Innovation and Circular Economy in Mountain Forest Supply Chains: How to Close the Loop?
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Circular economy and sustainable development with a focus on Southeastern Europe

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Conventional anthropocentric development paradigm

- Past development of modern industrial society was determined by anthropocentric development paradigm which perceives nature exclusively as a tool to satisfy human needs
- Positioning a person in the centre of life on Earth led to the emancipation of society from nature and implementation of the concept of infinite economic growth
- It was believed that inexhaustible natural resources will enable production of unlimited quantity of products, and that waste created in the production processes and consummation of these products will never exceed the absorption capacity of the environment

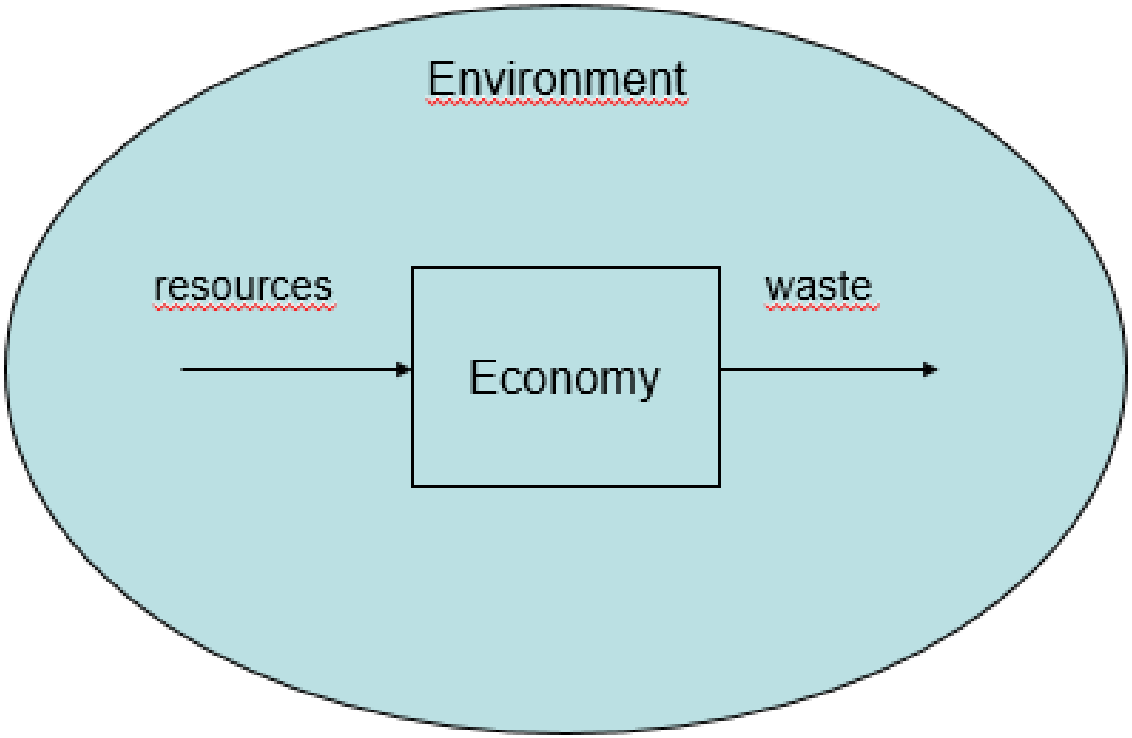
Links between the economy and the environment

- An economy is an area of the production, distribution, trade, and consumption of goods and services by different agents in a given geographical location.
- Economy is connected with the natural environment in 2 ways:

1. Environment is a source of natural resource inputs for economic processes
2. Absorption capacity of environment is a waste sink for materials and harmful emissions which are a by-product of economic processes

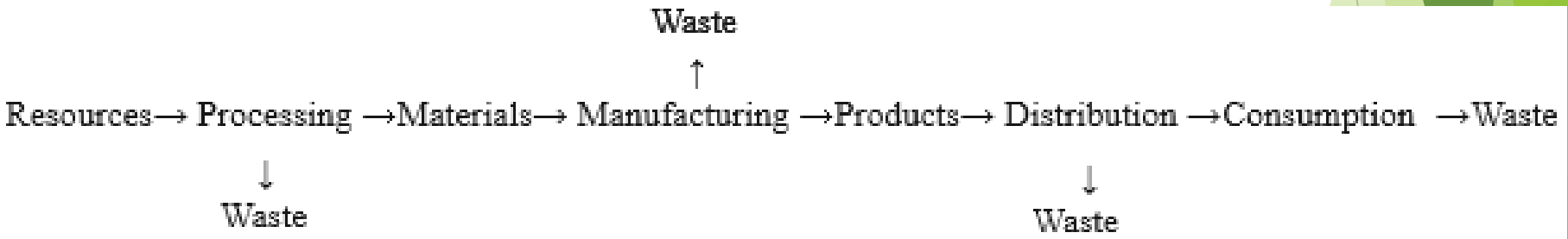
Links between the economy and the environment

- From the perspective of the flow of energy and materials, the traditional industrial economy is a one-way linear economy



Links between the economy and the environment

- A linearly structured economic system functions in the manner to receive the inflow of natural resources which, in processing, manufacturing and consumption processes, is transformed into waste and harmful emissions which are not biodegradable and economically useful



Characteristics of the traditional linear economic system

- Linear technical production cycle
- Use of easily available and " cheap " material inputs, regardless of their environmental effects
- Waste management at the end of the production process
- Minimum liability of economic entities for negative environmental impacts
- Economies of scale and mass distribution of products which are permanently disposed of in landfills or incinerators at the end of their life cycle
- Subsidizing infrastructure that accelerates the extraction of natural resources
- Profit is made exclusively through the increase in production and sales (short lifetime of the product increases sales !!!)

Growth limits of linear economy

- Economy is not an isolated system so growth of economic activities without a increase in material and energy consumption is utterly impossible and yet unrecorded in history
- Degradation of the environment refers to overexploitation of natural resources, and pollution of the environment represents the excessive use of its absorption capacity.
- Since natural resources and environmental containers represent a factor provided by nature for processes of human production and consumption, degradation and environmental pollution are two sides of the same process, excessive exploitation of natural environment with the purpose of economic growth

Growth limits of linear economy

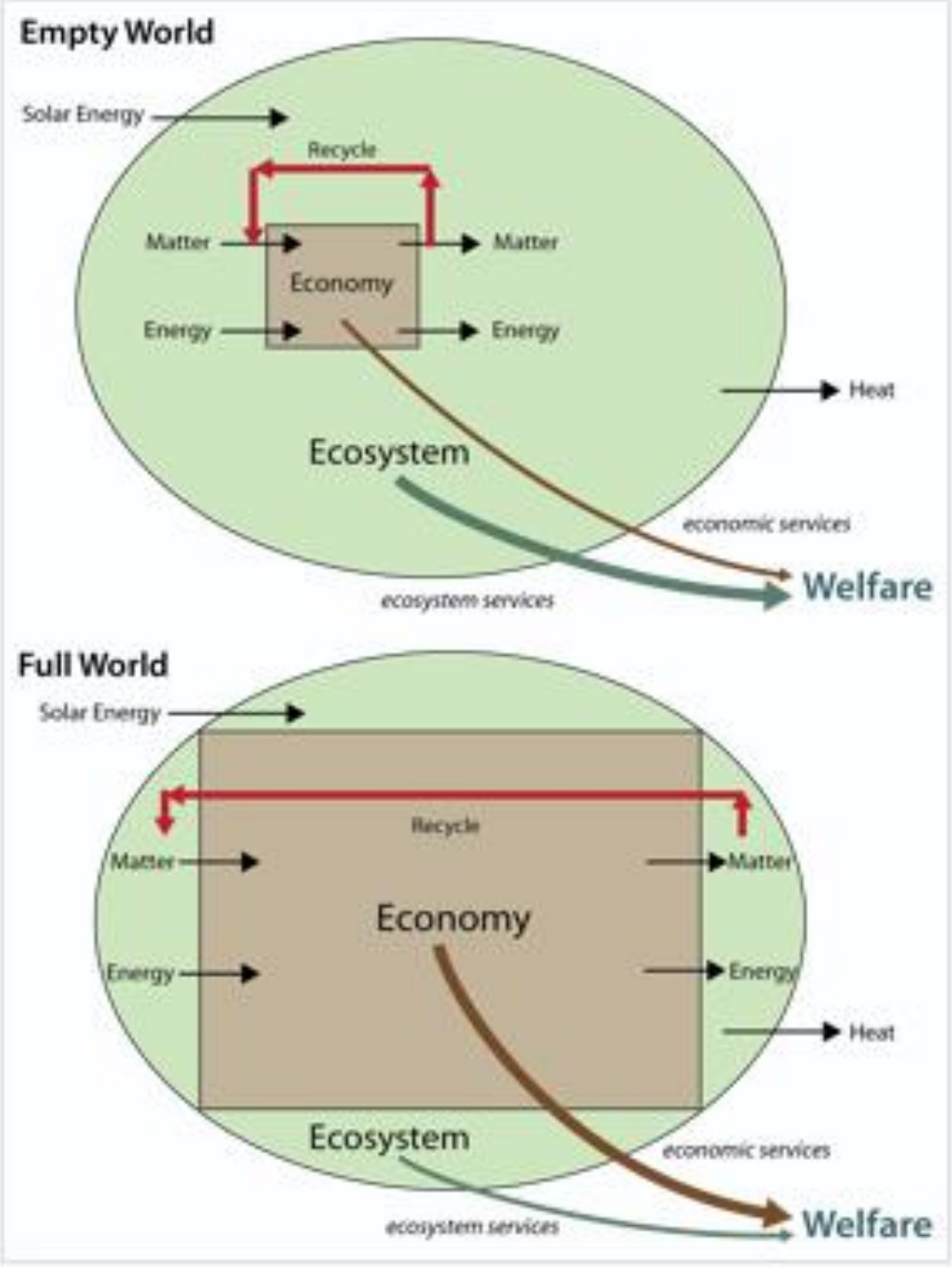
- All the energy and material flows between economy and environment are determined by unchangeable ***laws of thermodynamics*** which represent a key for deeper understanding of ecological limits of economic growth.
- The first law of thermodynamics refers to the phenomenon of residual flows of economic activity and is directly connected with the environmental pollution issue. The second law of thermodynamics, the law of entropy, is connected with the problem of scarcity of resources.

1st law of thermodynamics

- The first law of thermodynamics says that total energy and matter in the universe is finite. Energy cannot be created nor destroyed, but can only transform from one form into another. This means that total quantity of matter/energy that is entered into any production process must be equal to the quantity of matter/energy after this production process.
- For example, in coal-fired electricity generating plant the coal is heated which produces electricity. A by-product of this process is waste heat that is transported away as cooling water or gases. In addition, various waste gases are emitted into the atmosphere, which cause pollution, such as acid rain.
- If Earth is viewed as a system governed by the laws of thermodynamics, pollution of the environment is, in fact, a consequence of non-efficient conversion of natural resources into finished products. Thus, environmental pollution is not only a consequence of thoughtless and irresponsible human behaviour, but also inevitably follows economic activity.

2nd law of thermodynamics

- The second law of thermodynamics states that the total entropy in isolated systems is constantly increasing, i.e. usable energy is continuously converted into useless. In order to reduce the entropy in a natural or a man-made system, it is necessary to ensure introduction of energy and material into this system, which directly increases the entropy in its surroundings. Given that the process of entropy is irreversible, satisfying the continuously growing global energy and natural resources needs implies (inevitable) reduction of energy potential of the Earth.
- Thus, the second law says that as long as there is utilisation of material inputs and energy for production and consumption activities, the level of entropy will be high. Economic activity helps to convert low entropy resources and energy into high entropy wastes i.e., resources into wastes. So, becuse of linear economy and constant transformation of natural resources into energy, and useful energy into non-useful, there is less and less useful energy on Earth.



Growth limits of linear economy

Are the production factors really perfect substitutes???

$$Q = K^{a1} R^{a2} L^{a3}$$

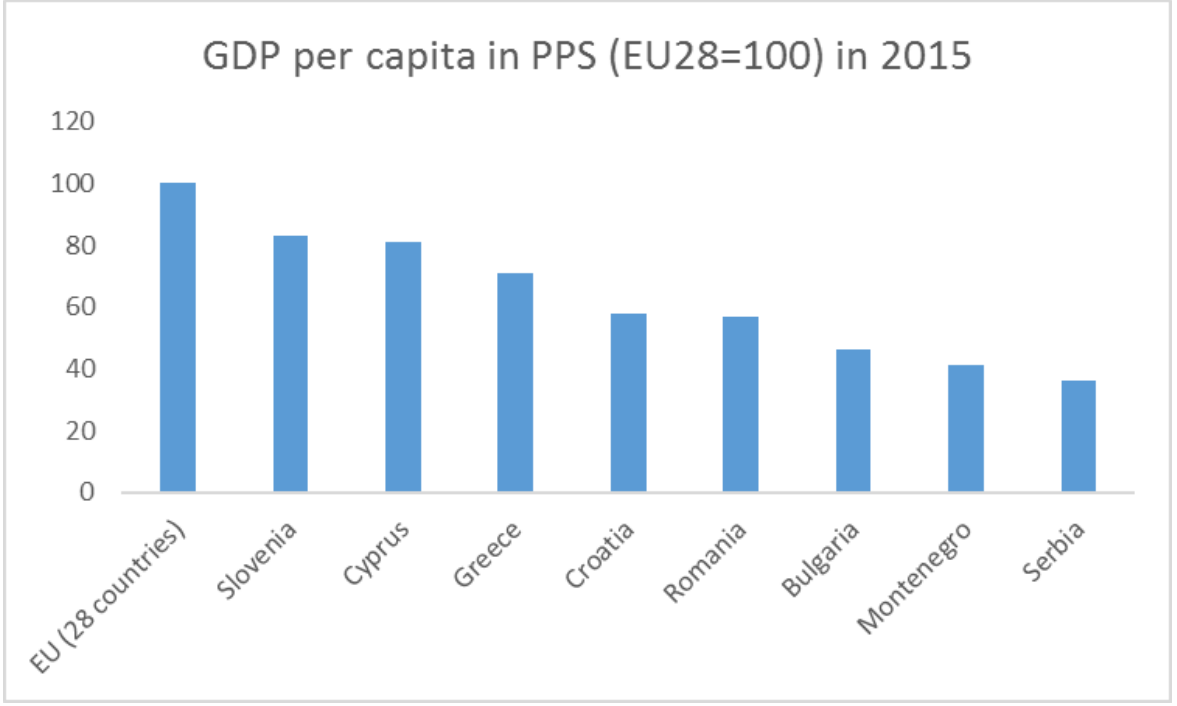
Q = output
L = labour force
K= produced capital
R = natural resources
a1 + a2 + a3 = 1

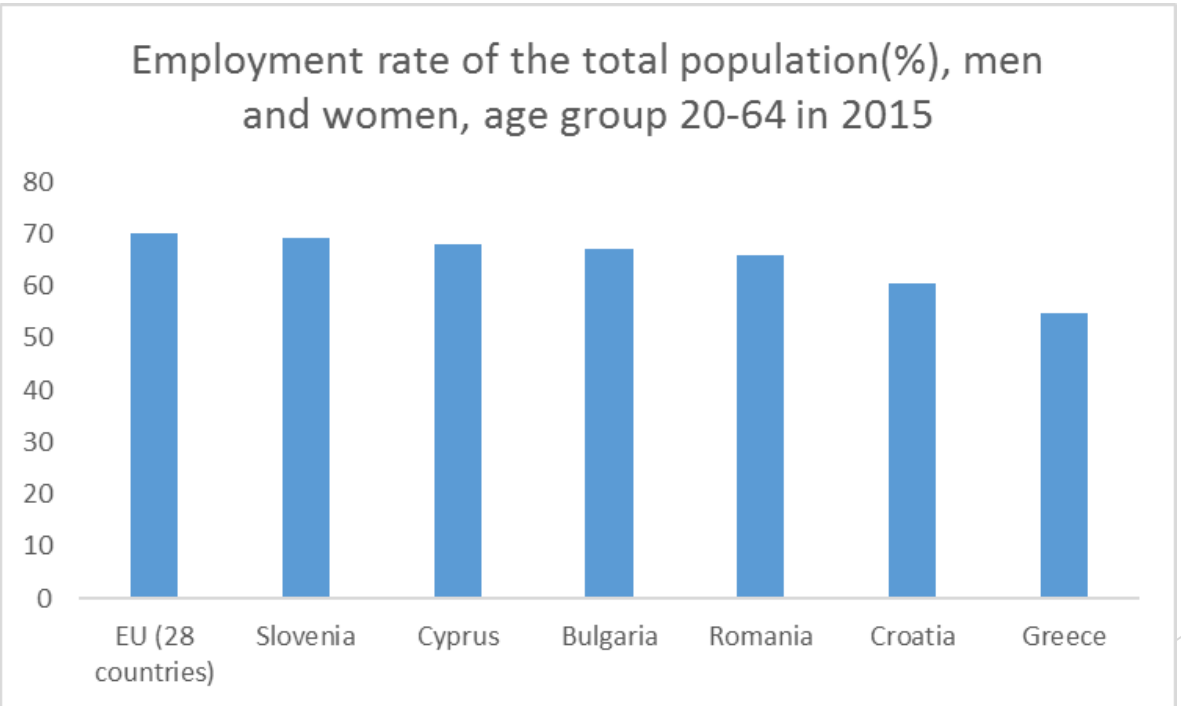
According to economists from the neo-classical school, the socalled “technological optimists”, unlimited substitution is allowed between natural and produced capital because technological development will provide the adequate substitutes when natural capital becomes scarce.

Are the production factors really perfect substitutes???

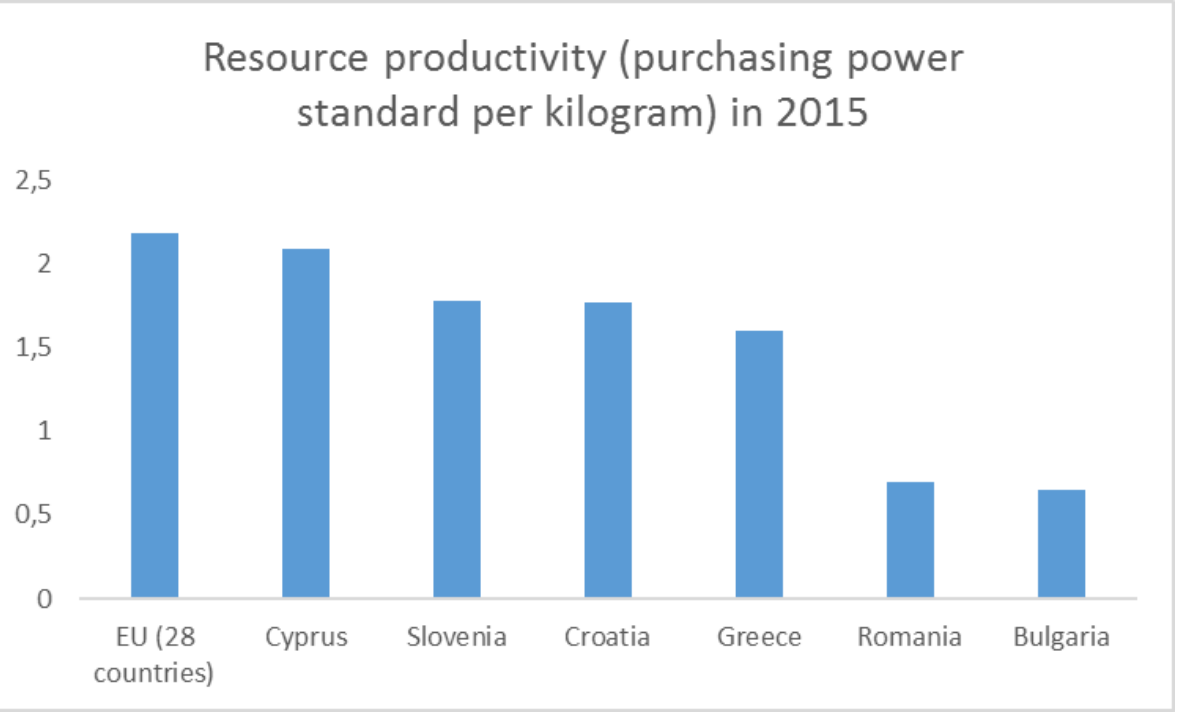
- However, in reality, an increase in produced capital causes additional spending of natural resources. So, if unlimited substitution between natural and produced capital were allowed, natural resources would eventually be exhausted because of creation of produced capital.
- Labour and capital are merely the factors of transformation of natural resources and are not physically integrated in the final output; thus, in the production process, only various forms of labour and capital, or various natural resources, may be substituted, while interrelation between production factors and natural resources is fundamentally complementary

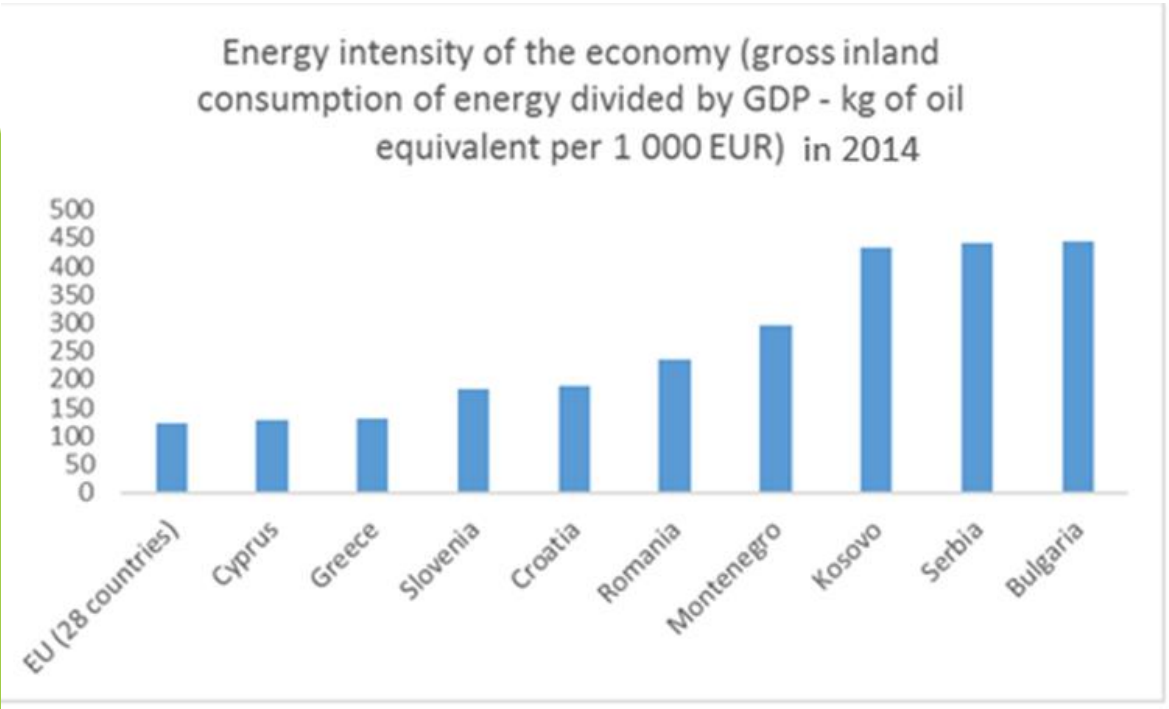
Effects of linear economy in Southeast Europe





Source: Eurostat





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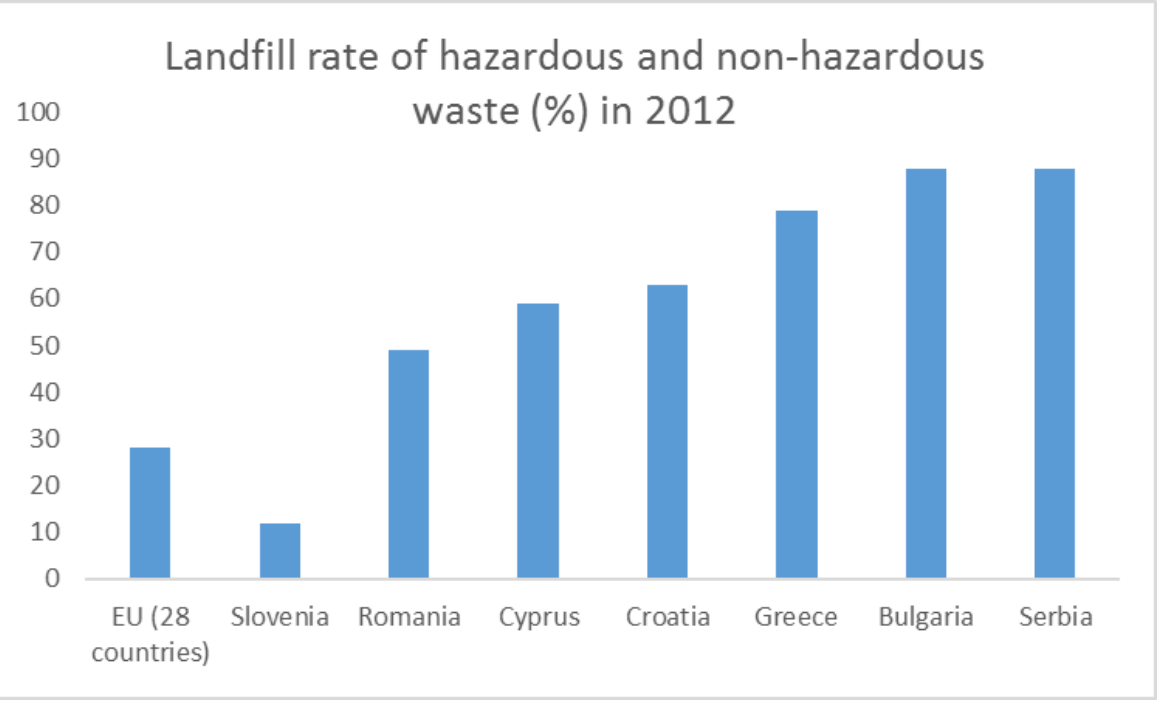

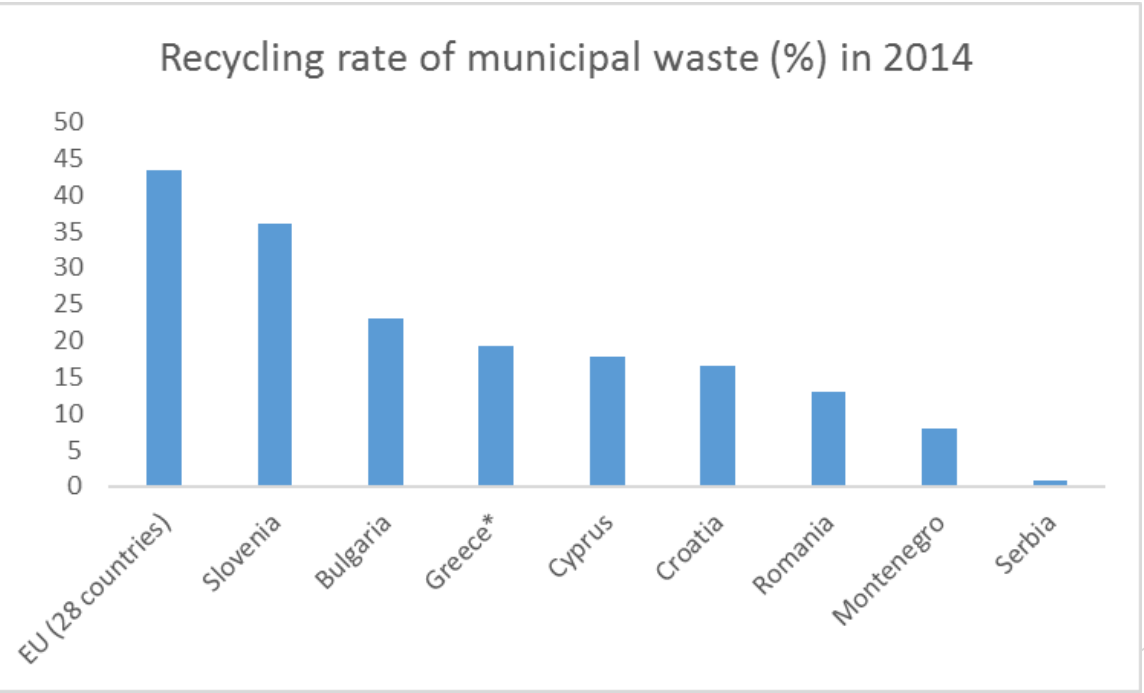

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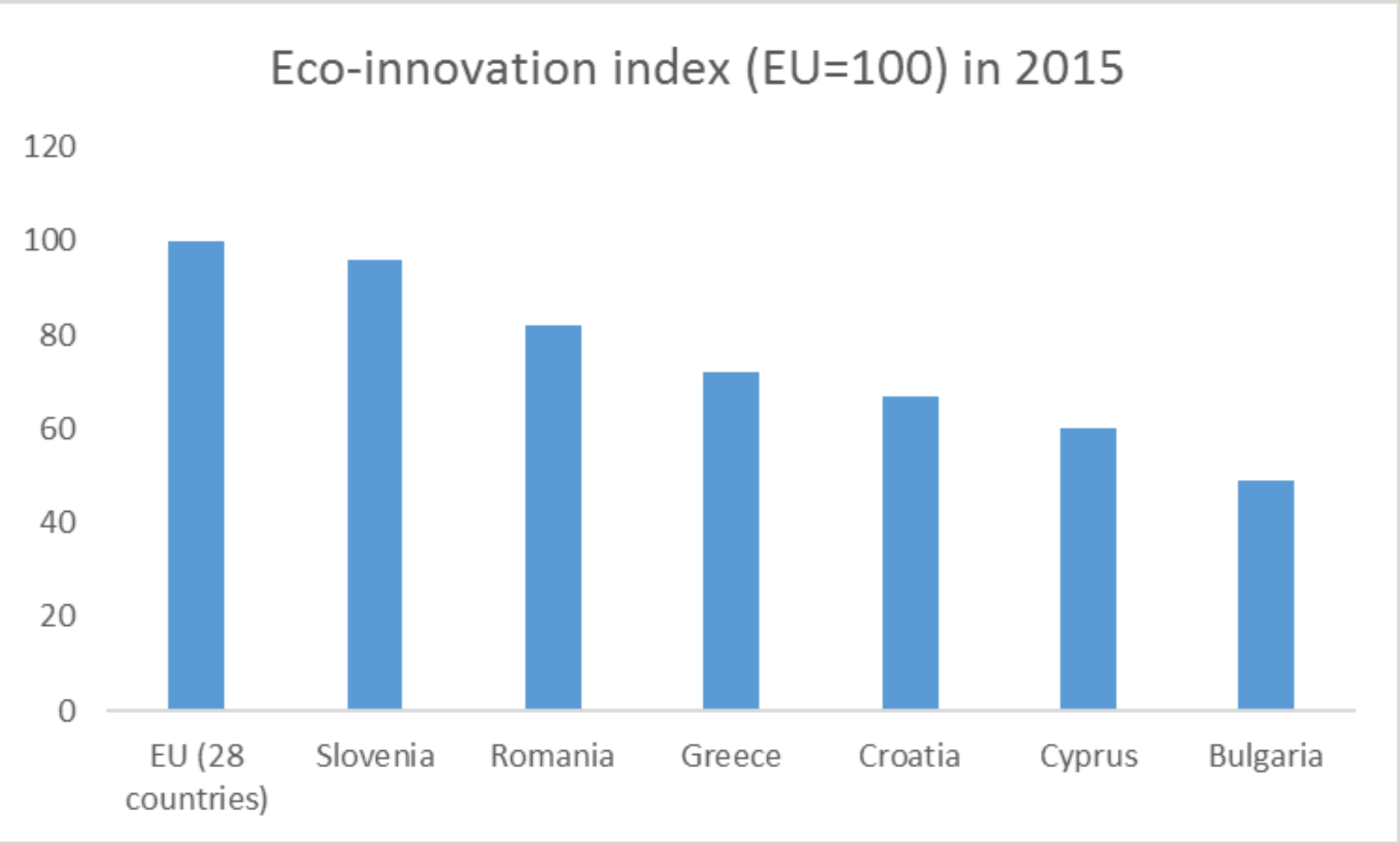


Source: Eurostat

The need for a new development model

- Due to the limited absorption capacity of the environment and the increasing reduction of the original ecosystem, the concept of economic growth has become fatal for the environment
- In the long run, sustainable economy may exist only in a sustainable symbiosis with the natural system, upholding natural laws and respecting natural limits of economic growth.
- **From the aspect of economic activities this implies abandoning the dominant paradigm of linear economy, and acceptance and implementation of the circular economy as a new development model!!!**

Circular economy

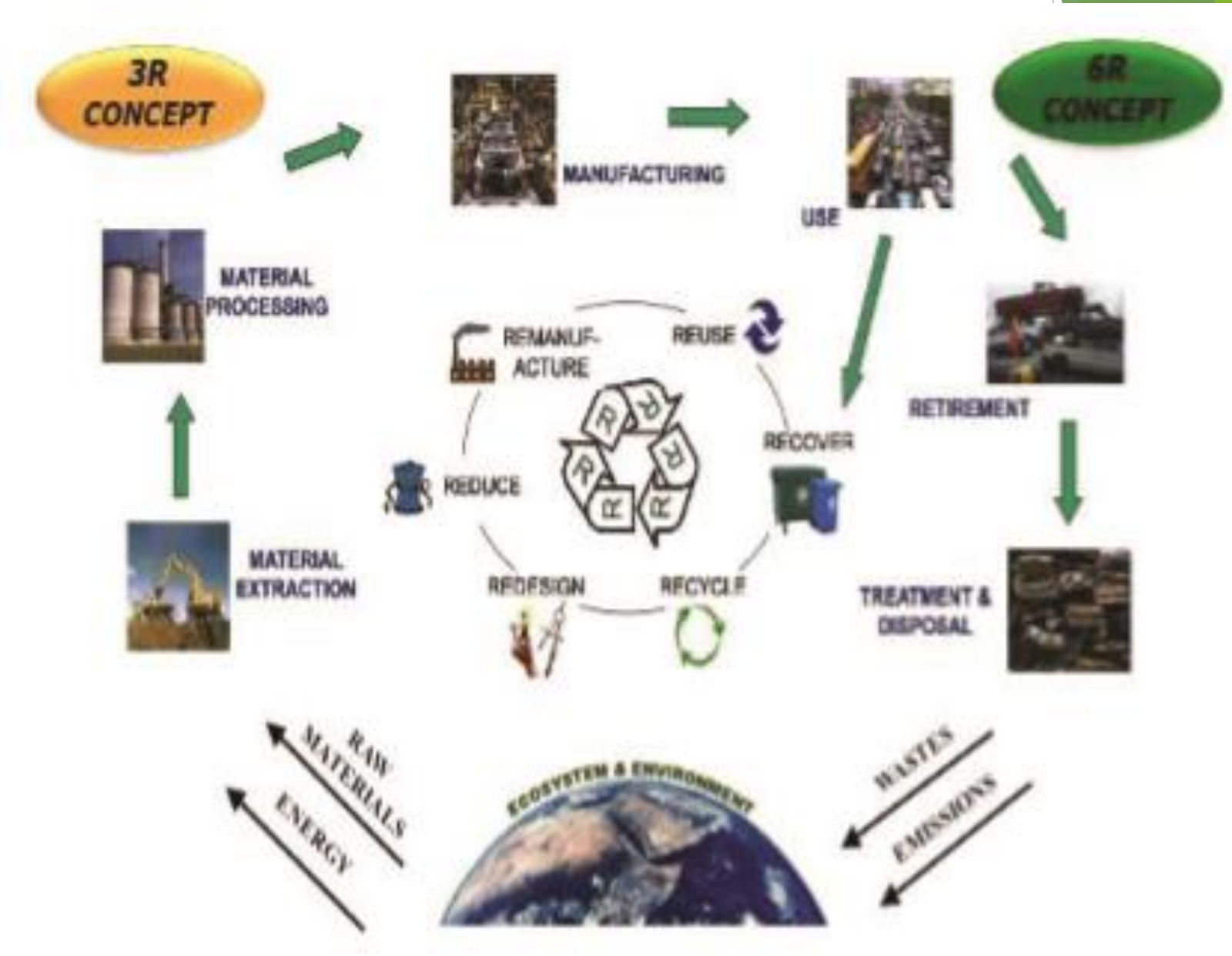
- The concept of circular economy began to develop during the 60s of the last century
- It is believed that the book American economist Kenneth E. Boulding ***The Economics of the Coming Spaceship Earth*** is the earliest theoretical presentation of the circular economy.
- Boulding in his book examines the relationship of the economic system to limited supply of raw materials and concludes that man must find his place in a cyclical ecological system which is capable of continuous reproduction materials.

Circular economy

- Circular Economy is based on the optimization of material flow (raw materials, biomass, water, waste, energy, etc.) Within the economic system. The goal is to minimize the accumulation of harmful waste and ensure the availability of stable input for future production processes.
- Circular economy is a system of production, distribution and consumption which is based on the 6R principle:

1. ***Reduce*** - reduce the intake of new materials and energy
2. ***Reuse*** - increase the usability of the product, equipment and services
3. ***Recycle*** - reduce the amount of waste
4. ***Recover*** - collecting products at the end of the use stage, disassembling, sorting and cleaning for utilization in subsequent life-cycles of the product
5. ***Redesign*** - use of components, materials and resources recovered from the previous life-cycle of products
6. ***Remanufacture*** - re-processing parts and components of already used products for the reuse without loss of functionality

6R-based closed loop system for sustainable manufacturing



The life cycles of products in the circular economy

- **The biological cycle** - based on the use of biodegradable materials in the production. Biodegradable products can be safely disposed of in the nature because they have properties that do not degrade the natural ecosystems
- **Technical cycle** - the products are designed in such a way that they can be fully utilized after their life cycle

Key Challenges in a transition from a linear economy to a circular economy

- Develop research and eco-innovation
- Develop production and use of renewable energy and materials
- Modify existing products and production processes
- Implement Zero waste concept
- Develop complementary and holistic national action plans
- Establish an integrated environmental economic accounting system for measuring and monitoring economic and material flows in the economy

Thanks for your attention