SUSTAIN

GAME-BASED LEARNING ON URBAN SUSTAINABILITY

SUSTAIN Project - Funded under the Erasmus+ KA2- 2017-1-EL01-KA203-036303

Co-funded by the Erasmus+ Programme of the European Union

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Project Facts

- **Project title:** Game-Based Learning on Urban Sustainability
- **Project Acronym:** SUSTAIN
- **Agreement n°** 2017-1-EL01-KA203-036303
- **Funded under the** ERASMUS+ Programme, Key Action 2 - Strategic Partnerships
- **Start Date of the Project:** 01-10-2017
- **End Date of the Project:** 31-03-2020

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Project Consortium

1. University of Macedonia (Greece) – Project Coordinator

2. System Dynamics Italian Chapter (Italy) – Partner

3. Centre for Research and Technology Hellas Certh (Greece) – Partner

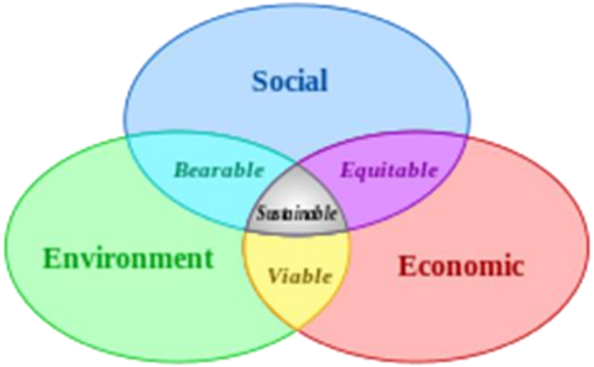
4. Centre for System Solutions (Poland) – Partner

5. Ergo Ludo Editions (Italy) – Partner

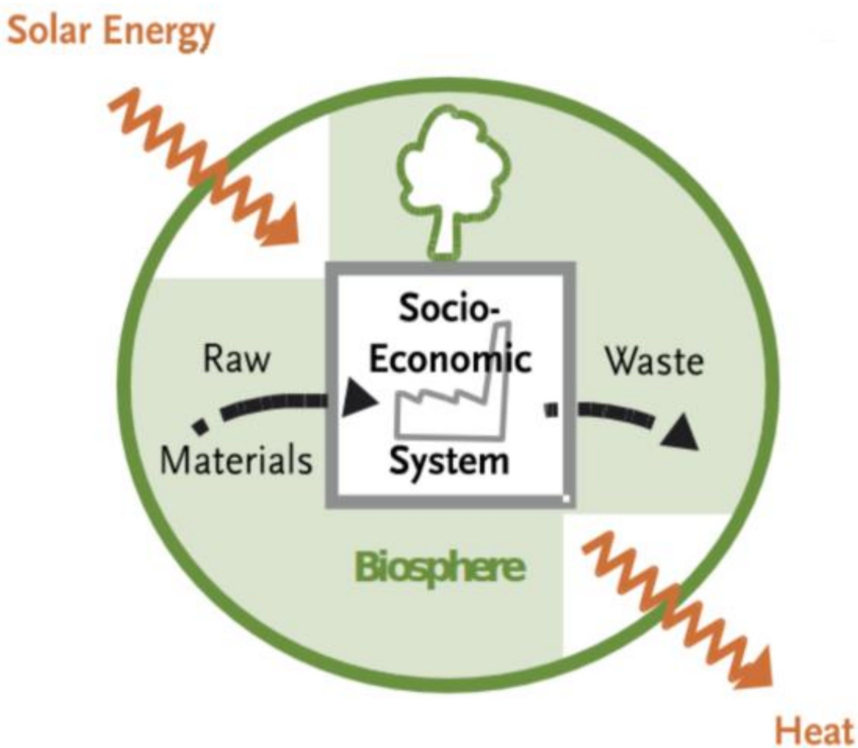
6. Asociatia "Societatea pentru Consum Responsabil" (Romania) – Partner

Objective

The SUSTAIN project's overall objective is to commence and promote sustainable literacy among students of higher education (and young people in general) through an innovative and student-centered education.

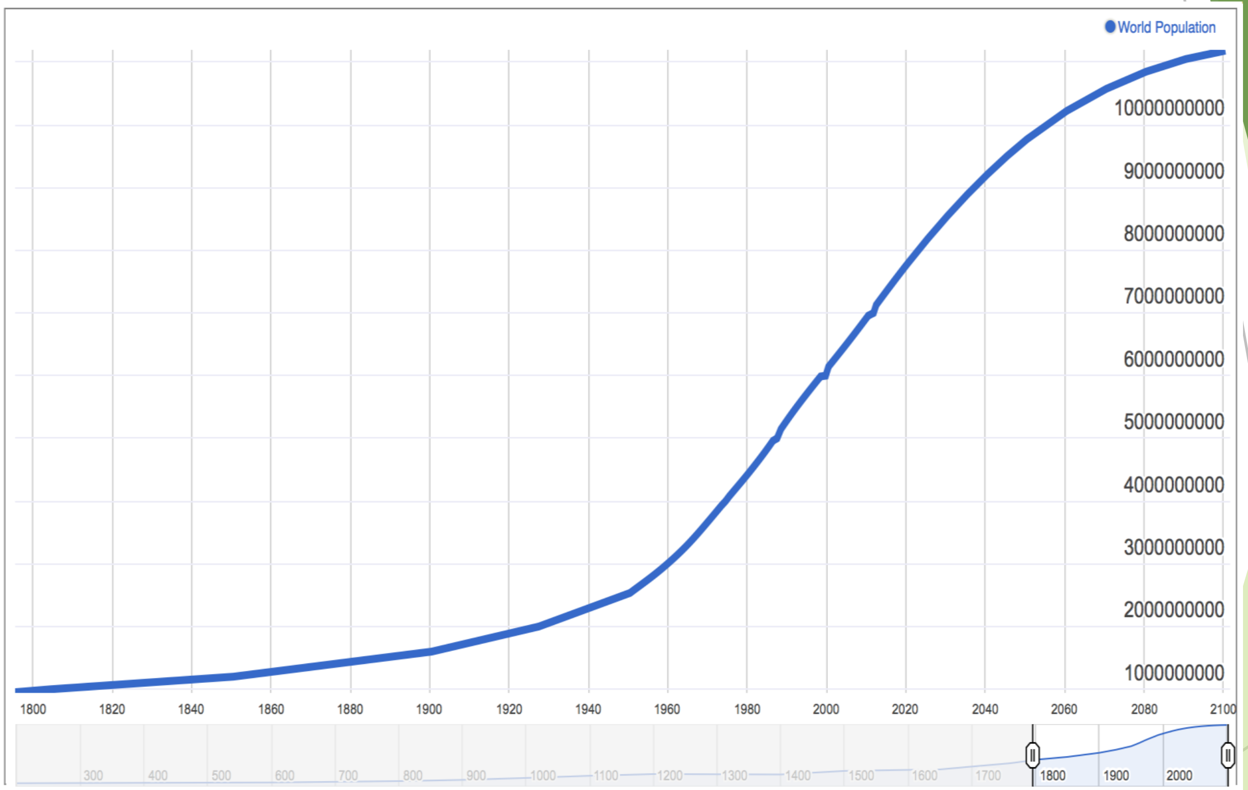


Societal Metabolism

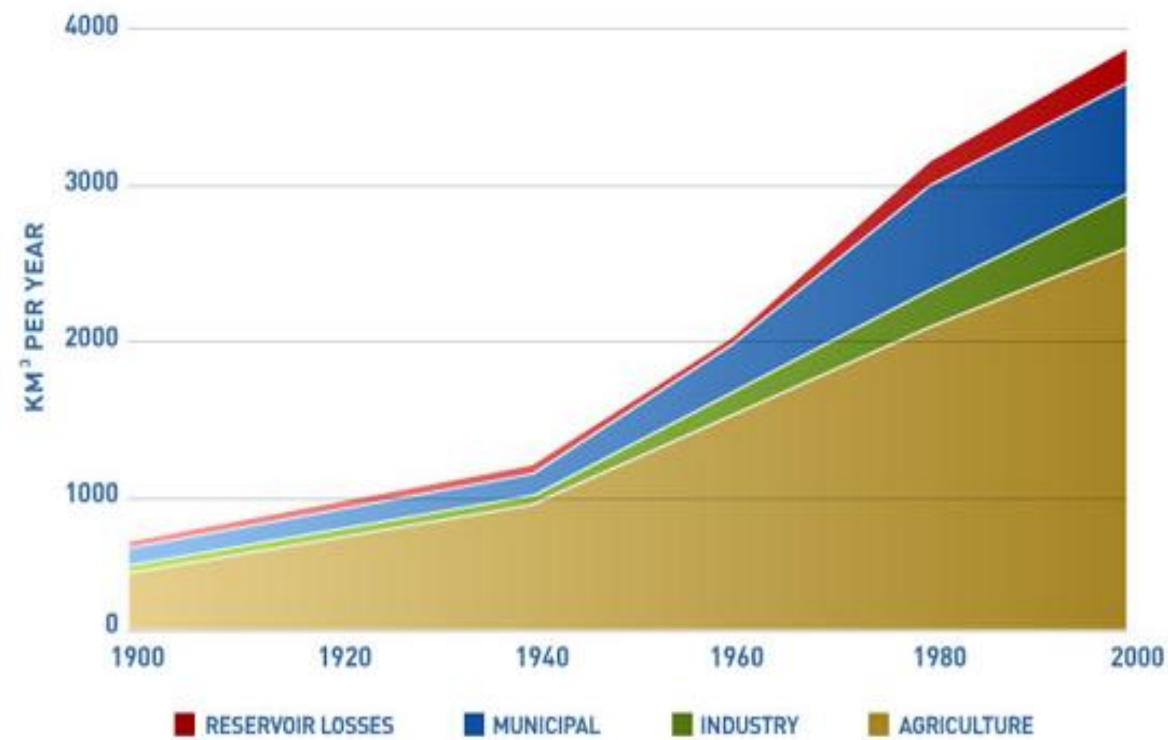


Social metabolism describes the exchange of energy and materials across social and environmental systems

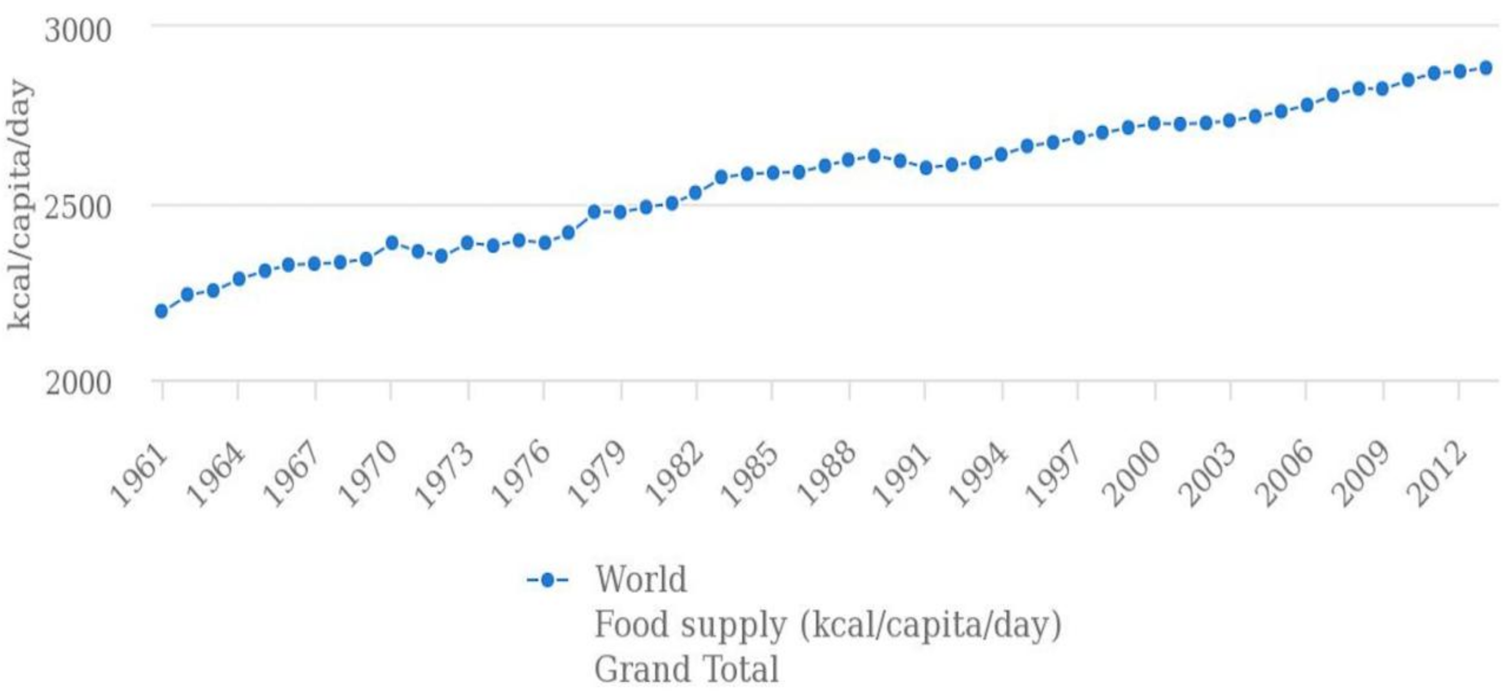
Change in world population throughout history



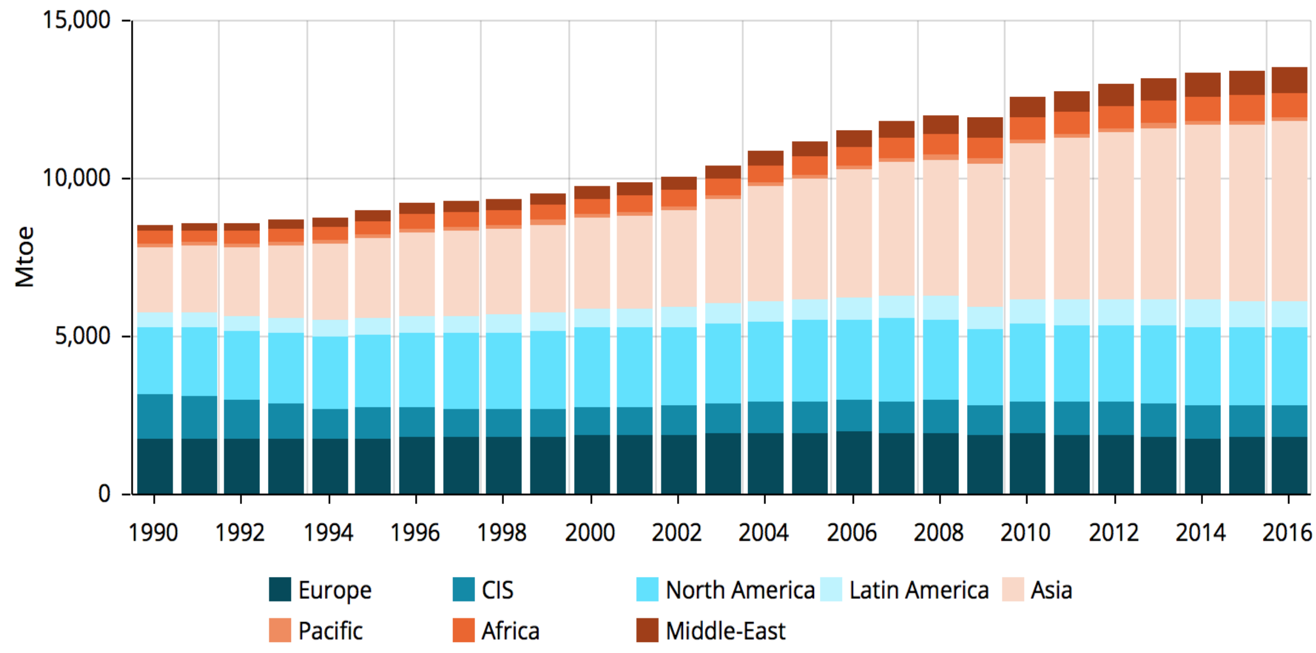
Estimated global water use from 1900 to 2016



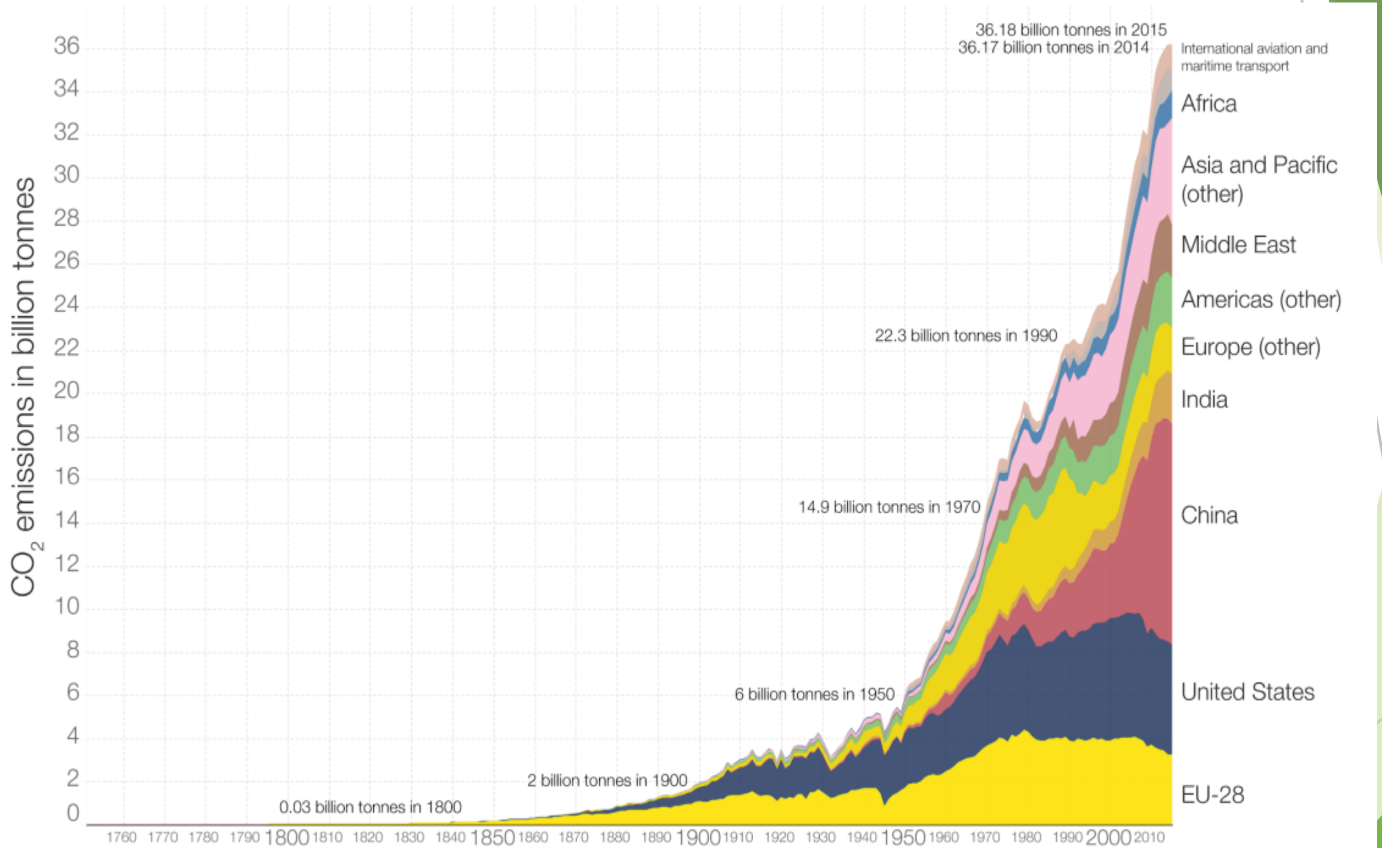
Food supply in the world from 1961 to 2012, expressed in kcal produced per capita per day



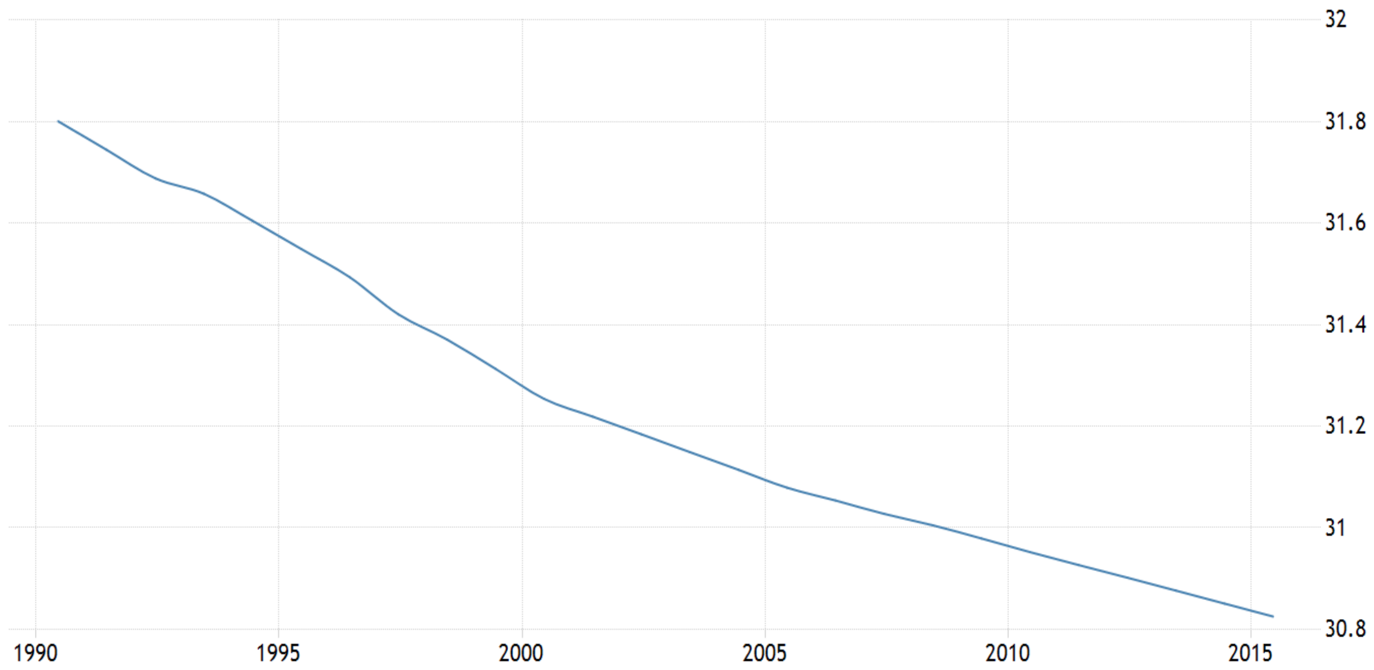
Global energy consumption trend from 1990 to 2016

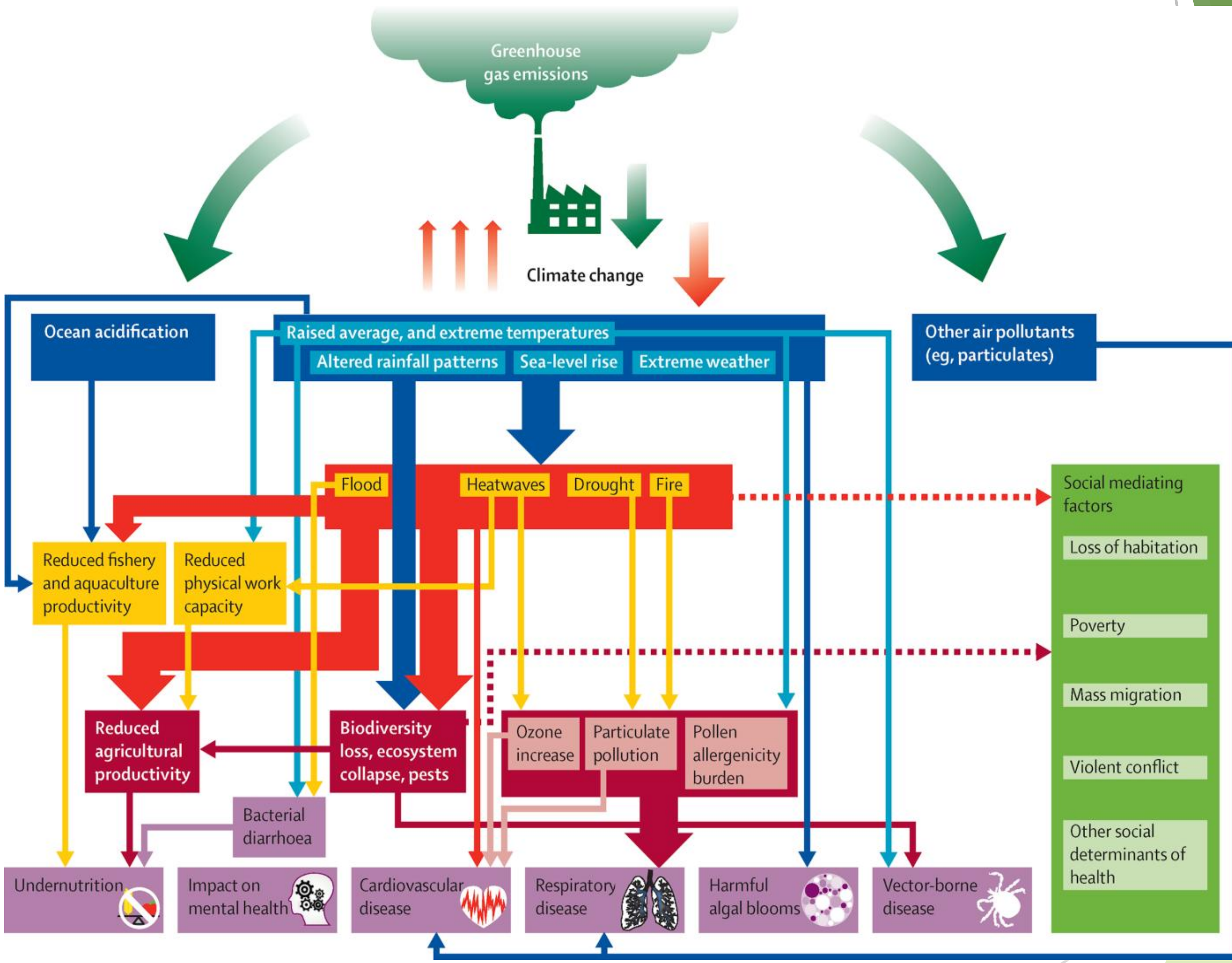


Global CO2 emissions by world region from 1751 to 2015



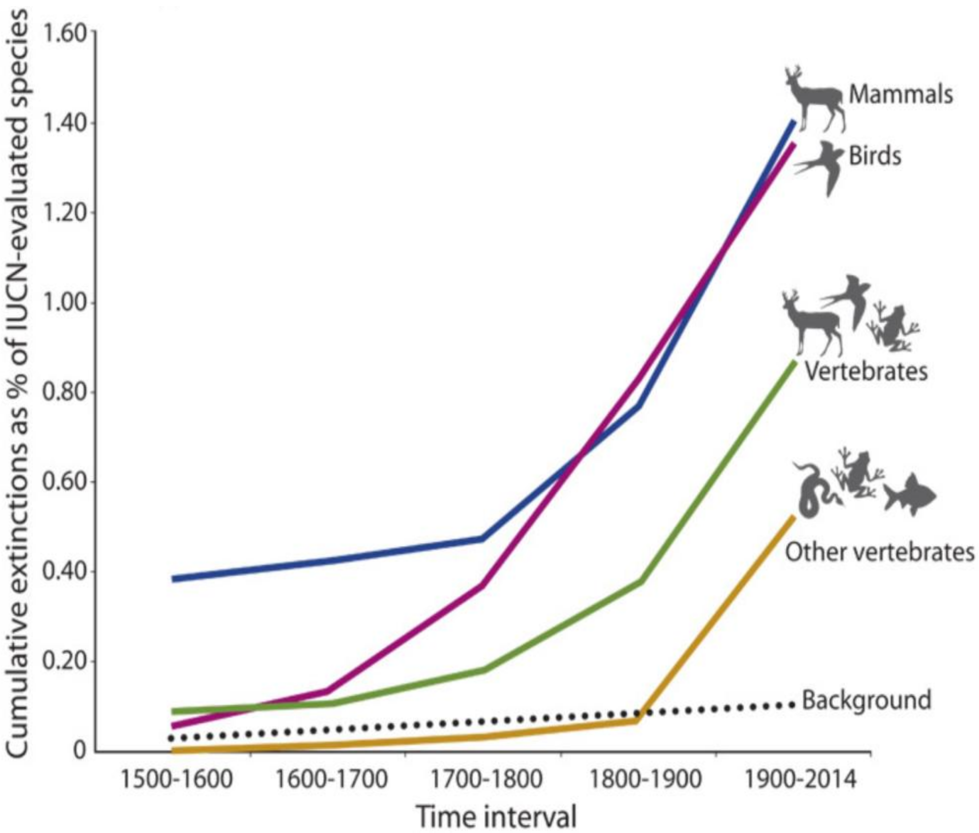
Forest area as % of land area in the World was reported at 30.83 % in 2015. The graph illustrates the decrease in forested area in the world between 1990 and 2015.





Greenhouse gas emissions
Climate change
Ocean acidification
Raised average, and extreme temperatures
Altered rainfall patterns
Sea-level rise
Extreme weather
Other air pollutants (eg, particulates)
Flood
Heatwaves
Drought
Fire
Social mediating factors
Loss of habitation
Poverty
Mass migration
Violent conflict
Other social determinants of health
Reduced fishery and aquaculture productivity
Reduced physical work capacity
Reduced agricultural productivity
Biodiversity loss, ecosystem collapse, pests
Ozone increase
Particulate pollution
Pollen allergenicity burden
Bacterial diarrhoea
Undernutrition
Impact on mental health
Cardiovascular disease
Respiratory disease
Harmful algal blooms
Vector-borne disease

Cumulative species recorded as extinct by IUCN (2012).



Objectives of this Module

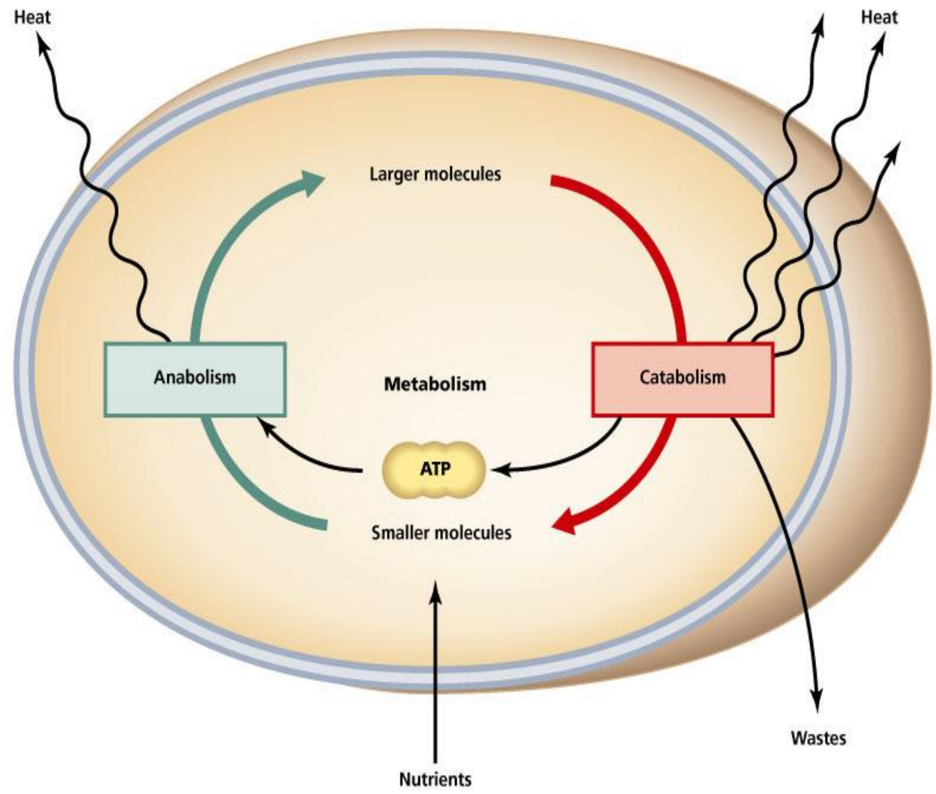
The purpose of this module is to help students better understand the complexities of modern urban systems. Going through this module, the students will be:

- Introduced to main definitions used in the societal metabolism analysis, and familiarized with these definitions through examples of and inference from real-life applications.
- Presented with displays and descriptions of formal theoretical models based on real-life cases. This should help them understand how these theoretical notions can be translated to elements of everyday life, and make it easier for students to transfer/translate them to any context.
- Acquainted with the rationale and the concepts that are in the background of the SUSTAIN game.

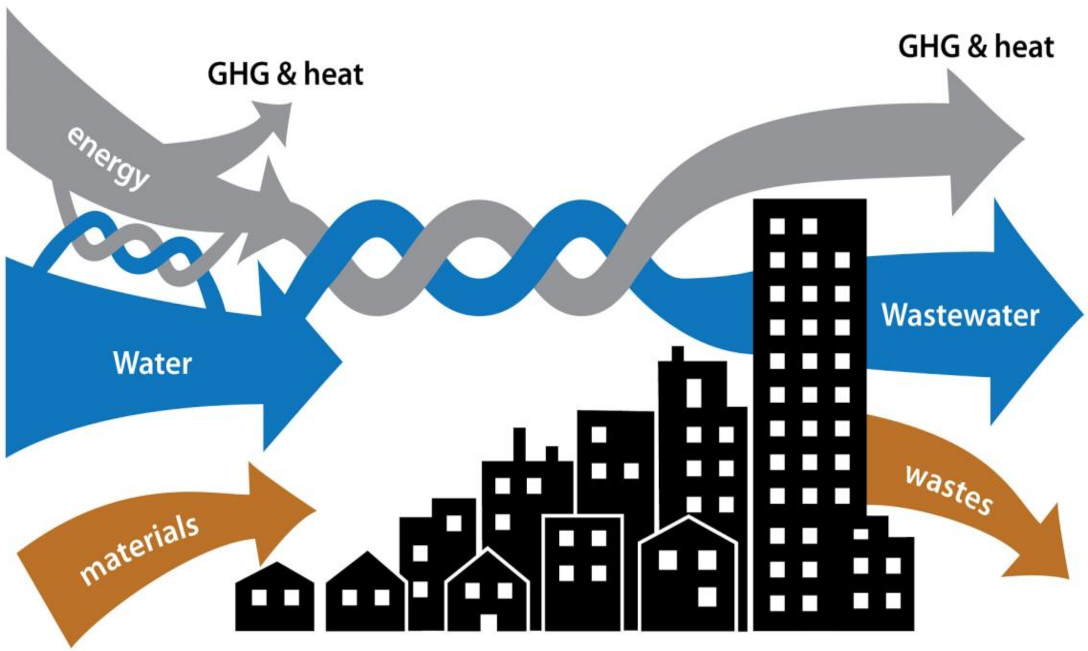
Understanding the Key Terminology in this Course

- Societal Metabolism
- Urban Metabolism
- Stocks
- Flows of materials
- Flows of Energy
- Environmental Impact
- Sustainability
- Systems Thinking
- Circular Economy
- Sustainable Urban Mobility

A simplified graphical representation of metabolic process in a cell

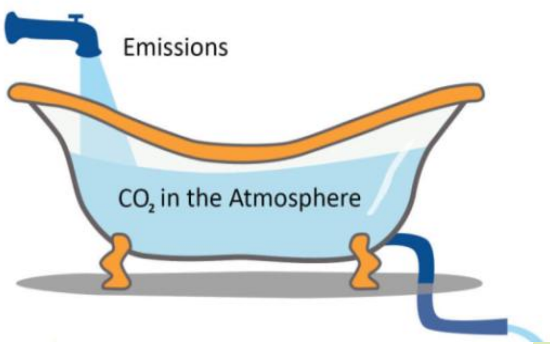


A simplified representation of urban metabolism model as an application of societal metabolism framework at an urban level



A bathtub with water is an example of a stock/an accumulation of water

The atmosphere is a stock of CO_2 in the same way in which a bathtub is a stock of water



Flows of material (and energy) through an urban settlement

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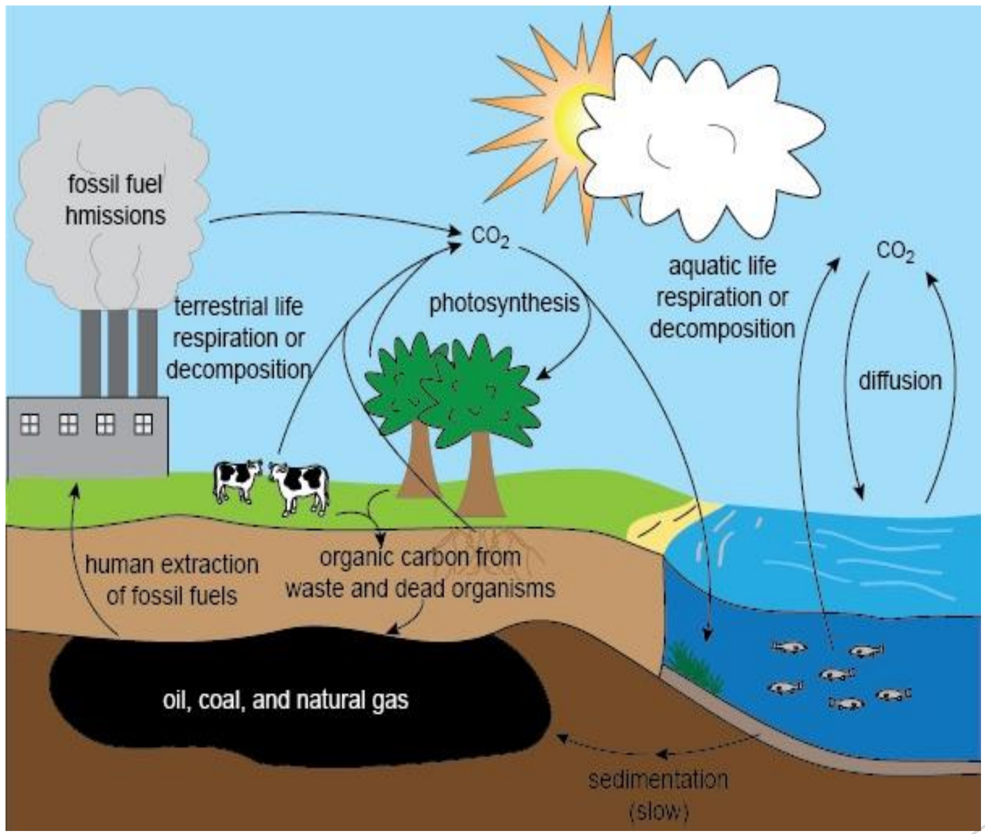
Carbon cycle is an example of continuous and complex flows of carbon in various forms throughout across the globe



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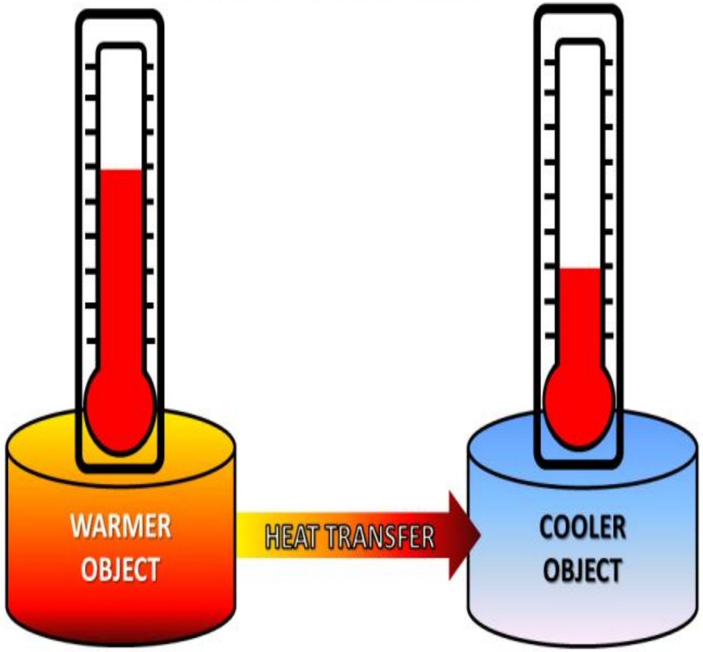
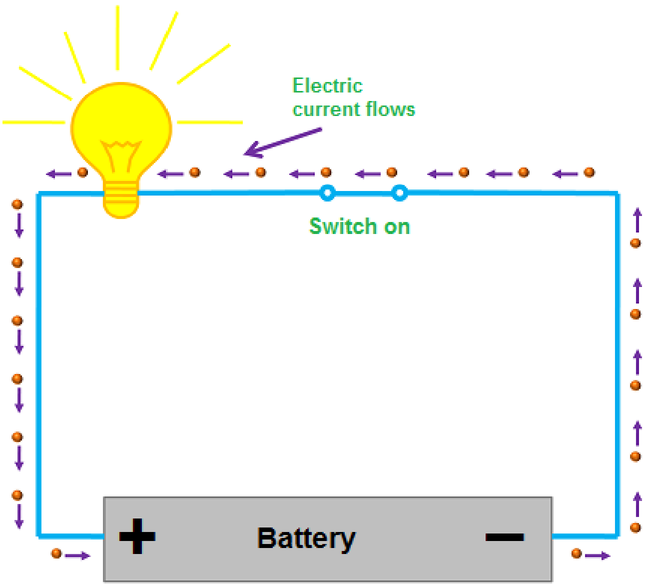
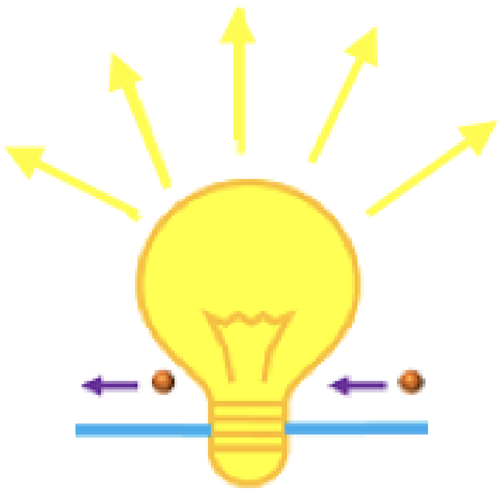
Heat transfer is an example of flow of thermal energy



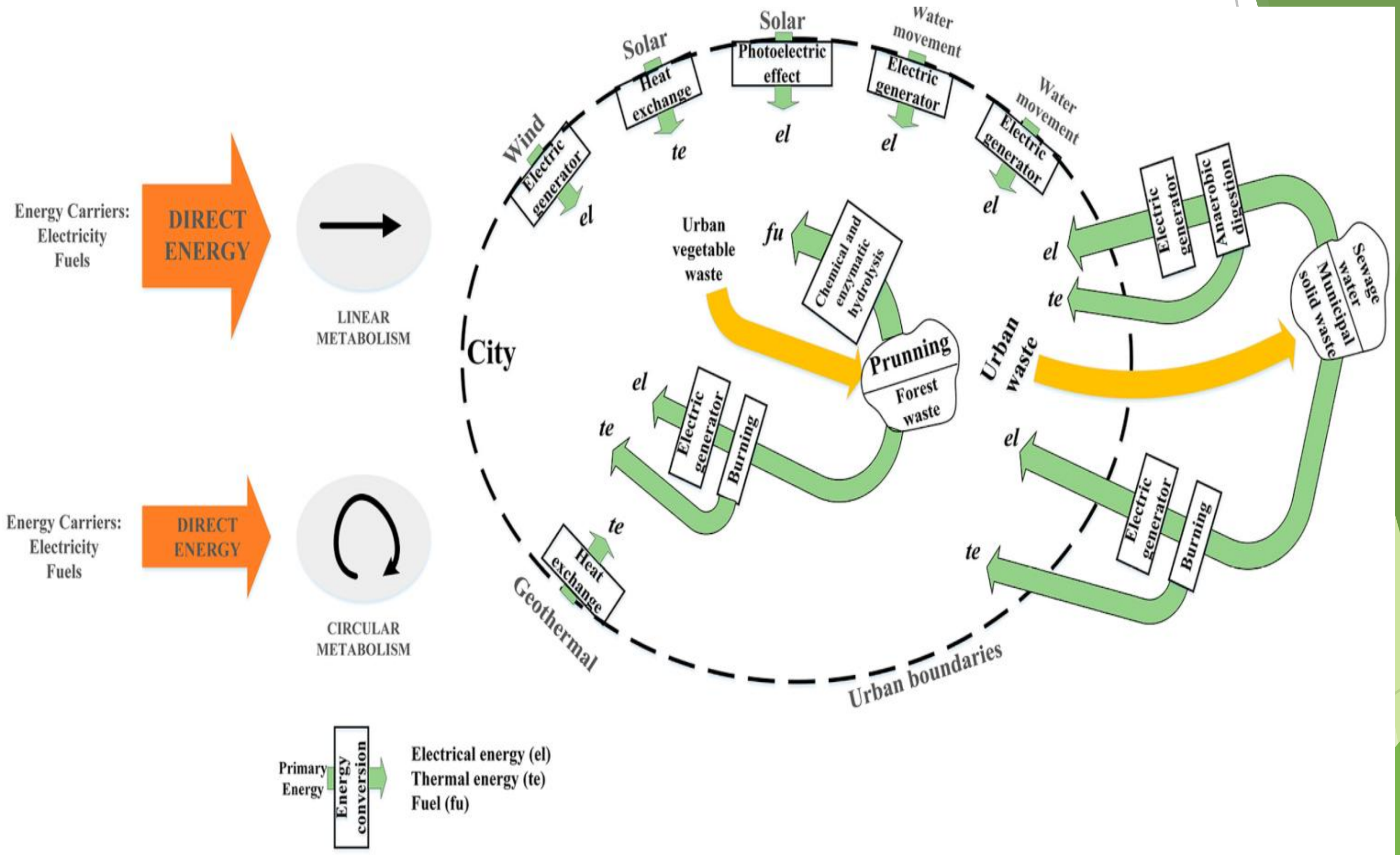




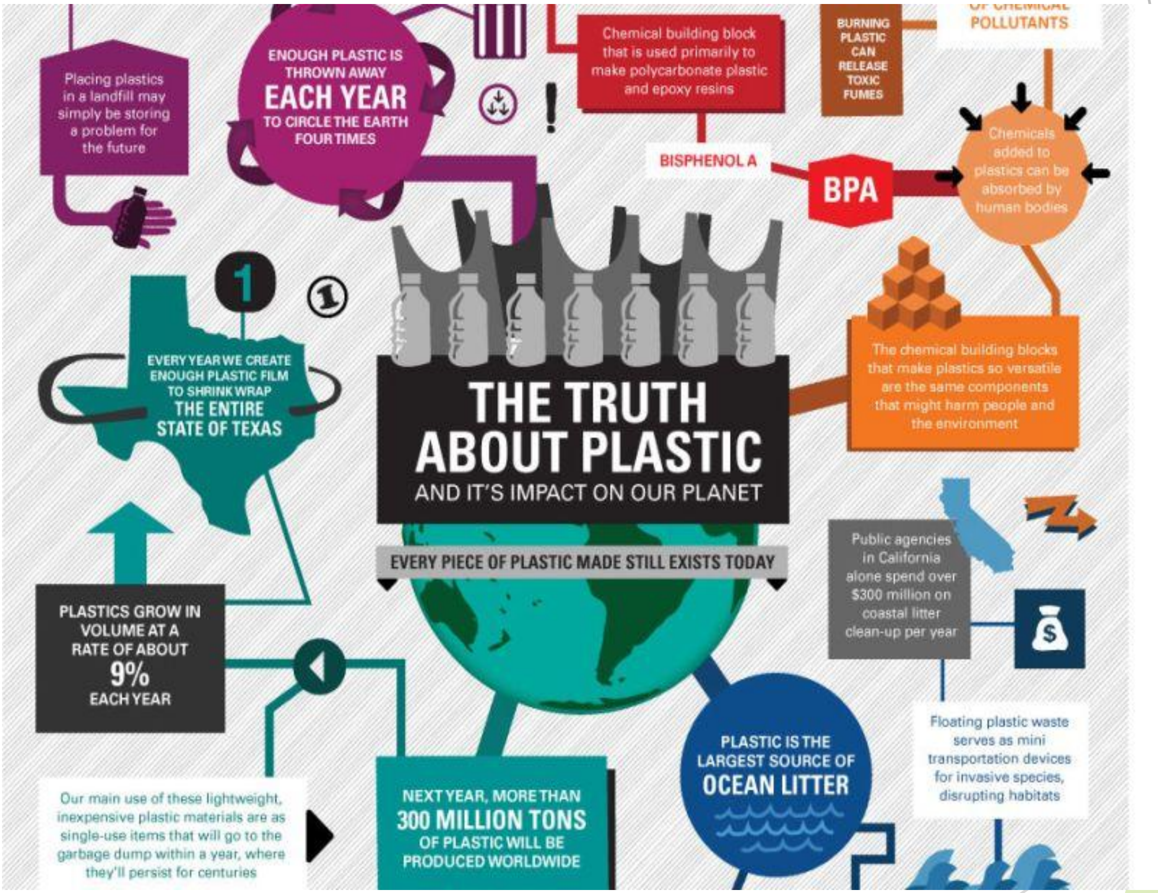
Electric current flow is another example of flow of energy.

The light bulb transforms (metabolises) electric energy flow into light energy, which flows out to light up the surroundings

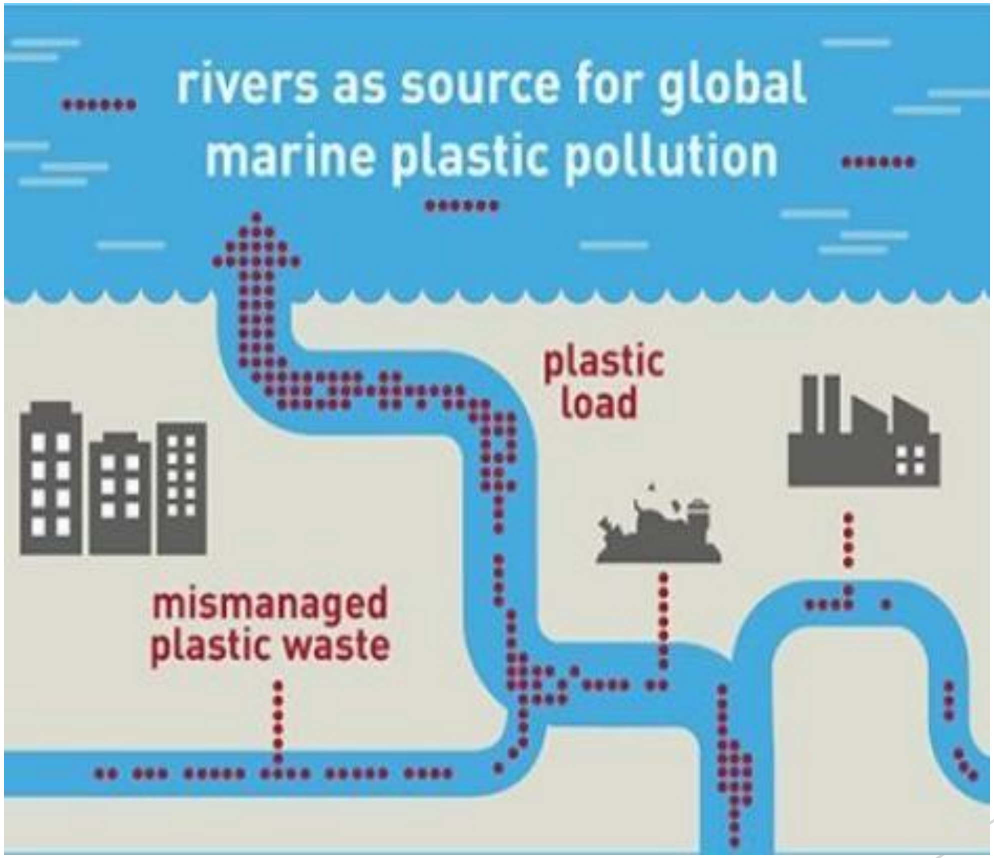
Electric current flow is another example of flow of energy



Environmental Impact
Example 1 - Plastic pollution



Plastic pollution is one example of environmental impact. Mismanaged plastic waste ends up in rivers, seas and oceans



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Sustainability

Sustainability is the ability of something to be maintained at a steady level without exhausting natural resources or causing severe ecological damage. It also means that something can keep going, can continue into the future and go on forever. From a human perspective, sustainability for our planet means that it can continue to provide fresh air, clean water, produce food, and allow us all to have a high quality of life indefinitely.

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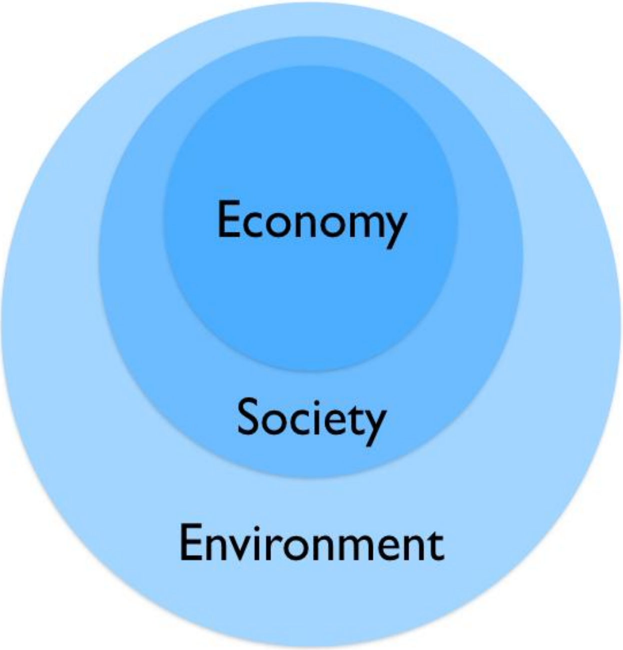
Three pillars of sustainable development: a safe and healthy environment supports the development of human society. A healthy society is the basis of a healthy economy



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Sustainable Development Goals (SDGs) are part of the new sustainable development agenda adopted by countries on September 25th 2015

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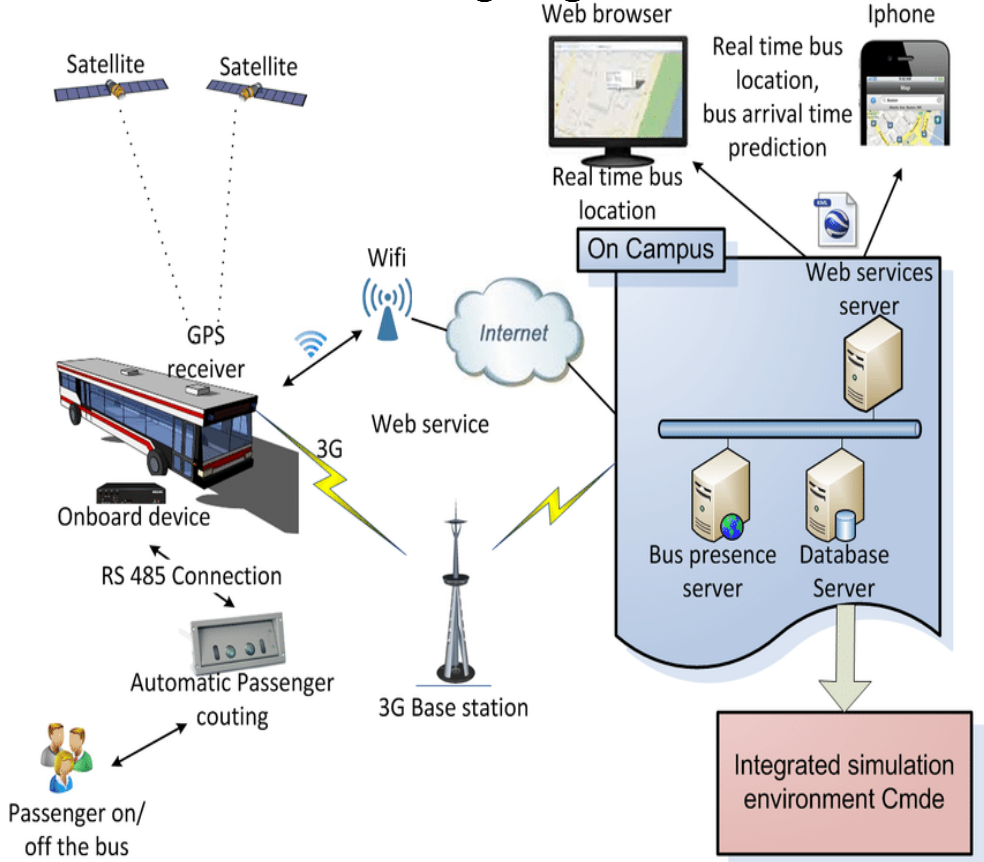
Systems thinking: Advanced public transportation system architecture for Wollongong, Australia



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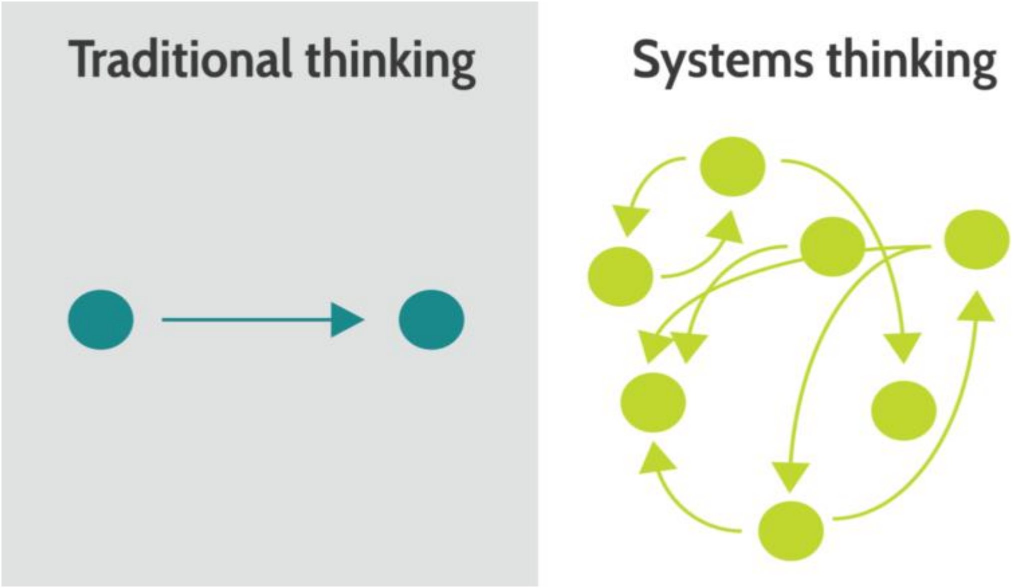
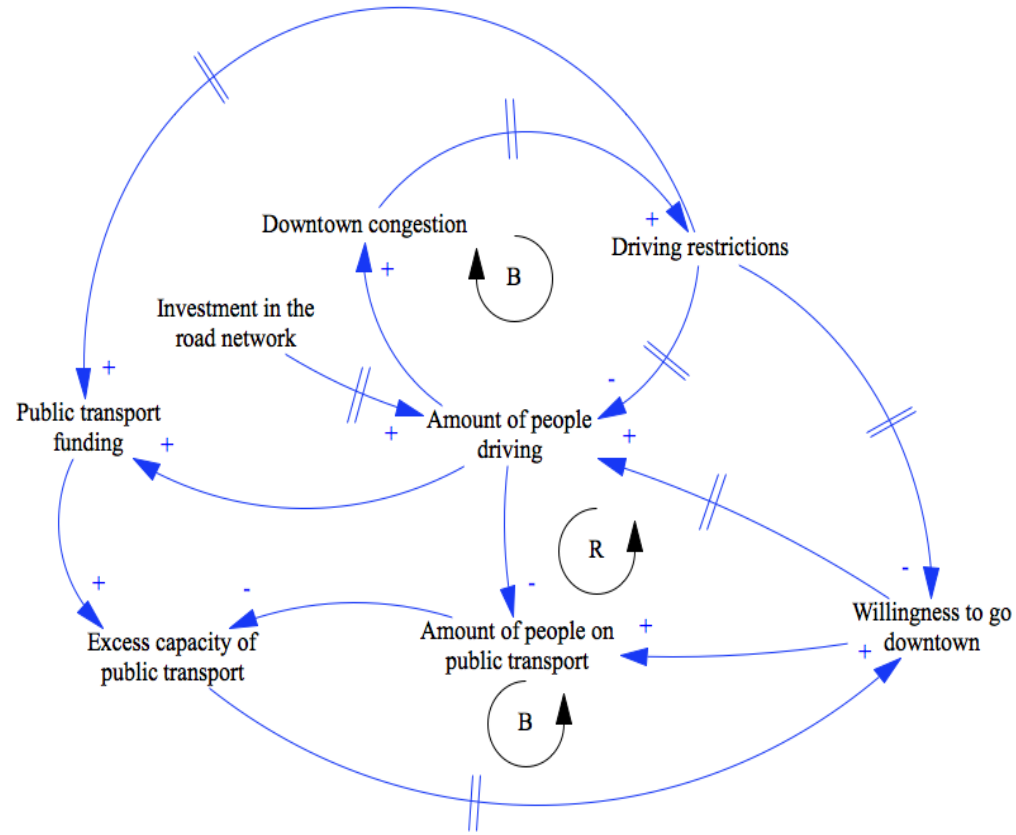

Traditional thinking
Systems thinking



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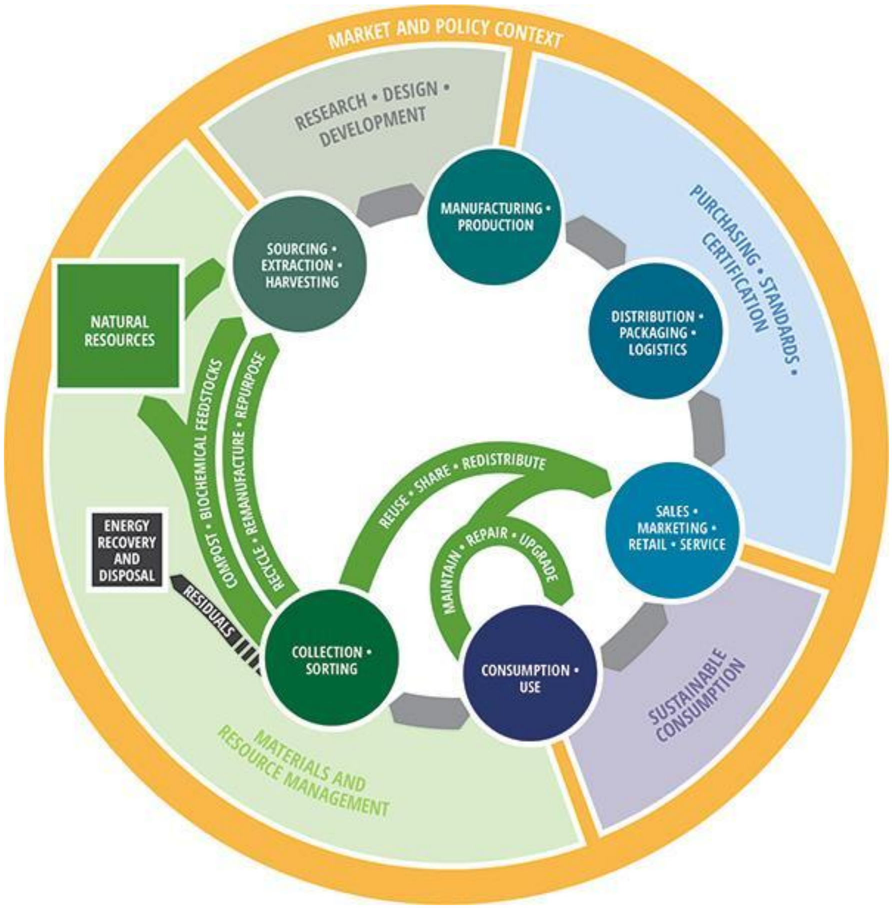
Circular economy



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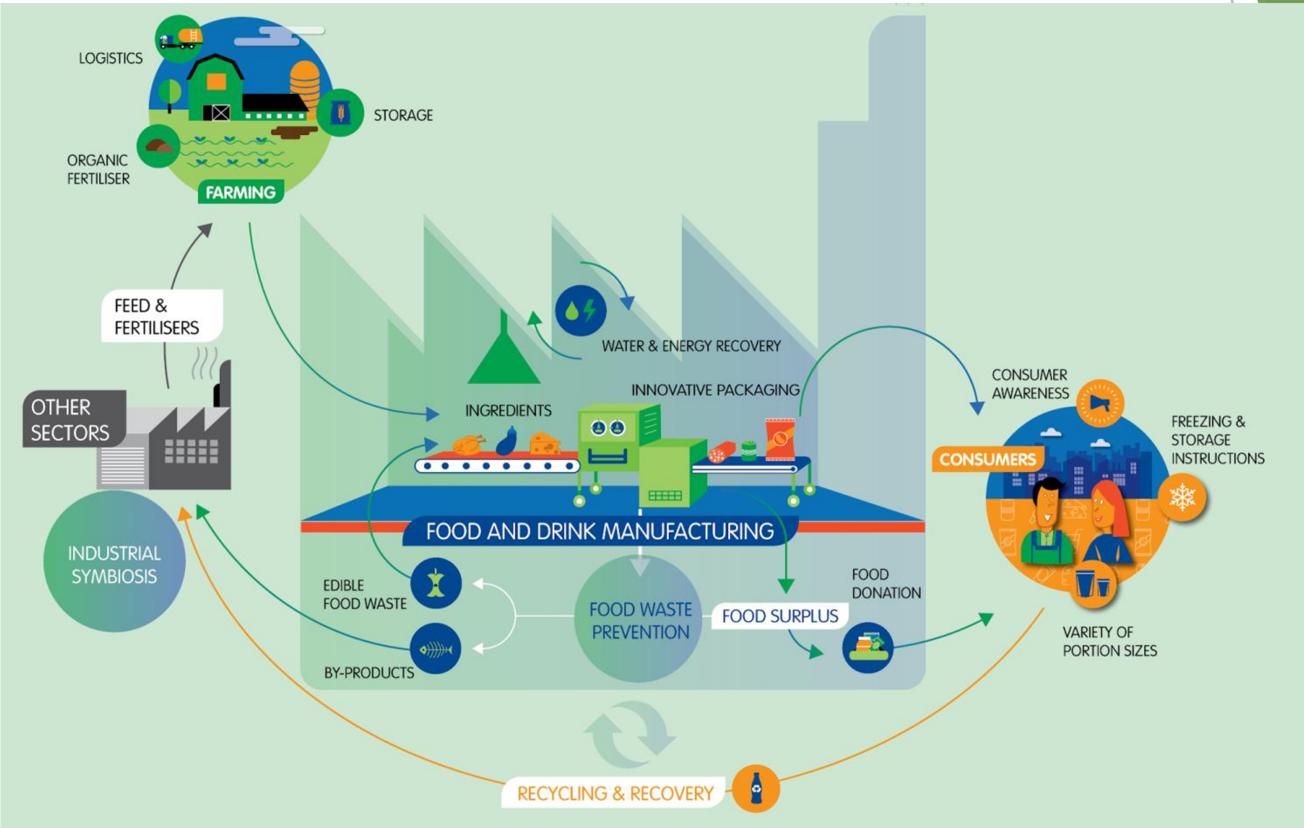
Enhancing a resource-efficient, circular economy in the food and drink industry



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Connecting the Societal Metabolism approach to real life examples

Example of unsustainable practices: Fossil fuel transport

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Terminology:	How to apply the key concepts when analyzing the practice?
Urban metabolism	Fossil fuel is metabolized into air pollutants, including greenhouse gases (GHG) (carbon monoxide, nitrogen oxides, volatile organic compounds including hydrocarbons). To identify where we can inter look at what the fossil fuel is used for, when it is being used, what is it decomposed into (e.g. cars burn the fuel and generate emissions), etc.
Stock	Fossil fuel accumulates in the city as substance (petrol, gas for cars) and/or energy (kCal, KJ, etc.)
Flow of materials (Material flow)	To understand what are the sources of pollution, it is needed to investigate how fossil fuel is brought into the city, how much of it is brought in per month/year. Then, one looks at what goes out from the city as a result of its urban metabolism (e.g. tones/year of emissions).

Flow of energy	It is needed to take a look at how much energy the amount of fossil fuel brought into the city can generate, and then look at how that energy goes out from the city as a result of its urban metabolism (e.g. tones/year of thermal energy/ heat that warms up the environment).
Environmental Impact	This is a qualitative metric, defined by looking at what are the negative and positive impacts of the use of fossil-fuel based transport. E.g. CO2 emissions contribute to climate change. Thermal energy (heat) can create “heat islands” in the cities. Particulate matters (e.g. PM5, PM10) contributes to air pollution.
Sustainability	This characteristic of the practice of using fossil fuel in transportation is defined by analyzing if the use of fossil fuel based transport can be sustained into the future. Can it be carried on indefinitely? Or is there a limitation for its use (e.g. time, resources) ?

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Systems thinking	When analyzing urban metabolism and sustainability of fossil-fuel based transport, a systems way of thinking looks at the means of transport that use fossil fuel, people that use personal cars or public transport, etc. as components of a system. At the same time, this requires looking at the linkages and interactions between the components. Some examples include: decisions that people take to use cars or transport; what increases the attractivity of fossil-fuel based cars compared to electric cars or public transport, how the price of fuel and the regulations of city councils influences the amount of fossil fuel consumed by city inhabitants, etc.
Circular economy:	In contrast to the common, linear economy (i.e. materials in - waste out), by adopting this perspective, one looks into what can be done to reduce the amount of fossil fuel consumed and the waste generated, as well as how to reintroduce the waste into the economy of the city as a reusable material/resource. For example, one way to reduce resource consumption and waste would be to share rides. However, the waste generated by burning fossil fuel (PMs and CO_2) cannot be reintroduced in the economy. This is one of the reasons why fossil fuel based transport is considered unsustainable.
Sustainable urban mobility	From this standpoint, one needs to look at what are the more sustainable alternatives to fossil-fuel based transport. Some examples may include: electric public transport (tramways, trolley buses, trains, etc), bicycles, or walking.

Examples of practices that contribute to sustainable urban metabolism:

Ecopixel - Recycled and Recyclable Plastic

Terminology:	How to apply the key concepts when analyzing the practice?
Urban metabolism	Human society consumes/metabolizes the Low-Density Polyethylene (LDPE) waste-material in order to obtain a new recycled and recyclable material that can be used for different products. The raw material used for ECOPIXEL comes from industrial waste or from any other field including household-waste. The waste material is shredded, melted at a low temperature and re-transformed into products used by the urban community.
Stock	The accumulation (stock) of plastic waste in a city is increased through generation of waste by urban population, and is decreased by disposal, incineration or recycling of plastic waste. In this example, the stock of plastic waste is significantly reduced due to the fact that the waste material is recycled, and the generated product is still recyclable at the end of its life.
Flow of materials (Material flow)	When looking at the dynamic of plastic waste in a city, one can identify the input of goods (plastic goods, packaged non-plastic goods) into the shops and markets of a town as inflow of plastic material. Once consumed, the generated material can be considered as an outflow of waste from households. Within the manufacturing process of ECOPIXEL production, the flow of material can be visualised as follows: Inflow: 'raw' waste material; Outflow: products manufactured from recycled plastic.

Flow of energy	One way of looking at flows of energy in this example is by considering that to recycle the plastic material product, manufacturers consume energy. For example, there is an inflow of electric energy to the recycling and manufacturing machines in order to keep them functioning. There is also an inflow of heat to melt the plastic. Depending on the production process, the outflow can be either as heat, as well, or/and as chemical energy binded into the recycled plastic product.
Environmental Impact	Some non-exhaustive examples of analyzing the environmental impact of ECOPIXEL during its lifecycle include: ● Using material composed of 100% recycled Low-Density Polyethylene (LDPE) reduces the need to generate new raw material from petrol → minimizes impact on finite natural resources; ● Recyclable material that can be remelted multiple number of times without altering its properties → minimizes generated waste; ● Using waste as raw material for production of consumer goods provides an alternative for plastic incineration or storage → minimizes pollution of the environment with plastic materials.

Sustainability	Plastic waste recycling into new plastic objects answers the needs of consumer society without needing new, finite raw material resources to be extracted. It also provides a solution for waste management that can be repeated multiple times into the future. In addition, the resulted products can be further recycled at the end of their lifetime, which makes this practice a sustainable one.
Systems thinking	Systems thinking means that one looks at the connections and the implications of plastic waste materials and the changes that ECOPIXEL is bringing. What causes and consequences are there for generation of plastic waste? What are the stocks and flows of materials in this process? What are the factors that influence the generation and recycling rates of plastic waste? Are there "side-effects" of plastic generation and recycling process that have an unexpected effect on the system? - these are some of the questions a systems thinker would look at.

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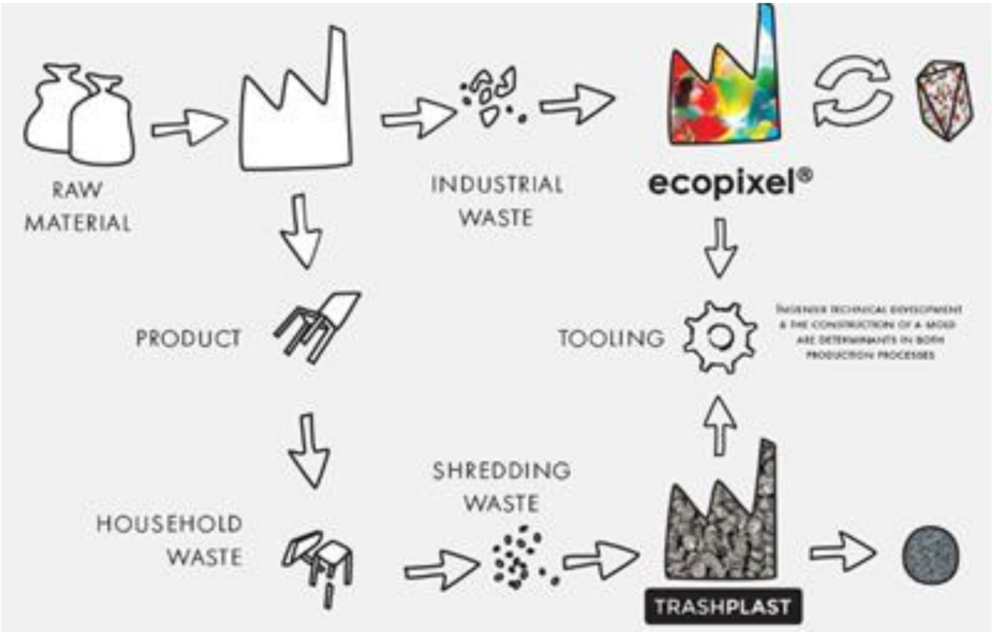
Circular economy:	ECOPIXEL collects, separates, chips into pieces and re-transforms into products what others throw away. It is made from ‘raw’ waste material that can be reintroduced into the economy nearly infinite number of times, thus creating a continuous cycle in material-use



Example 2: Every Can Counts

Organization or Company: AluPro

Terminology:	How to apply the key concepts when analyzing the practice?
Urban metabolism	The beverage cans are introduced in urban societies as packages for various sorts of drinks and foods. As the packed goods are consumed, the cans are discarded as waste. AluPro is an initiative to transform this waste into new recycled cans.
Stock	There are a number of accumulations in this process, for example: stock of canned beverage, stock of cans discarded as waste, stock of recycled cans, and others. The stock of aluminium waste is increased by the consumption of aluminium-packed beverage, and decreased by incineration or recycling.
Flow of materials (Material flow)	Inflowing can-packed beverages determine how much potential aluminium waste will be generated after product consumption. Similarly, once generated, the discarded cans enter the recycling process. At this stage, discarded cans are both outflow from the consumers, as well as inflow for the recycling process. It takes only 60 days for a single aluminium can to be produced, filled, distributed, consumed and recycled into a new can.

Flow of energy	Recycling aluminium uses only 5% of the energy needed to produce it from virgin materials, reducing greenhouse gas emissions by 95%. By recycling the aluminium, we reduce the need for additional energy to produce new cans. Thus, the required inflow of energy with in process is reduced.
Environmental Impact	Aluminium is valuable at every stage of a product's life cycle - from production to end of use. It can be repeatedly recycled while keeping the properties of the recycled material. Using recycled aluminium reduces the need for primary aluminium and therefore minimizes need for mining for aluminium ores and avoids finite resource depletion, minimizes waste, and lowers greenhouse gas emissions across a product's life cycle.
Sustainability	This program is trying to provide a more environmentally and economically-friendly alternative to the depletion of natural resources and mining that has often caused ecological damage by exploiting raw aluminium ores. If pre-treated and/or sorted, aluminium products can be recycled for use in almost all aluminium applications since the metal's atomic structure is not altered during melting. Aluminium recycling benefits present and future generations by conserving energy and other natural resources.

Systems thinking	A systems thinker would look not only at what generates the waste and what is the output of waste generation directly and try to tackle the problem of excessive waste from this perspective solely. Instead, looking at aluminium waste from beverage products in a systemic way, one would seek to understand what is the pathway of aluminium throughout the urban system. For example (but not exhaustively): Who generates it and how much of it is generated? What is the capacity to generate aluminium from raw materials/mining? What could be alternative uses? How much of it can be potential input for a recycling process? What would be a reasonable recycling rate given the waste generation rate? How would aluminium be best reintroduced in the economy?
Circular economy:	Aluminium is a material that can be melted and remolded (i.e. recycled) multiple times. In this way, its inherent properties do not change during use and following repeated recycling into new products. Encouraging recycling of aluminium cans is thus one way to achieve a circular economy, whereby waste is regenerated as new products.

Looking at examples around us - case study from our local reality

Exercise type: group work.

Task: In teams of 4-5 people, identify an example from your local community or country that exemplifies a sustainable/ less sustainable case of urban metabolism. Explain why is a good/bad practice. In your arguments make use of:

- The definitions used in the course;
- Data from official sources (e.g. UNEP; website of environmental agency; reports from WHO, country statistics, etc).

Output: Prepare a minimum 1 page - maximum 5 page team report and share the findings in the class in a 5 minutes presentation.

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Thank you!

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