”

<https://dictionary.cambridge.org/>

“Característica de modelo de desenvolvimento económico que procura a melhoria do nível de vida das populações, garantindo em simultâneo a **preservação do ambiente e dos recursos naturais**, através da sujeição das **atividades económicas** e industriais a princípios de equilíbrio ecológico, de modo a satisfazer as necessidades das gerações existentes sem comprometer as necessidades das gerações futuras.”

<https://www.infopedia.pt/>

Sustentabilidade

“Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future”



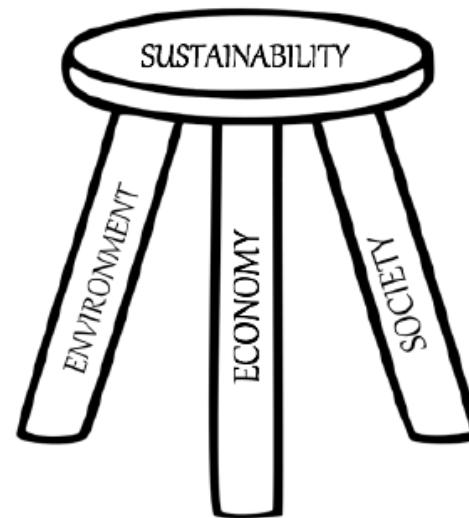
FIGURE 1.1

The cover of the Brundtland commission report, the starting point for discussing sustainable development.

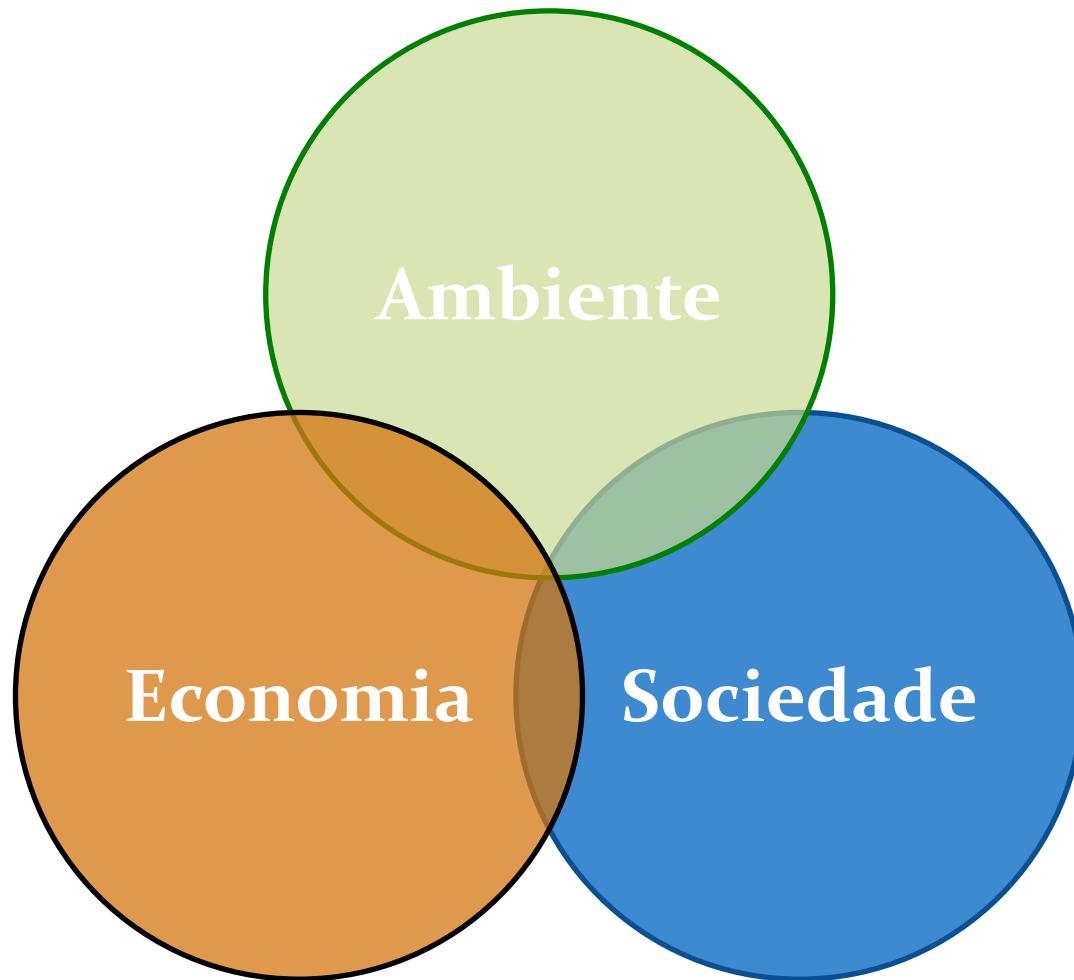
Fonte: “The Brundtland Report of the World Council on Economic Development (WCED, 1987).”

Sustentabilidade

A sustentabilidade é uma abordagem holística que considera simultaneamente as dimensões **ambiental**, **social** e **económica**, reconhecendo que estas devem ser considerados em conjunto para uma prosperidade duradoura.



Pilares da sustentabilidade



Sustentabilidade

Sustentabilidade ambiental

Os recursos naturais devem ser conservados e geridos, especialmente os que não são renováveis ou são fundamentais ao suporte de vida.



Para tal, devem ser implementadas ações para minimizar os impactos negativos no ar, na água e no solo, a biodiversidade deve ser preservada, a qualidade do ambiente deve ser protegida e melhorada, promovendo a produção e o consumo responsáveis.

Sustentabilidade

Sustentabilidade social

- Os direitos humanos são universais e a igualdade de oportunidades de todos os indivíduos na sociedade são respeitados.



- Promover uma sociedade mais justa, com inclusão social e distribuição equitativa dos bens com foco na eliminação da pobreza é imperativo.



- A diversidade cultural das comunidades locais também deve ser reconhecida e respeitada, evitando toda e qualquer forma de exploração.



Sustentabilidade

Sustentabilidade económica

Refere-se à **prosperidade** em diferentes níveis da sociedade e à eficiência da atividade económica, incluindo a viabilidade das organizações e das suas atividades na geração de riqueza e na promoção de emprego digno.



8 TRABALHO DIGNO
E CRESCIMENTO
ECONÔMICO

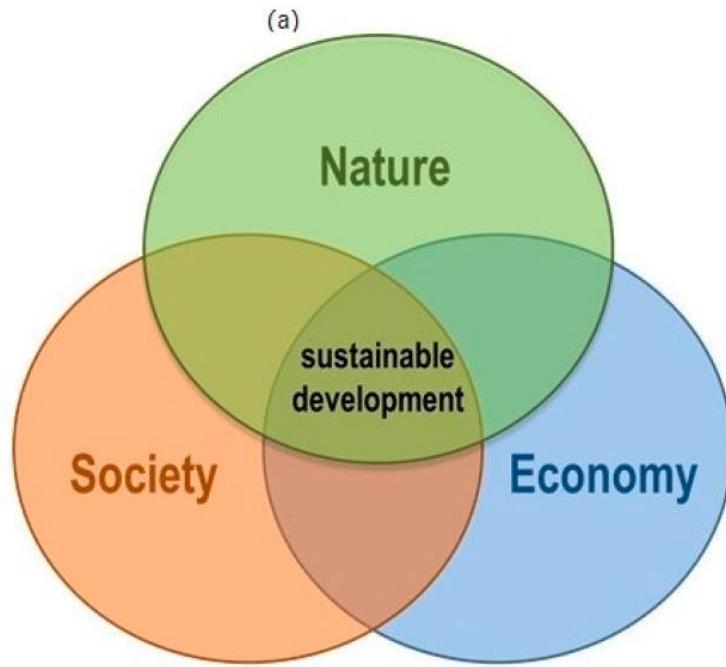


PROMOVER O CRESCIMENTO
ECONÔMICO INCLUSIVO
E SUSTENTÁVEL, O EMPREGO PLENO
E PRODUTIVO E O TRABALHO
DIGNO PARA TODOS



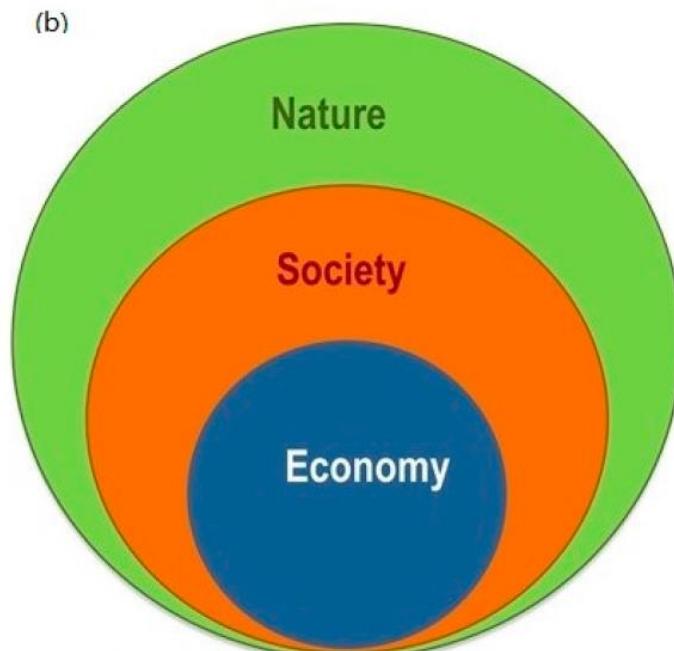
Sustentabilidade

Modelos de sustentabilidade



Weak sustainability

Based in Brundtland 1987.



Strong sustainability

Giddings 2002.

Sustentabilidade

Sustentabilidade fraca vs forte

- ❖ **Sustentabilidade forte:** a ênfase está nos pilares ambiente e justiça social. A utilização de recursos naturais é necessária, contudo o crescimento económico não deve ser o fator determinante.



- ❖ **Sustentabilidade fraca:** A natureza é meramente um “recurso” para atingir as necessidades humanas. Os mercados são vistos como a melhor ferramenta para guiar o desenvolvimento dos países.

Desenvolvimento sustentável



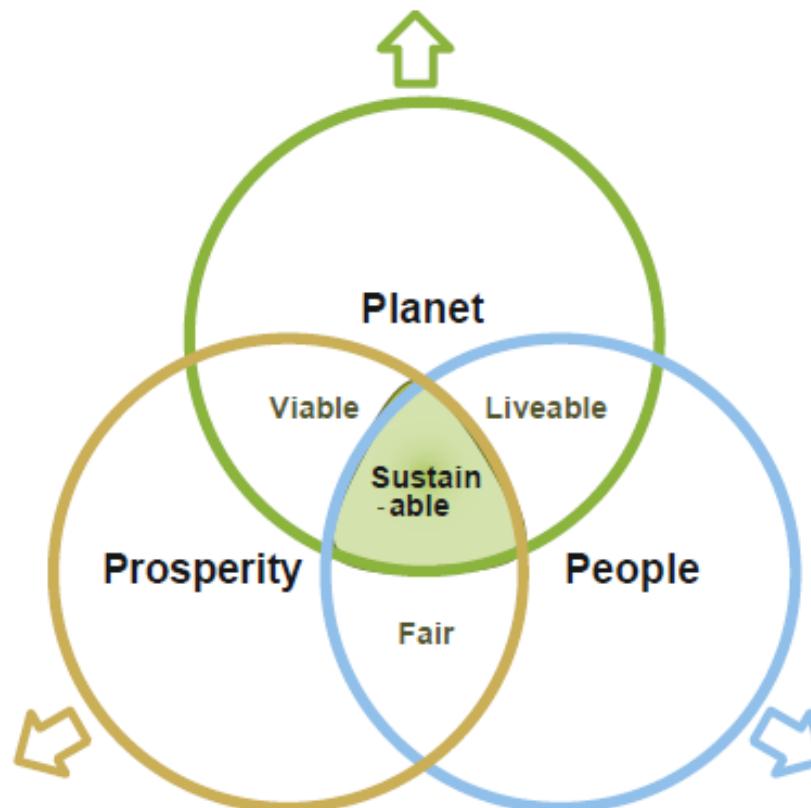
Desenvolvimento sustentável



“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

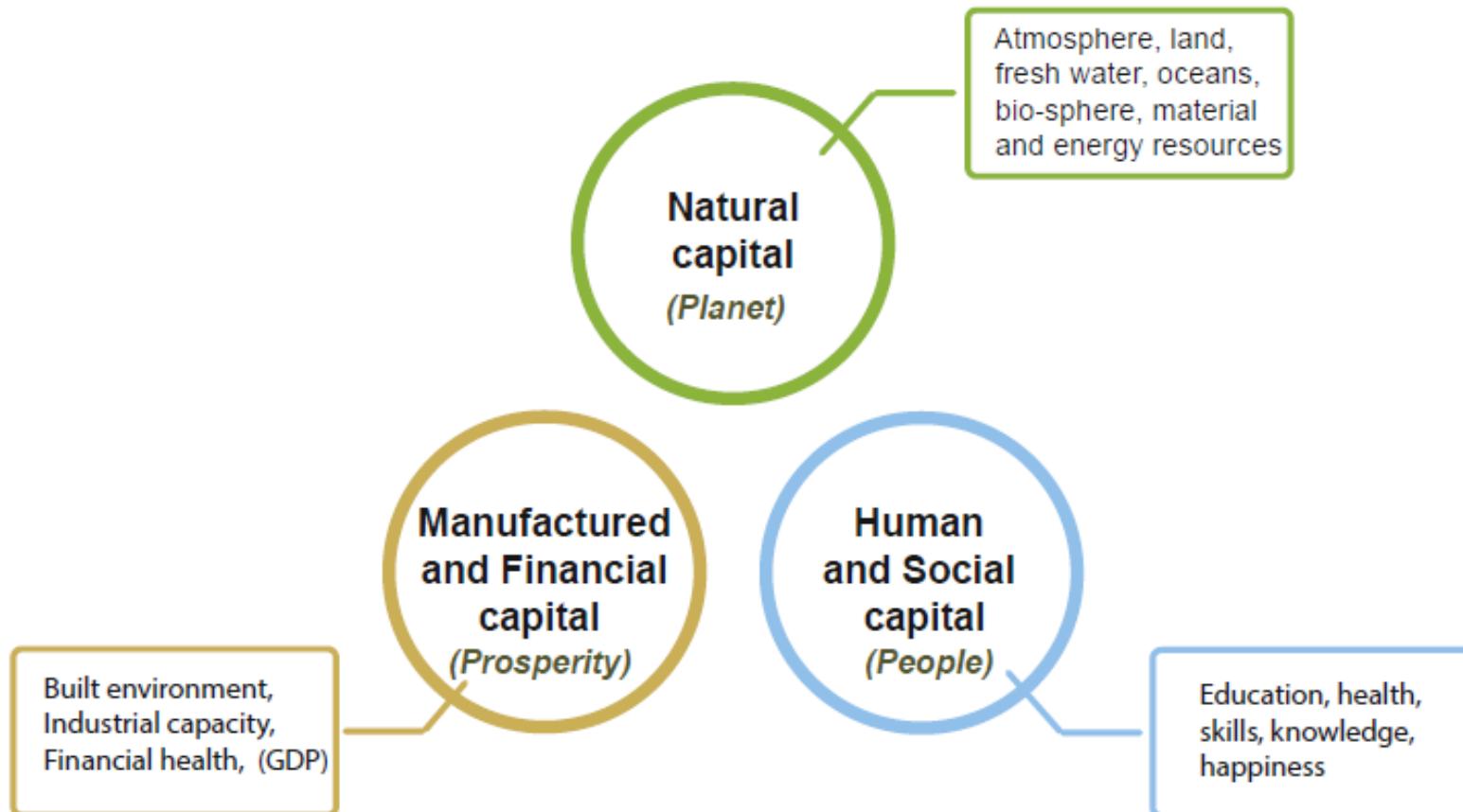
Desenvolvimento sustentável

Desenvolvimento sustentável é a passagem de um estado menos sustentável para outro de maior sustentabilidade. Contempla três dimensões: pessoas, planeta e prosperidade.



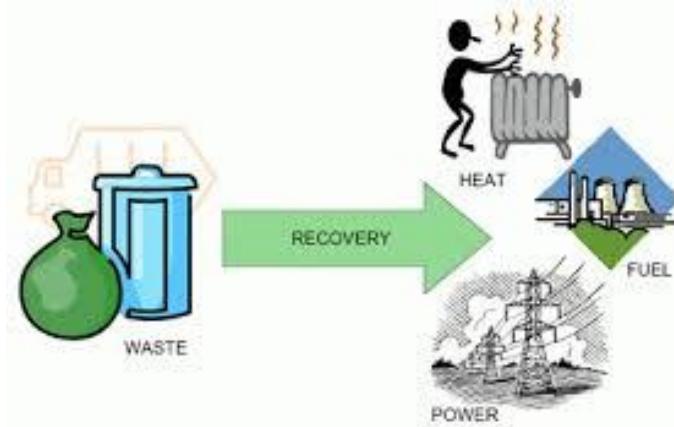
Desenvolvimento sustentável

Os três capitais:



Desenvolvimento sustentável

O reconhecimento da importância dos capitais social e natural estimula a adoção de medidas que visam diminuir os impactos associados ao **crescimento económico**, tais como a diminuição do consumo de **recursos**, **emissão de gases** e **as desigualdades sociais**.



Desenvolvimento sustentável

A **Agenda 2030** é uma agenda alargada e ambiciosa que aborda várias dimensões do desenvolvimento sustentável (sócio, económico, ambiental) e que promove a paz, a justiça e instituições eficazes. A **Agenda 2030** e os **17 Objetivos de Desenvolvimento Sustentável** são a visão comum para a Humanidade, um contrato entre os líderes mundiais e os povos e “uma lista das coisas a fazer em nome dos povos e do planeta”.

Os **Objetivos de Desenvolvimento Sustentável** são o modelo para alcançar um futuro melhor e mais sustentável para todos. Eles abordam os desafios globais que enfrentamos, incluindo os relacionados à pobreza, desigualdade, mudança climática, degradação ambiental, paz e justiça.

Desenvolvimento sustentável



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

Desenvolvimento sustentável

 **SUSTAINABLE DEVELOPMENT GOALS** |  1 NO POVERTY



DONATE WHAT YOU DON'T USE.
More than 700 million people still live in extreme poverty.

Goal 1: No Poverty

 **SUSTAINABLE DEVELOPMENT GOALS** |  2 ZERO HUNGER



WASTE LESS FOOD AND SUPPORT LOCAL FARMERS.
A third of the world's food is wasted, yet 821 million people are undernourished.

Goal 2: Zero Hunger

 **SUSTAINABLE DEVELOPMENT GOALS** |  3 GOOD HEALTH AND WELL-BEING



VACCINATE YOUR FAMILY.
Vaccinations resulted in an 80% drop in measles deaths between 2000 and 2017.

Goal 3: Good Health and Well-Being

 **SUSTAINABLE DEVELOPMENT GOALS** |  4 QUALITY EDUCATION



HELP EDUCATE THE CHILDREN IN YOUR COMMUNITY.
617 million children and adolescents lack minimum proficiency in reading and mathematics.

Goal 4: Quality Education

 **SUSTAINABLE DEVELOPMENT GOALS** |  5 GENDER EQUALITY



EMPOWER WOMEN AND GIRLS AND ENSURE THEIR EQUAL RIGHTS.
1 in 3 women has experienced physical and/or sexual violence.

Goal 5: Gender Equality

 **SUSTAINABLE DEVELOPMENT GOALS** |  6 CLEAN WATER AND SANITATION



AVOID WASTING WATER.
Water scarcity affects more than 40% of the world's population.

Goal 6: Clean Water and Sanitation

Desenvolvimento sustentável

 SUSTAINABLE DEVELOPMENT GOALS | ☀️ 7 AFFORDABLE AND CLEAN ENERGY



USE ONLY ENERGY-EFFICIENT APPLIANCES AND LIGHT BULBS.

Three billion people still lack clean cooking fuels and technologies.

Goal 7: Affordable and Clean Energy

 SUSTAINABLE DEVELOPMENT GOALS | ⚒ 8 DECENT WORK AND ECONOMIC GROWTH



CREATE JOB OPPORTUNITIES FOR YOUTH.

One-fifth of young people are not in education, employment or training.

Goal 8: Decent Work and Economic Growth

 SUSTAINABLE DEVELOPMENT GOALS | ⚙ 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



FUND PROJECTS THAT PROVIDE BASIC INFRASTRUCTURE.

Roads, water, sanitation and electricity remain scarce in many developing countries.

Goal 9: Industry, Innovation, and Infrastructure

 SUSTAINABLE DEVELOPMENT GOALS | ⚡ 10 REDUCED INEQUALITIES



SUPPORT THE MARGINALIZED AND DISADVANTAGED.

The poorest 40% of the population earn less than 25% of global income.

Goal 10: Reduced Inequalities

 SUSTAINABLE DEVELOPMENT GOALS | 🏙 11 SUSTAINABLE CITIES AND COMMUNITIES



BIKE, WALK OR USE PUBLIC TRANSPORTATION.

9 out of 10 urban residents breathe polluted air.

Goal 11: Sustainable Cities and Communities

 SUSTAINABLE DEVELOPMENT GOALS | ∞ 12 RESPONSIBLE CONSUMPTION AND PRODUCTION



RECYCLE PAPER, PLASTIC, GLASS AND ALUMINIUM.

By 2050, the equivalent of almost three planets could be required to sustain current lifestyles.

Goal 12: Responsible Consumption and Production

Desenvolvimento sustentável



SUSTAINABLE DEVELOPMENT GOALS | **13 CLIMATE ACTION**

ACT NOW TO STOP GLOBAL WARMING.
Global emissions of carbon dioxide (CO₂) have increased by almost 50% since 1990.

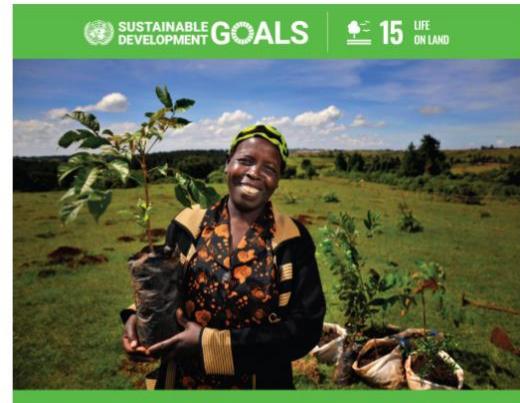
Goal 13: Climate Action



SUSTAINABLE DEVELOPMENT GOALS | **14 LIFE BELOW WATER**

AVOID PLASTIC BAGS TO KEEP THE OCEANS CLEAN.
Over three billion people depend on marine and coastal biodiversity for their livelihoods.

Goal 14: Life Below Water



SUSTAINABLE DEVELOPMENT GOALS | **15 LIFE ON LAND**

PLANT A TREE AND HELP PROTECT THE ENVIRONMENT.
Forests are home to more than 80% of all terrestrial species of animals, plants and insects.

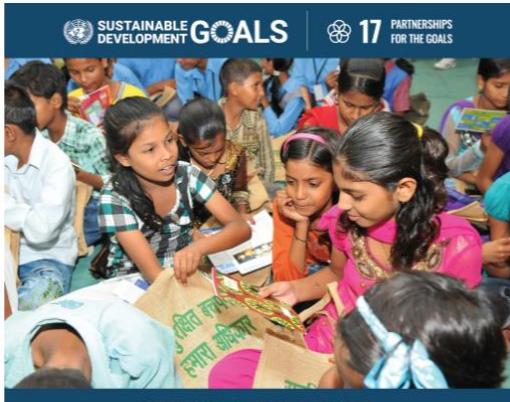
Goal 15: Life on Land



SUSTAINABLE DEVELOPMENT GOALS | **16 PEACE, JUSTICE AND STRONG INSTITUTIONS**

STAND UP FOR HUMAN RIGHTS.
In 2018, the number of people fleeing war, persecution and conflict exceeded 70 million.

Goal 16: Peace, Justice and Strong Institutions



SUSTAINABLE DEVELOPMENT GOALS | **17 PARTNERSHIPS FOR THE GOALS**

LOBBY YOUR GOVERNMENT TO BOOST DEVELOPMENT FINANCING.
Achieving the SDGs could open up US\$12 trillion of market opportunities and create 380 million new jobs by 2030

Goal 17: Partnerships

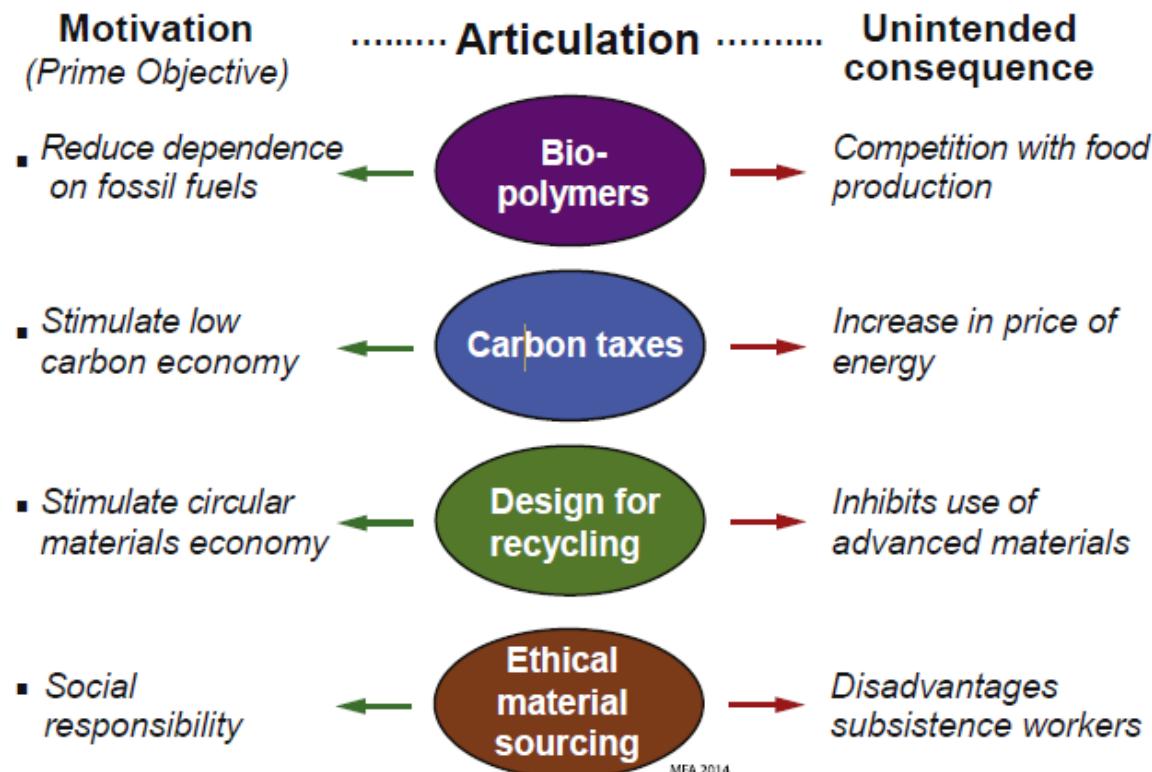
Desenvolvimento sustentável



Desenvolvimento sustentável

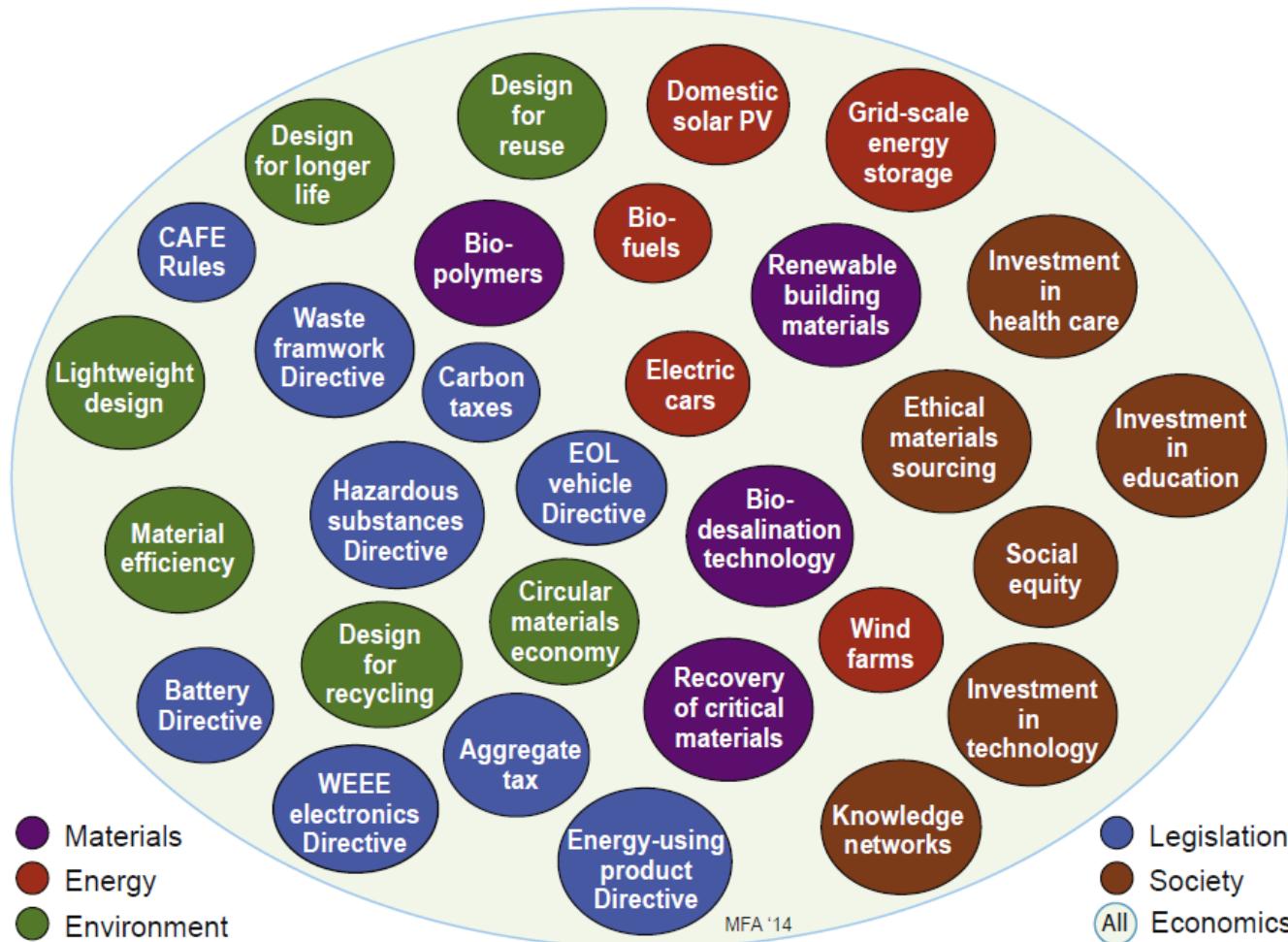
Articulações para um desenvolvimento sustentável

Cada articulação é motivada por um objetivo principal (coluna da esquerda). A sua concretização pode acarretar efeitos negativos (coluna da direita), a ponderar cuidadosamente!



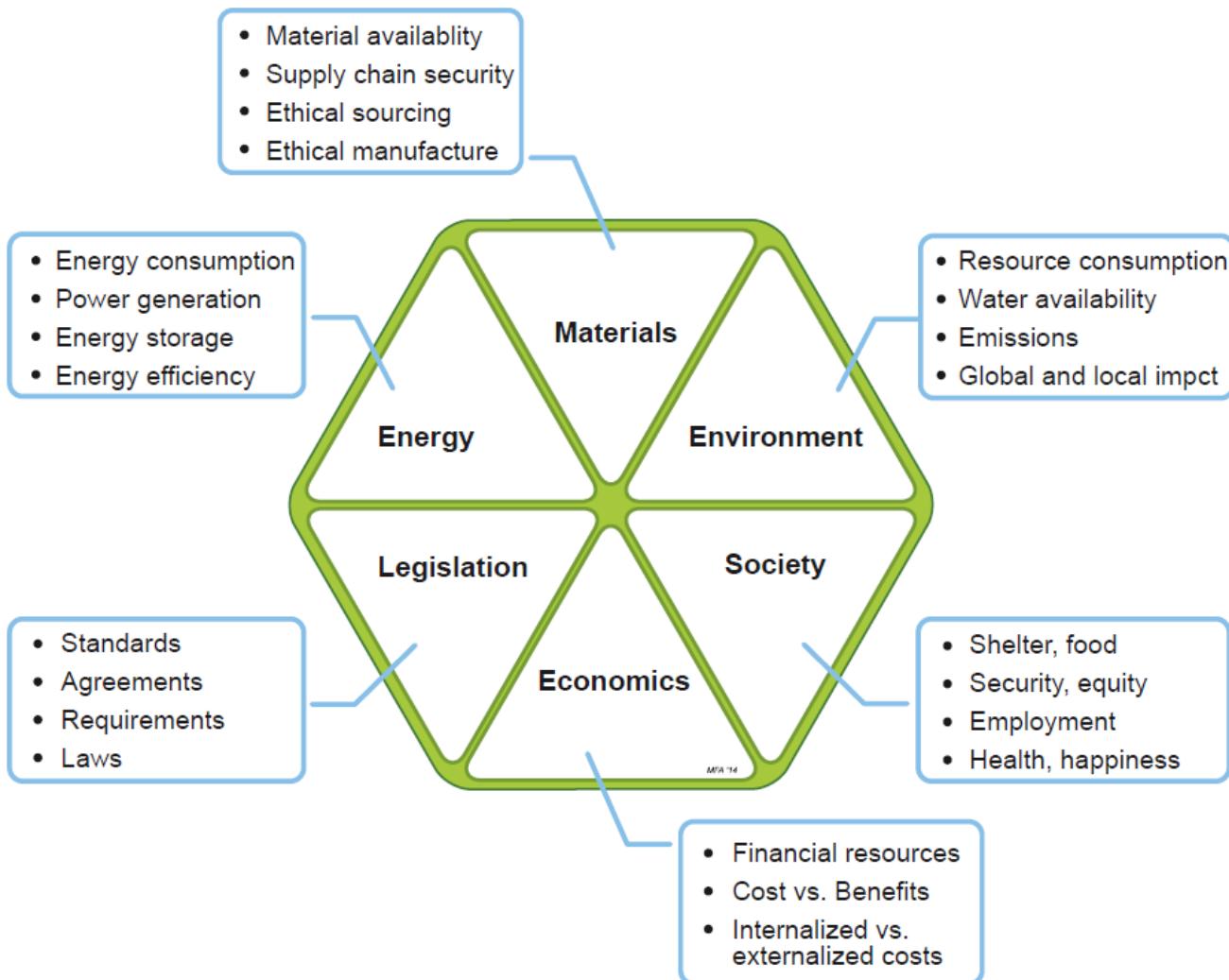
Desenvolvimento sustentável

Articulações para um desenvolvimento sustentável



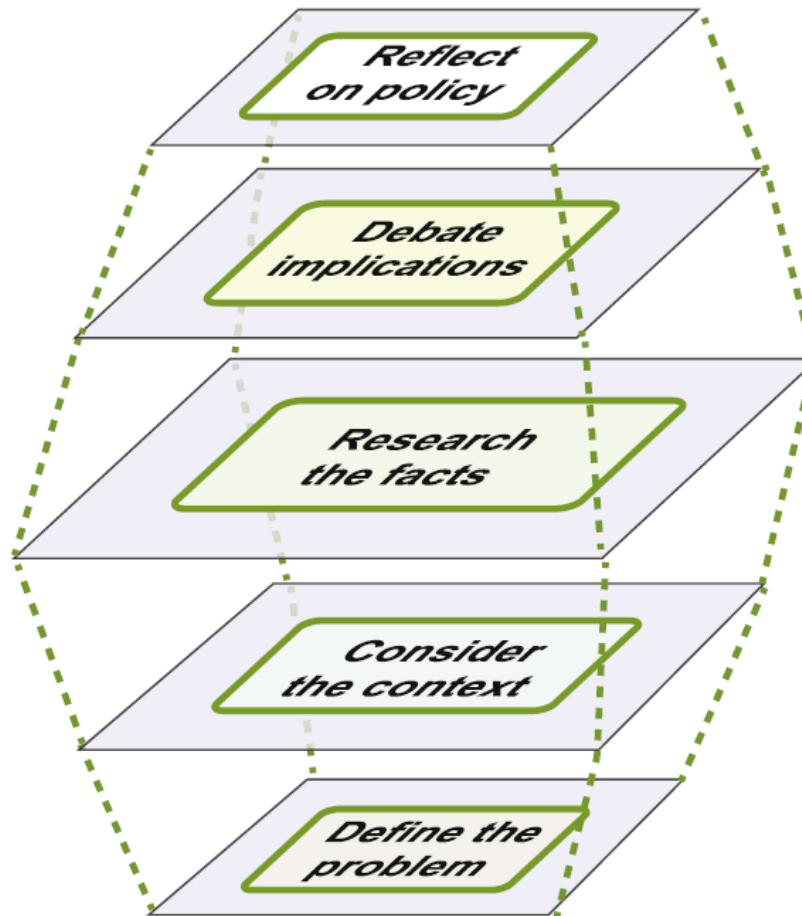
Desenvolvimento sustentável

Desconstrução das articulações:



Desenvolvimento sustentável

Abordagem para sistemas complexos:



Desenvolvimento sustentável

Abordagem para sistemas complexos:

Passo 1: Definição do problema

Qualquer articulação de sustentabilidade tem um motivo subjacente designado por “objetivo principal” (*prime objective*). A articulação só terá impacto se a escala temporal for adequada e a cota de mercado significativa comparativamente com o problema que pretende resolver.

Passo 2: Identificar as partes interessadas e as suas preocupações

Stakeholders (parte interessada) são indivíduos ou organizações que são de alguma forma afetados pela articulação.

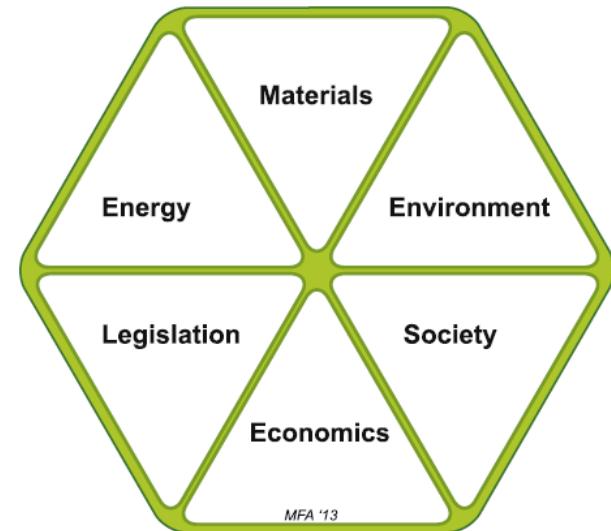


Desenvolvimento sustentável

Abordagem para sistemas complexos:

Passo 3: Estudar os dados existentes

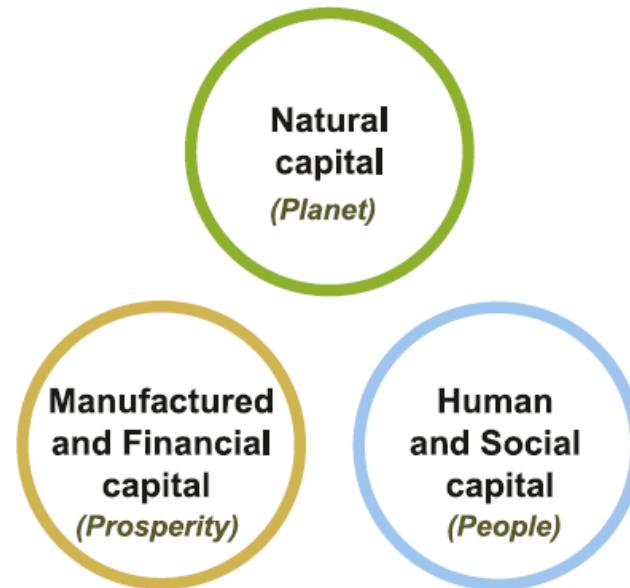
- Impacto ambiental
- Energia necessária
- Matérias-primas: quais e onde podem ser obtidas (materiais críticos), etc
- Legislação existente
- Infraestruturas
- Preocupações dos stakeholders
- ...



Desenvolvimento sustentável

Abordagem para sistemas complexos:

Passo 4: Estabelecer uma opinião fundamentada considerando os impactos nos três capitais



Passo 5: Alternativas

Esta etapa envolve uma reflexão sobre as possíveis alternativas.

- O objetivo principal foi atingido?
- A escala permite fazer a diferença?
- Os benefícios superam os malefícios?
- O objetivo principal pode ser obtido de forma alternativa e mais produtiva?

Desenvolvimento sustentável

Case study:

Fonte: "Materials and Sustainable Development." MF Ashby (Elsevier, 2016)

Substituição do alumínio por aço nas latas de cerveja

Passo 1: Definição do problema

Example. The Beneficial Brewing Corporation markets beer in 16 ounce (473ml) aluminum cans. Their sales average 500 million cans per year, roughly 1% of the US beer market. At the annual general meeting (AGM) a group of eco-minded shareholders propose that the company should use steel cans instead of aluminum because steel has a lower embodied energy and carbon footprint than aluminum (Figure 3.3). The CEO of Beneficial Brewing is thereby presented with an articulation for a sustainable development. Here it is

- Qual é o objetivo principal?
- Qual a dimensão e a escala temporal?
- Os benefícios superam os malefícios?
- O objetivo principal pode ser obtido de forma alternativa e mais produtiva?

Desenvolvimento sustentável

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Fonte: "Materials and Sustainable Development." MF Ashby (Elsevier, 2016)

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- *Prime objective:* reduce energy demand and carbon emission by replacing aluminum by steel cans.
 - *Size scale:* 500 million cans per year.
 - *Time scale:* less clear, but the shareholders will expect some sort of response by the time of the next AGM in 1-year time.
-

Desenvolvimento sustentável

Case study:

Passo 2: Identificar as partes interessadas e as suas preocupações

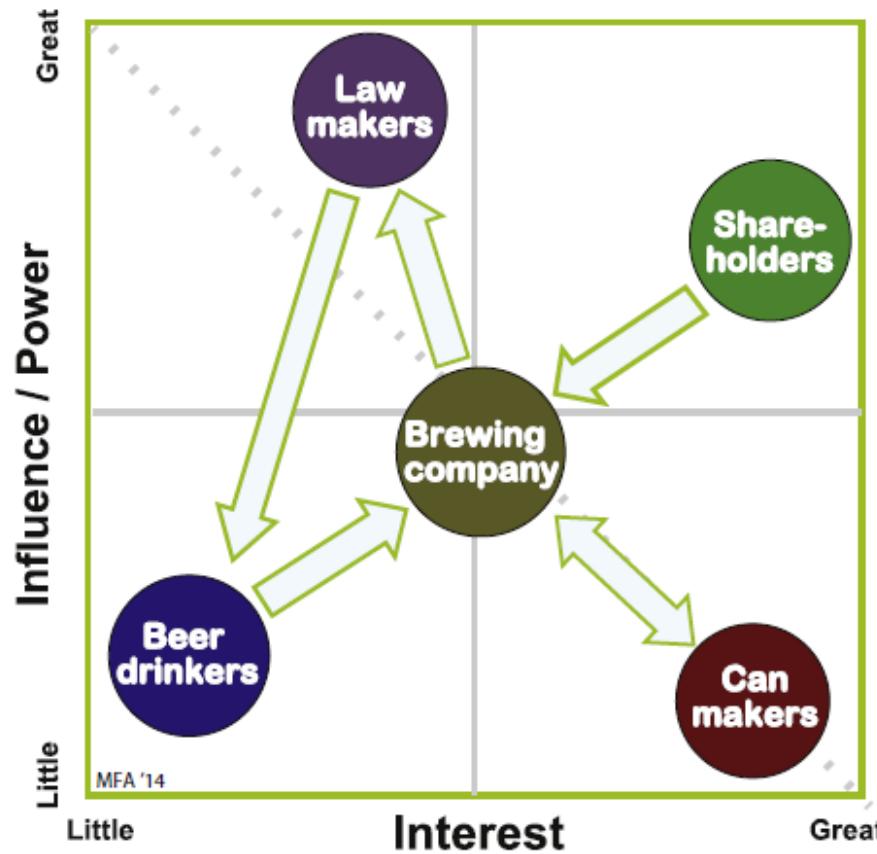
Example, continued

The CEO of Beneficial Brewing asks: who is interested or affected if we change from aluminum to steel cans? The shareholders have urged the change and are in a position to exert pressure on the company to adopt it: they are stakeholders with both interest and influence. The makers of aluminum cans may not wish to lose trade, but the makers of steel cans may be happy to get it – both are interested parties. Surveys suggest that most beer drinkers do not know or care what the cans are made from – they are stakeholders with little interest or influence so long as they get their beer. Law makers could, if so motivated, pass legislation mandating the use of steel cans but there is little reason to think that they would; they have influence but no interest. The important stakeholders are those above the diagonal (dotted) line. This is useful information, focusing the attention of the CEO on the key players and their concerns. Their views must be recognized in seeking the best path forward.

Desenvolvimento sustentável

Case study:

Passo 2: Identificar as partes interessadas e as suas preocupações

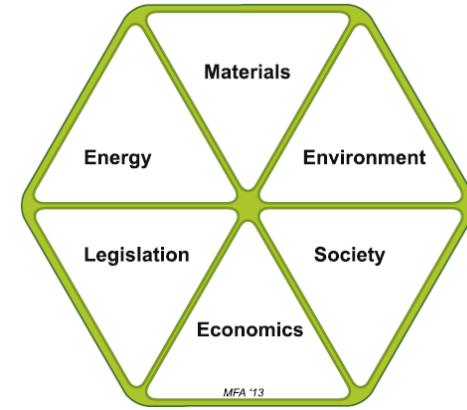


Desenvolvimento sustentável

Case study:

Passo 3: Estudar os dados existentes

- **Materials.** Is the supply-chain secure? Is a supplier of steel cans available? Have they the spare capacity to provide 500million cans per year?
- **Energy.** The shareholders believe that steel cans require less energy than aluminum cans. What are the values? If the change was made, how much energy would the company save in a year? What is this as a fraction of the total energy used by the company? Is it significant?
- **Environment.** What are the relative environmental impacts of the two sorts of can? Does one have a lower carbon footprint than the other? Is one recycled more effectively than the other?
- **Regulation.** What regulations bear on the use and recycling of cans? Is it the same for steel and aluminum? Are there any other legal or regulatory constraints?
- **Society.** Are steel cans as acceptable as aluminum to drinkers of beneficial beer? Would the lower embodied energy of the cans be seen as a demonstration of environmental responsibility?
- **Economics.** Do steel cans cost less than aluminum cans? What is the cost of re-equipping to cope with the change from steel and of aluminum? What are the benefits? Do they justify the cost?



Desenvolvimento sustentável

Case study:

Passo 3: Estudar os dados existentes

Example, continued

Material, Environment and Energy. It is true, as the shareholders of the Benevolent Brewing Co claim, that steel has a much lower embodied energy than aluminum for virgin material – it is about 25 MJ/kg for steel, 200 MJ/kg for aluminum, a factor of 8 larger. Cans are not made from virgin stock but from stock with a considerable recycle content. The embodied energy of typical grades of can stock are about 18 MJ/kg for steel and 110 MJ/kg for aluminum, a factor of 6. Does this mean that the embodied energy of the two sorts of can differ by the same factor? The answer is no – a 5000-series aluminum 440ml can weighs 13 grams; the equivalent steel can weighs 44 grams ([Figure 3.6](#)), so the embodied energies per can differ by much less – that of the aluminum can is just 1.7 times more than the steel one.

The forming energies to make the cans also differ. To make a valid comparison the CEO of Beneficial Brewing needs a life cycle

Desenvolvimento sustentável

Case study:

assessment (LCA) for the production of each type of can. A detailed LCA from 2002¹ reaches the conclusion that the differences both in energy and in carbon emissions for the two types of can are so small that, given the inherent uncertainty in all embodied energy data, the energies and carbon emissions of the two are not significantly different.

Legislation and Regulation. Much regulation, easily found via a Web-search, now applies to packaging such as cans. The UK packaging (Essential Requirements) Regulations of 2003 is typical. It applies to any company that makes, fills, sells or handles packaging. It aims to minimise waste and ensure that packaging can be reused, recovered or recycled. To comply, a producer must join a registered compliance scheme. The legislation applies equally to aluminium and steel cans.

Economics. Can-grade steel costs about \$0.4/kg; so the material cost for 500 million steel cans is about \$8.8 million. Can-grade aluminum costs about \$1.7/kg, making the material cost for 500 million cans \$11.0 million. There could, therefore, be a possible saving of \$2.2 million in changing to steel.

Society. Are steel cans as acceptable to the beer drinking public as aluminum cans? Surveys suggest that most do not care, and the fact that the two competing brands pictured in Figure 3.6 use different can materials reinforces this perception.

¹<http://www.apeal.org/uploads/Library/LCA%20study.pdf>



FIGURE 3.6
440 ml aluminum (left) and steel (right) cans.

Desenvolvimento sustentável

Passo 4: Estabelecer uma opinião fundamentada

Example: continued

The CEO can now present the facts to the Brewery Board and initiate a discussion of their impact on the three capitals.

Natural capital. Contrary to the intuition of the shareholders, the facts suggest that the differences in embodied energy and carbon footprint of steel and aluminum cans are too small to be significant. This is because of the high recycle content of can-stock, because aluminum cans are much lighter than those made of steel and because (according to the LCA) the deep-drawing of aluminum to make cans is less energy intensive than the equivalent process for steel. The supply chains for both metals are robust with no global or national shortages (indeed at the time of writing there is over-capacity). Beneficial Brewing requires only 1% of the can market and cans account for about 10% of the global aluminum consumption so the impact of material choice by Beneficial is very small.

Human capital. A can is ... well ... just a can. The material of which it is made carries no emotional, cultural or (since it is decorated) intrinsic aesthetic baggage that needs unpacking. No significant impact here.

Manufactured and financial capital. If the prices of steel and aluminum are directly reflected in can prices, a switch to steel could provide an annual saving of about \$2 million. At a (guessed) shipping price of 50¢ per filled can, Beneficial's revenue stream from beer is of order \$250 million, so this saving is about 0.8% of turnover. But against this must be set the cost of re-equipping the brewery's production line to deal with steel cans and the possible disruption of production while this happens. The CEO and the Board take the view that the risks exceed the benefits.

Desenvolvimento sustentável

Case study:

Passo 5: Alternativas

Example, continued

Is the shareholders' "articulation" a sustainable development or not? Taken together, the impacts on the three capitals suggest that it is not. But the shareholders are stakeholders with both interest and influence. Their views must be respected.

Reflection. This is the moment to return to the Beneficial Brewery, pour a glass of beer, and ponder on alternatives – preferably those that do not require re-equipping the production line. The prime objective was to reduce depletion of natural capital associated with beer cans. Could aluminum cans be made thinner and thus less energy intensive? Aluminum can makers have already thought of that. Increase the recovery of aluminum cans for recycling by charging a deposit? That will work only if it is mandated nation- or state-wide, something the brewery cannot do by itself. But the brewery could lobby for such legislation, thereby demonstrating to shareholders its commitment to the environment without the disruption of changing material.

Sustainable development



The global goals we've made progress
on -- and the ones we haven't | Michael
Green

<https://www.youtube.com/watch?v=N3SQLrmV1cE>