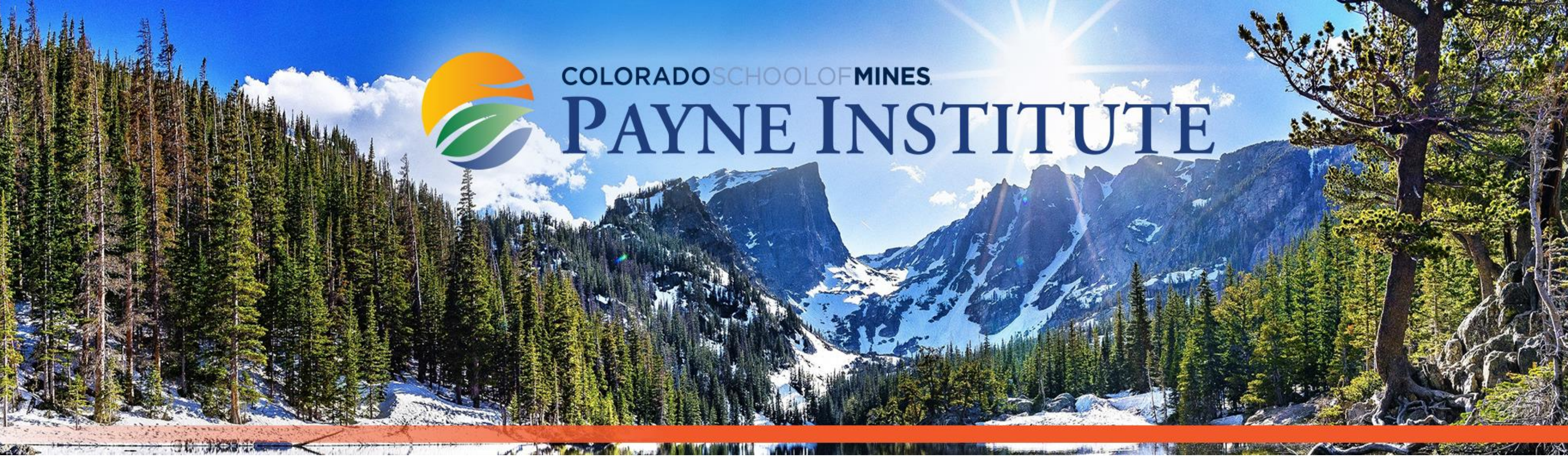




# CIRCULAR ECONOMY FOR THE ENERGY TRANSTION

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**C**ircular economy is a term that has recently emerged. The Ellen McArthur foundation defines it as "A framework for an economy that is restorative and regenerative by design". In the past other names such as dematerialization or industrial ecology have been used for the same concept.

The traditional pattern of production, distribution and consumption is linear: a producer manufactures a product by using primary raw materials, subsequently the product is distributed to the end user for consumption and finally the product is disposed as waste where its building blocks are only minimally recovered. The linear economy has negative impacts on the economy and environment as it relies on a continuous supply of virgin resources, omitting the utilization of the value in waste products and the synergies between the different sectors and stages of the economy.

Transitioning to a circular economy does not only amount to adjustments that will mitigate the negative impacts of the linear economy. The concept of circularity has deep historical and philosophical origins. Its potential is significant. Ernst von Weizsacker, Amory and Hunter Lovins proposed in 1997 a factor four a guiding improvement potential for doubling wealth and halving resource use.

The concept of a circular economy is very much related to the management of physical flows. Circular flows are better from an environmental perspective because they reduce the need to extract primary resources, and they reduce the need to dispose of waste. Circular flows can also reduce energy needs. For example recycling of materials is often more energy efficient than production of primary materials from natural resources. In an earlier Payne Institute CSM working paper we have elaborated the potentials on a global scale. A reduction of 50% and more of energy and resource use can be achieved for many sectors and products. In addition, the same material can be recycled several times without losing quality properties. Finally, there is often a sound economic reason for recycling that can create additional revenue streams for businesses.

Priorities and drivers to circular economy differ across countries. For instance, Japan has one of the most energy and resource efficient manufacturing industries in the world because of its limited indigenous natural resources, a policy driver for decades. The topic is gaining more international attention. For example the Group of Seven (G7) countries have established the Alliance for Resource Efficiency under the German Presidency in 2015.

Recycling, reuse, materials substitution, more materials efficient designs, use of sustainable biomass resources are all part of this concept. Circular economy is therefore closely related to the concept of energy transition that builds on the two pillars of energy efficiency and renewable energy.

Various tools exist that can help to understand circular economy concepts and their relevance for energy transition:

- Industrial ecology - Materials flow analysis and environmental product life cycle analysis
- Partial equilibrium technology rich systems engineering models that combine energy and material flows

The concept of circular economy is especially relevant for the manufacturing industry. The production of a few energy-intensive commodities account for the bulk of global industrial energy use. Circular economy adds to the list of strategies that can be deployed to reduce related energy use and CO2 emissions.

The most common example of circular economy relates to recycling. Another option is reusing parts of a good after consumer use. Alternatively, worn parts of a good can be repaired or remanufactured before turning into new end products (re-use). There are several examples today that demonstrate how industry creates value from such circular economy.
For example several car manufacturers have standardized the production of various car components across their different models. Once cars are scrapped, standard components are either reused as a spare or turned into new products through remanufacture. This reduces costs, increases resource efficiency and saves the valuable embodied energy in car components.

New forms of environmentally friendly plastics produced from biomass feedstock save on oil use and reduce carbon dioxide emissions. Production of platform chemicals from biomass is technically feasible and it is done of a commercial scale today. But this is generally not economic at today's oil and gas prices. A fundamental rethink is needed how to adjust pricing and regulations in order to create the right incentives.

Also use of residues and by-products offers interesting opportunities. In dairy and meat production, waste by-products are processed into biogas for on-site generation of electricity and process heat. Another recent example is the use of plastic waste in blast furnaces as a reducing agent in iron production. Such opportunities are not yet fully utilized, in some cases further development is needed for example in the use of steel slag for cement making.

Circular economy makes often economic sense. But this is not always the case. An example is plastics recycling. In Germany extensive and costly recycling systems were established more than 25 years ago. Yet in Germany waste volume is the highest in Europe, 626 kg per capita in 2016, including 222 kg of packaging waste and 38 kg plastic packaging waste. This amount has risen by 11% between 2005 and 2016. 66% of this waste is collected for recycling. The recycling rate is much higher for paper and board and glass than for plastics. Nearly 50% of plastic packaging waste is recycled, the other half is incinerated.

The general trend is not towards a less resource intensive circular economy. Economic growth is one reason: German packaging waste volume is four times that of the best European country, Croatia. The internet economy, home delivery industry is showing phenomenal growth but clearly adds to the packaging waste problem. The amount of packaging waste is on the rise. Germany does have the biggest collection system for reusable PET and glass bottles worldwide but an ongoing trend is moving toward single-use bottles.

In addition to managing physical flows, behavior change can accelerate the transition to a circular economy. Collaborative use of services like car sharing in cities and home sharing during holidays can all contribute to savings on energy and reduce the negative environmental impacts from the manufacture of new products to be used in buildings and transport equipment.

Clearly there is a need for policy to steer this development in a different direction. Both economic and regulatory instruments can be used. It is encouraging to see the efforts to eliminate plastic bags in many countries including Rwanda and Kenya. In Europe, recent legislation will eliminate or significantly reduce the use of single-use plastics.

New regulatory frameworks, new financing tools and even digital marketplaces for the management of a circular economy will be needed. A societal rethinking will be essential to promote customer interest and acknowledge the value that can be created by shifting from linear to circular economy. It will be important to understand and quantify the impacts of circular economy on the economy, environment and the society such as: How much resources can we save on raw materials and water? How will the quality of new materials look under a circular economy and how can we measure these? How does the labor intensity of different economic activity change? What are the impacts of circular economy on social wealth and well-being of the citizens? How can innovations between large-scale industrial players be linked with the crucial efforts undertaken by the small- and medium-sized enterprises?

On conclusion, circular economy holds promise of significant energy and climate benefits. But there is a need to enhance the understanding of its techno-economic potentials and progress measurement. A renewed effort is needed to put theory into practice. The need to limit climate change to 1.5 degrees, as recommended by IPCC, makes this even more urgent.

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