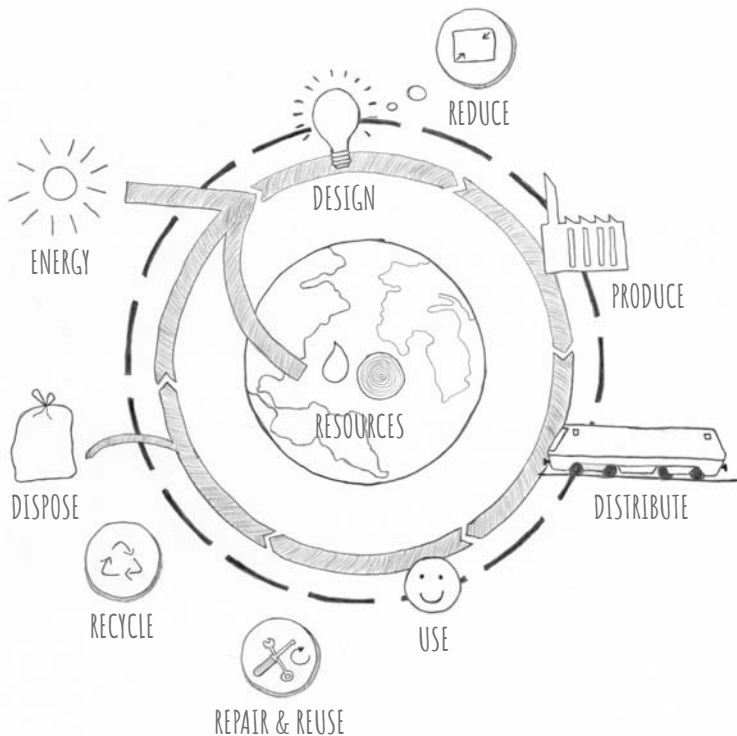


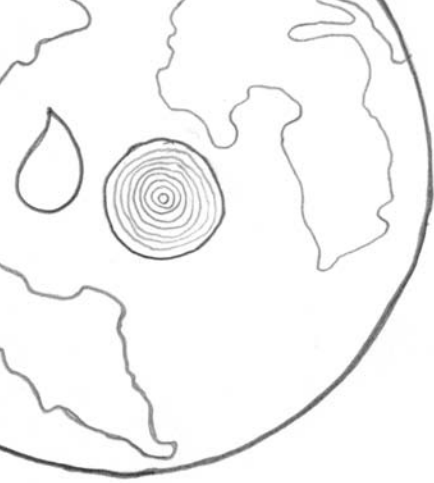
LACE knowledge transfer note n° 1

# A Circular Economy within Planetary Boundaries

An interdisciplinary research team develops  
a robust definition of a sustainable and resource-based  
circular economy



Original paper reference:  
Desing, H., Brunner, D., Takacs, F., Nahrath, S., Frankenberger, K., & Hischier, R. (2020). A circular economy within the planetary boundaries: Towards a resource-based, systemic approach. *Resources, Conservation and Recycling*, Volume 155, April 2020, 104673. <https://doi.org/10.1016/j.resconrec.2019.104673>



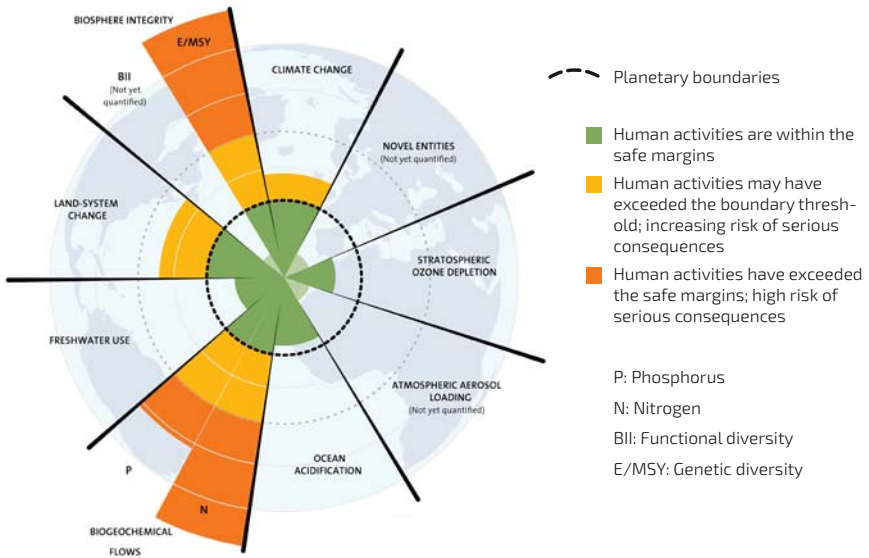
## A Circular Economy within Planetary Boundaries

Many companies, states, regions or cities are currently adopting circular economy (CE) strategies and implementing CE initiatives. To take but one example, the European Union is currently implementing a new [Circular Economy Action Plan](#) that gathers numerous measures all along the life cycle of products, from ecodesign to waste management. Yet, beyond the current popularity of CE, the meaning and end destination of this transition often remains vague. Are all these efforts towards more circularity enough to reach a truly sustainable economy operating within **planetary boundaries** (see box p. 3)? And how can an individual actor such as a company be sure to move in the right direction?

These questions are at the core of this sci-

entific paper published by the [Laboratory for Applied Circular Economy \(LACE\)](#), an interdisciplinary research project from the National Research Programme “Sustainable Economy” (NRP 73). The paper offers a new definition of CE as an economy directed towards human well-being, while operating within clear physical and environmental limits. In view of an optimal use of the earth’s limited resources, it also discusses three guiding principles and the idea of a resource budget for individual actors. The implementation of such an approach is finally discussed, implying major changes in current production methods and consumption patterns, but also deeper consequences from a socio-economic, legal and business perspective.

## What are the Planetary Boundaries?



The [planetary boundaries framework](#) identifies a safe operating space for societal development in the long run (in green). This space is stable and ensures the viability of the Earth for humans. Beyond these biophysical boundaries, the Earth risks moving in a different state where rapid and violent environmental changes are likely (in yellow, as for climate change and land-system change for instance). Staying within the safe operating space means that human activities need to stay within the biophysical capacity of our one and only planet.

Credit: J. Lokrantz/Azote based on Steffen et al. 2015.

## Which Resource-base for a Circular Economy?

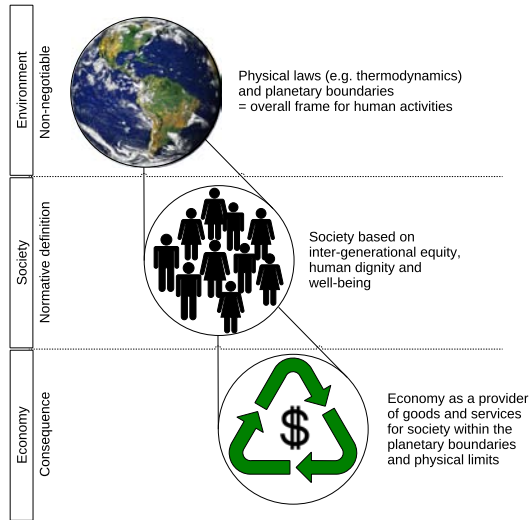
How does a sustainable CE thus look like? First and foremost, it is an economy that does not use more of the Earth's resources than are required for ensuring the long-term survival of humanity. It means that there are absolute limits defining a "resource base" into

which humans can tap and that can be quantified. Referred to as planetary boundaries, these limits are considered as non-negotiable in two related ways. Firstly, any activities conducted in the economic and social spheres are to be hierarchically submitted to envi-

ronmental limits. Secondly, any violations of these limits mean that activities cannot be considered sustainable because they jeopardize the basis for life of current and future generations. At the level of individual actors

such as a company or a country, the key to a sustainable CE therefore lies in deriving all the business and socio-economic decisions from the global limits of the Earth system (see figure below).

The three-layer framework for a resource-based circular economy (from the authors).



## Principles for an Efficient Use of Available Resources

Once these limits are set, how can we use available resources as efficiently as possible? What principles can guide our activities and

the development of a CE? Three main principles are outlined in the paper.

1

***The use of resources should aim at minimizing entropy production*** (see box p. 5).

The idea of CE is often seen as allowing materials to be cycled indefinitely, the plastic of a bottle being recycled and used in another product for instance. Yet, because of inevitable loss and degradation processes, material cycles cannot be fully cycled,

and virgin materials need to be added in the manufacturing process. As every step in a product life cycle produces entropy, the design of products and end-of life strategies should be guided with the aim of reducing entropy production and keeping resources at the lowest state of entropy as long as possible.

2

***Durability and longevity are key to preserve material value.***

Since material cycles cannot be fully cycled, the faster a product needs to be replaced, the more material is lost to provide the same service. Hence, an important principle of the CE is to slow cycles, which means, to extend the lifespan of products through ecodesign, maintenance, reuse, repair or refurbishing activities for instance.

3

***The use of resources needs to be optimized in order to sustain the resource base.***

Materials and energy are available in limited quantities. It is therefore critical to decrease material and energy use per product. This applies both during manufacturing and during the use-life of products, for instance through minimizing manufacturing wastes or the energy demand.

## What is Entropy?



Entropy is a term of thermodynamics and measures the state of molecular order in a given system. The entropy is low when the order is high, and vice versa. For instance, the entropy is low in a crystal structure, while it is high in a random distribution of molecules in gases or in demolition wastes. Take the image of tires: when we drive, tires get used and micro-rubbers end up in soils and water – a process of abrasion and entropy creation. While we could restore the original state of tires, it would require extravagant efforts and energy. Hence, minimizing entropy production means to conserve resources closest to their state of high order, or, in the case of products, keeping their functions or reusing them. This concept can help to choose between various options after the first life of a product: repairing a product usually retains more value than recycling it, i.e. it creates less entropy.

## Towards a Resource-based Definition of Circular Economy

Based on these principles and considering the physical and environmental limits discussed before, a new definition of CE is offered by the authors:

“ The circular economy is a model adopting a resource-based and systemic view, aiming at taking into account all the variables of the system Earth, in order to maintain its viability for human beings. It serves the society to achieve well-being within the physical limits and planetary boundaries. It achieves that through technology and business model innovation, which provide the goods and services required by society, leading to long-term economic prosperity. These goods and services are powered by renewable energy and rely on materials which are either renewable through biological processes or can be safely kept in the technosphere, requiring minimum raw material extraction and ensuring safe disposal of inevitable waste and dispersion in the environment. CE builds on and manages the sustainably available resources and optimizes their utilization through minimizing entropy production, slow cycles and resource and energy efficiency.”

This ambitious definition can be considered as an ideal version of CE, against which to benchmark and assess any CE initiatives, measuring progress and the degree of “circularity” that has been reached. It has wide implications and requires a profound shift in the way we integrate planetary boundaries into our socio-economic choices, business decisions and legal systems. For instance, **legal provisions** on resources often focus on end-of-life stages (waste collection, recycling, incineration...) and do not comprehensively cover all aspects of a CE. The legal framework therefore needs to shift further towards life cycle thinking, by putting products at the centre through their entire life phases and associated impacts (extraction of raw materials, processing, manufacturing, use, recycle, etc.).

More broadly, environmental considerations should be seen as integral parts and cross-cutting issues of all socio-economic regulations, not as a distinct compartment of the policy-making process. Hence, the sustainable resource base has to be regarded as the frame within which all decisions in every sector and activity must be made. This implies a shift from traditional market coordination mechanisms based on short-sighted and partial price signals, towards the prioritization of a sound resource management.

What does this mean for **economic actors**? The authors suggest the idea of calculating a resource budget that gives an indication of how much resources can be consumed within the planetary boundaries. From a business perspective, the profound

shift lies in the fact that the integration of a sustainable and limited resource-budget becomes a key factor in strategic decisions. Mobilizing resource-budgets could lead companies to convert sustainability challenges into business opportunities, most notably

through business model innovation processes. Hence, companies could play an important role in the transition towards CE if they voluntarily internalize resource-budgets into their business management strategies and in their business models.

## Conclusion

Overall, the paper by Desing et al. (2020) offers a robust and clear definition of CE embedded in a planetary sustainability perspective. This definition is an important milestone towards a systemic and interdisciplinary approach of CE. It clarifies the links between environmental, social and economic dimensions of CE. It also provides a better integration between the global level of analysis, i.e. global sustainable resource budget, and individual

actors, especially when it comes to determining how global budgets can be broken down at the level of countries, regions, companies, and individuals. Ongoing research by the LACE research team will elaborate on these questions, in particular on how to allocate shares of the available resource base to various actors, as well as on the link between a CE and one specific planetary boundary, namely climate change.

## About the NRP 73

This research project is part of the National Research Programme “Sustainable Economy: resource-friendly, future-oriented, innovative” (NRP 73) of the Swiss National Science Foundation (SNSF).

NRP 73 aims to generate scientific knowledge about a sustainable economy that uses natural resources sparingly, creates welfare and increases the competitiveness of the Swiss economy. NRP 73 takes account of the environment, the economy and society as well as all natural resources and stages of the value chain.



**Sustainable Economy**  
National Research Programme

Further information on the National Research programme can be found at:  
[www.nfp73.ch](http://www.nfp73.ch)

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## About the LACE

The Laboratory for Applied Circular Economy (LACE) is an inter- and trans-disciplinary project that gathers researchers from three Swiss higher-education institutions, and from various disciplines: environmental and material sciences, business administration, as well as law and political sciences. The LACE project is working together with seven well-known partner companies in order to show how the resource-efficient patterns of the circular economy and related business models can be introduced into the value chains of the participating companies. The aim of this project is to demonstrate that the principles of circular economy can be ecologically beneficial and profitable for Swiss companies. The sanu durabilitas foundation is knowledge-transfer partner of the LACE project.



Further information on the Laboratory for Applied Circular Economy can be found at:  
[www.nrp73.ch/en/projects/circular-economy/laboratory-for-circular-economy](http://www.nrp73.ch/en/projects/circular-economy/laboratory-for-circular-economy)

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## About sanu durabilitas

The sanu durabilitas foundation is an independent Think and Do Tank based in Biel/Bienne. Its aim is to develop new practice-oriented and effective solutions for the transition towards a sustainable Switzerland which are being applied in economy, policy and public administration, and also to improve the institutional framework conditions for sustainability. In collaboration with partners from research, business, politics, administration and civil society, sanu durabilitas identifies promising solutions, develops them further, tests their application in the field, draws up recommendations, and brings them to the attention of decision-makers and the general public. The current focus areas of sanu durabilitas are circular economy, sustainable use of soils, and social cohesion in a changing society.



Further information on sanu durabilitas can be found at:  
[www.sanudurabilitas.ch](http://www.sanudurabilitas.ch)

